UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

September 29, 2011

EPA-SAB-11-016

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Review of EPA's Draft Oil Spill Research Strategy

Dear Administrator Jackson:

The Environmental Protection Agency's (EPA) Oil Spill Research Program conducts research under the Oil Pollution Act of 1990. The response efforts to the Deepwater Horizon oil spill highlighted the need for additional research to prevent spills, evaluate new spill response technologies, investigate the human health and ecological implications of deepwater oil spills, assess the use of dispersants, and estimate the acute and chronic health risks for spill response workers and the public from oil spills and spill mitigation.

To respond to these research issues, the EPA developed the *Draft Oil Spill Research Strategy* for FY12 through FY15 to present a research approach on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents and other mitigation measures. The goal of the research outlined in the Strategy is to provide environmental managers with the tools, models and methods needed to mitigate the effects of oil spills in terrestrial and aquatic systems in coastal, inland, and marine environments. The EPA's Office of Research and Development (ORD) requested the Science Advisory Board (SAB) to review and provide advice on the proposed research initiatives, as described in the EPA *Draft Oil Spill Research Strategy*. The SAB Staff Office formed an *ad ho*c panel, the Oil Spill Research Strategy Review Panel, to conduct this review. The charge to the SAB included questions about the proposed science questions, research activities and research outcomes outlined in the Strategy.

The SAB acknowledges the thoughtful effort made by the EPA to identify research needs for the Oil Spill Program. However, much work remains. The Strategy proposes EPA activities and identifies possible interagency research activities and collaboration, however, the Strategy is not clear on which agency will have primary responsibility for key research activities and how coordination will occur. In addition, it is not clear how the Strategy will be incorporated into ORD's new Integrated Trans-disciplinary Research approach. The EPA should incorporate this research into ORD's new approach and more clearly define its role and responsibilities for research that supports oil spill prevention, remediation and restoration as well as its mechanisms for coordination with other agencies. The SAB concludes the EPA needs to communicate effectively among the interagency partners, collaborators and oil spill decision makers to develop the needed research. The lack of clarity about which agency is in the lead for a research area, what roles collaborators have and the scope and goals of the research creates an uncertainty in whether the EPA will have the research results it needs to support decision makers during an oil spill response effort. The SAB recommends that the EPA should also identify priority research needs and distinguish between short- or long-term research activities.

The Strategy briefly outlines four research themes (dispersants, ecosystem impacts, innovative processes and technologies and human health impacts). The research on dispersants needs to more comprehensively define the efficacy of a dispersant and the ecological and toxicological endpoints that are being evaluated. In addition, dispersants and oil mixtures should be considered as a system recognizing that dispersants and other agents will perform differently in different environments and when reacting with different oil types. Finally, novel mechanical methods and chemical treatment agents (CTAs) for alcohol biofuel and alcohol-blended fuel spills merit attention because of the pronounced chemical differences from extant hydrocarbon fuels. The growing trends in production and large-scale transport of alcohol biofuels will increase the need for research in this subject.

Assessing the ecological effects of oil spills on shorelines, coastal and inland ecosystems requires a baseline characterization of ecosystem functions. Without baseline monitoring data and information the remediation and restoration efforts are difficult to assess and difficult to quantify. The Strategy should include a plan for baseline data collection, documentation, storage and easy retrieval by the EPA or other agencies. This baseline should include the identification of prototypical terrestrial, freshwater, coastal and marine ecosystems, and the development of indicators that can be used to evaluate post-spill ecosystem response and recovery.

The Strategy should further articulate the research for the key exposure pathways, (i.e., water, food and sediment) for human and ecological exposures. Exposure duration and pathways will vary depending on the exposed population under consideration. Human exposure will vary between oil spill response workers and residents of adjacent communities. Ecological populations and communities, as well as human populations, will also have different exposure scenarios and pathways that should be considered depending on site of the release and ecological community.

Environmental justice is implied in several of the Strategy's research themes. The SAB recommends explicit inclusion of environmental justice considerations in the Strategy. The Agency should identify the decision context(s) and key scientific questions for consideration within the Strategy's research themes and develop appropriate research topics.

Oil spill prevention is not discussed in the Strategy, presumably because this prevention research will be managed by other agencies. Nevertheless, the Pollution Prevention Act of 1990 establishes prevention as the nation's primary pollution management strategy. The Strategy should explicitly recognize the importance of prevention, even if the research on prevention is to be managed by other agencies.

Finally, the SAB recognizes that these themes are complex and inter-related. The SAB recommends that the Strategy develop approaches for integration of the research themes and develop mechanisms for adapting and updating the Strategy as lessons are learned from on-going oil spill responses.

In closing, the SAB encourages the EPA to continue efforts to identify and prioritize oil spill research and collaborate with its interagency partners to develop the best available science to support oil spill prevention, response, remediation and restoration efforts. We appreciate the opportunity to provide advice on this important research and look forward to your response.

Sincerely,

/Signed/	***/Signed/***
Dr. Deborah L. Swackhamer, Chair Science Advisory Board	Dr. David T. Allen, Chair SAB Oil Spill Research Strategy Review Panel

NOTICE

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Oil Spill Research Strategy Review Panel

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Mr. Thomas Carpenter, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board (1400R), 1200 Pennsylvania Avenue, NW, Washington, DC, Phone: 202-564-4885, (carpenter.thomas@epa.gov)

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Dr. Robert Watts, Professor of Mechanical Engineering Emeritus, Tulane University, Annapolis, MD

Dr. R. Thomas Zoeller, Professor, Department of Biology, University of Massachusetts, Amherst, MA

SCIENCE ADVISORY BOARD STAFF

Dr. Angela Nugent, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board (1400R), 1200 Pennsylvania Avenue, NW, Washington, DC, Phone: 202-564-2218, Fax: 202-565-2098, (nugent.angela@epa.gov)

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Acronyms and Abbreviations

BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
CDC	Centers for Disease Control and Prevention
CTA	Chemical treatment agents
DHS	Department of Homeland Security
DMF	Decision management framework
DOI	Department of the Interior
DWH	Deepwater Horizon
EBRS	Event-based Research Strategy
EPA	Environmental Protection Agency
FOSC	Federal On-Scene Coordinator
ICCOPR	Interagency Coordinating Committee for Oil Pollution Research
ITR	Integrated trans-disciplinary research
NCP	National Contingency Plan
NEBA	Net environmental benefit analysis
NIEHS	National Institute of Environmental Health Sciences
NIOSH	National Institute of Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
ORD	EPA Office of Research and Development
PAHs	Polycyclic aromatic hydrocarbons
SAB	Science Advisory Board
SAMSHA	Substance Abuse and Mental Health Services Administration
SPCC	Spill Prevention Control Countermeasures
USCG	United States Coast Guard

1. EXECUTIVE SUMMARY

The Environmental Protection Agency's (EPA) Oil Spill Research Program has conducted research since its authorization under the Oil Pollution Act of 1990 (OPA). The three primary agencies with which the EPA collaborates on oil spill-related research are the United States Coast Guard (USCG), the National Oceanic and Atmospheric Administration (NOAA) and the Department of the Interior's (DOI) Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). Each of these agencies has specific roles and responsibilities defined under OPA.

The EPA has regulatory authority over onshore and offshore non-transportation related facilities and requires them to have to have spill prevention, control and countermeasure (SPCC) plans and facility response plans. The Agency sets policy and guidance for the proper use and authority to use products on oil spills as defined in the National Oil and Hazardous Substances Pollution Contingency Plan Final Rule, Subpart J Product Schedule (40 Code of Federal Regulations Part 300.900). The National Contingency Plan (NCP) lists dispersants, surface washing agents, bioremediation agents, surface collecting agents and miscellaneous oil spill control agents that may be used in response to oil spills on land and on or near waters of the U.S., depending on the product and its proper application.

OPA also established the Interagency Coordinating Committee for Oil Pollution Research (ICCOPR) to coordinate oil spill prevention and response research. ICCOPR fosters cost-effective research with mechanisms that include the joint funding of the research and submission of a biennial report to Congress on activities carried out in the preceding two fiscal years and on activities proposed to be carried out in the current two fiscal year period.

The Deepwater Horizon (DWH) spill highlighted the need for additional research for spill prevention and response technologies. It raised questions relative to the use of dispersants in oil spill remediation, acute and chronic health effects for spill response workers and the public, whether new innovative technologies were available, and what are the most effective steps to restore coastal, shoreline and inland areas impacted by spills.

To respond to these research issues, the EPA developed a research strategy on potential human and environmental risks from oil spills and the application of dispersants, surface washing agents, bioremediation agents and other mitigation measures for FY12 through FY15. The *Draft Oil Spill Research Strategy*, hereafter referred to as the "Strategy," addresses four research themes: dispersants; ecological effects; innovative processes and technologies; and human health effects. The goal of the research is to provide environmental managers with the tools, models and methods needed to mitigate the effects of oil spills on terrestrial and aquatic ecosystems in inland, coastal, and marine environments. The EPA's Office of Research and Development (ORD) requested the Science Advisory Board (SAB) to review and provide advice on the proposed research initiatives, as described in the Strategy. The SAB Staff Office formed an *ad hoc* panel, the Oil Spill Research Strategy Review Panel, to conduct this review.

The Panel held a public teleconference to review the Strategy on April 11 - 12, 2011 and a follow-up public teleconference on June 9, 2011. The final report was reviewed by the chartered SAB on July 28, 2011.

The SAB responded to three charge questions in its deliberations. Charge questions 1 and 2 are closely related and the responses are provided below in an integrated summary.

1. *Does the draft Oil Spill Research Strategy encompass the most important research needed to enable EPA to better carry out its mission to prepare for and respond to oil spills, including future challenges such as biofuels discharges? Does the draft strategy appropriately address greener alternatives and innovation?*
2. *Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?*

The SAB acknowledges the thoughtful effort that already has been made by the EPA to identify the research needs for the Oil Spill Program. However, much work remains. The Strategy, presents interagency research activities and possible collaboration, but is unclear what research will be conducted by which agency and how the Strategy will be incorporated into the Office of Research and Development's (ORD) new Integrated Trans-disciplinary Research (ITR) approach. The EPA should incorporate the oil spill research into the new approach and more clearly define its roles and responsibilities for research that supports oil spill prevention, remediation and restoration and the mechanisms for coordination with other agencies. The EPA needs to communicate effectively among the interagency partners, collaborators and oil spill decision makers. The lack of clarity about which agency is the lead, the roles of collaborators and the scope and goals of the research creates an uncertainty in whether the EPA will have the research results it needs to support decision makers during an oil spill response effort. The EPA should also identify which research needs are priorities and which are short- or long-term research activities.

Although the Strategy is organized by research theme (dispersants, ecosystem impacts, innovative processes and technologies and human health impacts) the SAB recognizes that these themes are complex and inter-related. The SAB recommends that the Strategy develop approaches for integration of the themes and that the integration be a distinct element of the Strategy.

The Strategy's inclusion of green alternatives and innovation in oil spill responses serves as a potential strength of the report. However, the focus on greener alternatives and innovation is primarily focused on use of green chemistry to develop greener dispersants. The SAB recommends that the Agency consider green alternatives in a broader – and more appropriate – context that considers issues of sustainability beyond simply the ecological impact associated with deployment of dispersants.

The Strategy does not specifically mention environmental justice though it is implied in several of the research themes. The SAB concludes it is appropriate to include environmental justice consideration in the Strategy within the Strategy. The Agency should consider environmental justice in the decision context and key scientific questions for "Ecological Ecosystem Services, Health and Well-Being in Gulf Coast Communities." Furthermore, using a systems approach that integrates decision making frameworks and social and behavioral decision science research with research on the impact oil spills potentially have on ecosystems would also address issues of environmental justice.

The SAB acknowledges that there is a great deal of data and information on past oil spill response and remediation. However, changing practices (i.e., increased off shore drilling, extreme conditions under which the hydrocarbon industry is exploring and drilling and the increased use and availability of biofuels) will create new information needs. The EPA and its research collaborators will need to be adaptive in approaches to collect, develop and disseminate the best science to oil spill responders making decisions and answering complex questions, such as whether or not mitigate the release or rely on natural attenuation of the oil spill.

Charge question 3 is comprised of three components and the EPA requested that each of the four research themes outlined in the Strategy be examined (dispersants, ecosystem impacts, innovative processes and technologies and human health impacts). The SAB's recommendations on each research theme are summarized below.

3. Within each theme:

a. *Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.*
b. *Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?*
c. *Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.*

Dispersants

The research on dispersants needs to clearly define the efficacy of a dispersant and the endpoints that are being evaluated. Dispersants and other agents will perform differently in different environments and when reacting with different oil types. Dispersants are intended to simply change transport and eventual fate, essentially selecting between surface and shoreline ecological impacts or those in the water column and benthos. In certain cases, the use of dispersants is an irreversible option that may restrict other cleanup options (e.g., containment, burning, mechanical recovery). Without a clear understanding of the trade-offs and consequence of dispersant use a rational decision context is unavailable. The research projects described in the Strategy should also recognize and address the complexity of chemical treatment agent (CTA) and oil mixtures.

Toxicological studies of sub-chronic and chronic exposures to the variable complex dispersant mixtures are necessary. These studies should include naturally dispersed oil, CTAs alone and oil mixed with CTAs for a comparison of actions, effects and impacts. Weathered and fresh oils should be employed for all studies, including toxicity studies. Impact areas, such as benthos and shoreline, should be assessed separately. Considering key population-level effects for human and ecological populations such as those affecting sensitive subpopulations, reproductive success or developmental progress merits incorporation.

Transport and fate studies should include the CTAs in conjunction with the particular oils with which they would most likely be used. Given trends in offshore oil production, specific environments that should be addressed immediately include cold, high-pressure conditions to model cold/under-ice as well as deep-sea (such as what occurred with the DWH blowout) applications.

Alcohol-based biofuel spills are an emerging research priority that should be included because of their qualitatively different environmental transport modes and fate characteristics and the increased utilization of these fuels throughout the U.S. Although dispersants are unlikely to be useful in the case of a pure alcohol spill, because of the high water solubility of alcohols, the utility of dispersants for blended alcohol-hydrocarbon fuel spills are not well characterized. Furthermore, the intense biological oxygen demand that can result from an alcohol spill requires that new types of mechanical recovery and CTAs be developed for effective response.

Shoreline, Coastal and Inland Effects Research to Inform Oil Spill Decision-Making

Research on the ecological effects of shoreline, coastal and inland oil spills requires baseline data to enable comparisons. Effective long-term monitoring of the general health and changing conditions in hydrocarbon extraction, processing, and transportation regions (e.g., the U.S. Gulf Coast) should be improved and emphasized. The Gulf and other extraction regions are affected by numerous natural and anthropogenic disturbances other than oil spills and it is difficult to clearly assign a putative cause to a particular disturbance. Developing baseline data will require a long-term, sustained commitment to coordinated integrated natural system research at a variety of spatial scales and will require the development of a broad suite of indicators that can be used to evaluate an ecosystem's response and recovery.

Among the needs for improved shoreline, coastal and inland effects research are more thoroughly described exposure conditions (including spatial and temporal dynamics) and robust connections between exposure and ecological effects. To characterize risks from specific spill incidents adequately, these linkages should include baseline and background environmental conditions and stresses. Risk assessments building on key exposure-response relationships from laboratory tests where conditions reflect ambient exposures will better inform risk managers regarding the trade-offs following various response and restoration actions.

The research issues associated with shorelines, coastal and inland spill impacts should include population and community perspectives, using an associated decision management framework (DMF) that considers the existing and potential conditions for the region and its biota. This DMF should consider existing contamination, knowledge of local and regional food webs and the recruitment and refugia potential for local habitats. The DMF should also integrate an understanding of population, community and ecosystem recovery capacity. It will be important to link broad toxicology studies outlined in the dispersant section of the Strategy to endpoints that support impact and risk assessments at these higher levels of ecological organization. Single species toxicity studies should provide endpoints to assess population effects and help risk-based decision-making during an event and as part of restoration efforts.

Innovative Processes and Technologies Development

The SAB finds that innovative processes and technologies research should be focused on the EPA's regulatory role in certifying or approving various new approaches. the EPA should engage federal agencies, states and industry in their efforts. If the EPA wishes to encourage the development of new or improved technologies such as better booms, skimmers, absorbent materials, underwater collection methods and surface destruction methods, then specific operational criteria regarding toxicity, biodegradation and discharges should be clearly developed and made a part of the review and evaluation process.

The clarity of the technological development section could be improved by restructuring the text into a more sequenced net environmental benefit analysis (NEBA) type approach. A NEBA is specifically designed to address the environmental trade-offs associated with decisions during all stages of an oil spill response. It should be possible to define the potential regulatory and environmental of positive and negative consequences of different technologies. The agency should develop analyses and methodologies for what may be a limited number of standardized generic environments or incident types. This could also be in the form of a separate implementation plan. A NEBA analysis would help develop a clearer total life-cycle management ethos. This analysis could include the choice of greener clean-up materials and methods, their protocol of utilization and their subsequent greener active disposal by humans or passive degradation in the environment if not fully recovered.

Prevention is not discussed in the Strategy, presumably because this research will be managed by other agencies. Nevertheless, the Pollution Prevention Act of 1990 establishes prevention as the nation's primary pollution management strategy and the EPA has responsibility for prevention for inland spills. The Strategy should explicitly recognize the importance of prevention, even if the majority of the research on prevention is to be managed by other agencies.

Human Health Impacts

It appears from the document that much of the human health research regarding the Gulf Oil Spill will be conducted by federal agencies other than the EPA. The SAB found it difficult to determine from the document which federal agency is charged with conducting the research in specific target areas, as well as the level of commitment of federal partners to complete their portions of the research. While this lack of information regarding interagency coordination was pervasive in the Strategy, its absence was particularly problematic for evaluating whether the research agenda on Human Health Impacts is likely to be successful in meeting the EPA's information needs.

Several key issues are missing from the research strategy. Spills in terrestrial and aquatic ecosystems should include potential human health impacts such as freshwater spills impairing drinking water sources and research to communicate the possible risks. For example, this includes research to develop methods for assessing risk from short-term or intermittent exposure to chemicals, including short duration dermal contact with polycyclic aromatic hydrocarbons (PAHs). Additional research to support exposure assessment for oil spills is needed, including improved methods to estimate dermal absorption of PAHs, exposure information related to scenarios involving contact with water and beach sand/sediment and consumption of seafood from areas potentially impacted by oil spills.

The strategy describes the need for better communication, but does not include any risk communication research. New research in this area should be a priority. The research strategy should also address questions relating to environmental justice. Description of the proposed research projects is sufficiently vague that their potential contribution to evaluation of human health impacts is difficult to determine.

2. INTRODUCTION

This report was prepared by the Science Advisory Board (SAB) Oil Spill Research Strategy Review Panel in response to a request by the EPA's Office of Research and Development (ORD) to review *the Draft Oil Spill Research Strategy*, hereafter referred to as the Strategy.

The Oil Pollution Act of 1990 (OPA 1990; 33USC2701-2761) establishes liability for oil releases and a fund for responding to oil releases as well as restoring natural resources. Section 2761 of OPA 1990 authorizes research and development in multiple federal agencies, including the EPA and establishes the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR; www.iccopr.uscg.gov).

Research needed to implement OPA is delegated to several federal agencies. The EPA is responsible for non-transportation-related onshore facilities and incidents in the inland zone. The United States Coast Guard (USCG) has responsibility for marine transportation-related facilities and incidents in the coastal zone. The Department of Transportation's Office of Pipeline Safety oversees onshore transportation-related facilities. The Department of Interior has responsibility for offshore fixed facilities beyond the coastline. The National Oceanic and Atmospheric Administration (NOAA) is responsible for natural resource damage assessments relating to oil discharges.

The EPA responsibility includes requiring onshore and offshore non-transportation related facilities to have spill prevention, control and countermeasure (SPCC) plans and facility response plans, where applicable. The EPA sets policy and guidance authorizing the proper use of products on the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Final Rule, Subpart J Product Schedule (40 Code of Federal Regulations Part 300.900). The NCP lists dispersants, surface washing agents, bioremediation agents, surface collecting agents and miscellaneous oil spill control agents that may be used in response to oil spills on land and on or near waters of the U.S. depending on the product and its proper application (U.S. EPA 2010a).

The OPA authorizes Congress to appropriate up to $22 million per year among all the responsible federal agencies. ICCOPR published multi-agency research and technology plans in 1992 and 1997 and is presently developing a third update. The research focus of each agency in the 1997 plan generally aligns with its legal and regulatory authorities.

Prompted by the Deepwater Horizon spill in the Gulf of Mexico and its aftermath, the EPA developed a draft research strategy that would address the scientific and technical questions that could enhance the agency's ability to carry out its mission with respect to oil spills both in the short- and longer-term. The draft Strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions (U.S. EPA 2011a). The draft Strategy addresses four themes: dispersants; ecological effects; innovative processes and technologies; and human health effects. Research priorities that are principally the responsibility of other agencies are not included in this draft strategy, but will be considered in ICCOPR planning (see Figure 1-2 in the draft strategy).

The draft Strategy is deliberately not constrained by resource levels. ORD's intent was to develop a strategy that would address the scientific and technical questions that are central to the EPA's mission, recognizing that the research could be conducted by various members of the ICCOPR and others.

Implementation of the Strategy would entail coordination with those entities to ensure appropriate collaboration and leveraging.

ORD requested the SAB to comment on the scope, proposed science questions, research activities and research outcomes outlined in the Strategy. The Charge to the SAB is provided as Appendix A. The SAB Staff Office formed an *ad ho*c panel, the Oil Spill Research Strategy Review Panel, to conduct this review. The Panel held a public teleconference to review the Strategy on April 11 - 12, 2011 and a follow-up public teleconference on June 9, 2011. The final report was reviewed by the chartered SAB on July 28, 2011.

3. RESPONSE TO CHARGE QUESTIONS

The SAB's responses to the charge questions are provided below. Each Charge question is provided at the beginning of the response. Charge questions 1 and 2 focused on the scope of the Strategy in its entirety and whether the Strategy addressed and discussed the research and science that will be needed to support the agency's future challenges. Question 3 focused on each of the four research themes and sought SAB advice on whether the project areas under each research theme addressed the key issues, if there are science questions that should be added or deleted from the Strategy and if the proposed project areas are adequately described. For this question, the SAB responses are organized under each of the charge questions and research themes.

3.1. Current and Future Research Needs Identified in the Strategy

Does the draft Oil Spill Research Strategy encompass the most important research needed to enable EPA to better carry out its mission to prepare for and respond to oil spills, including future challenges such as biofuels discharges? Does the draft strategy appropriately address greener alternatives and innovation?

The SAB generally agrees that the Strategy encompasses the important research needed to enable the EPA to better carry out its mission. The four research themes presented in the Strategy address important research, however, many of the project areas and associated questions under each of the research themes are rather general and it is unclear how the studies will be designed to enable the EPA to carry out its mission. The Strategy needs to specify a plan to integrate data to understand the impacts from previous spills, such as DWH, as information becomes available and focus on broader spill response issues in new potential drilling environments. The SAB concludes it will be difficult for the EPA to assess where the priority research needs exist without a more detailed review and evaluation of current findings from previous, major oil spill studies and assessments of new information generated during the DWH incident. The SAB has identified specific examples of future challenges and additional research needs included these under each of the research themes of the Strategy. The SAB noted that environmental justice and behavioral science research have limited discussion in the Strategy's research themes.

Although bio-diesels are qualitatively similar to petrogenic diesels other non-hydrocarbon biofuels, such as alcohols, present new challenges for spill preparedness and response. An aquatic spill of alcohol is unlike that of typical petroleum spills because alcohols are readily miscible with water, do not create a surface slick and do not tend to evaporate into the atmosphere. Standard response techniques such as mechanical recovery, dispersion, or in-situ burning would thus be inappropriate. Focused research to accurately characterize the transport and fate of these contaminants is needed to develop response technologies that mitigate and remediate these types of spills. The processing and transport of biofuels will take place in terrestrial and aquatic environments that span from inland systems, across coastal regions, and possibly into marine environments. Research to address future spills will need to account for these different scenarios.
Alcohols can be readily metabolized by aquatic microbes. Respiration of these contaminants can lead to heightened biological oxygen demand. In the case of a large release, or in sensitive areas such as coastal waters and wetlands stressed by eutrophication, rapid microbial metabolism following an alcohol spill can utilize dissolved oxygen faster than it is replenished by photosynthetic activity or atmospheric ventilation leading to water column hypoxia. In this situation the spill may indirectly lead to mass die off

of fish and other aquatic fauna as hypoxic 'dead zones' rapidly develop within the water column. Furthermore, alcohol biofuels (e.g. methanol, ethanol) have varying degrees of toxicity to humans and aquatic fauna.

3.1.1. Consideration of Environmental Justice to Overburdened Communities and Behavioral Sciences Research

The EPA defines Environmental Justice as, "…the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies" (U.S. EPA 2011b). While oil spills impact surrounding communities regardless of race, color, or income, there may be special conditions and more radical impacts to those communities who are dependent upon fishing for food or economic livelihood or other activity potentially impacted by oil spills.

The Strategy does not specifically mention environmental justice though it is implied in several of the research themes. The SAB concludes it is appropriate to include environmental justice consideration in the Strategy within the Shoreline, Coastal and Inland Effects and Human Health Impacts research themes. For example, on page 34 of the Strategy, a table addresses the decision context and key scientific questions for "Ecological Ecosystem Services, Health and Well-Being in Gulf Coast Communities." The well-being in Gulf Coast communities would address issues of environmental justice, but there are no key scientific questions listed here related to environmental justice. Some key scientific questions would include assessment of the effects of oil contamination on subsistence communities near oil spills. In 2004, the agency awarded a STAR grant to examine the potential Effects of Oil Contamination on Subsistence Lifestyles, Health and Nutrition in an Alaskan EJ community (due to the Exxon Valdez oil spill). Likewise, some research is needed to examine the effect of the oil spills on subsistence communities in impacted areas – effects on health, nutrition, lifestyle and economy. Do effects (particularly human health effects) differ in subsistence communities versus other impacted communities? Are these subsistence communities more likely to suffer the adverse impacts of oil spills than other communities? Are there alternatives that these communities can utilize to decrease reliance upon food species that might be contaminated and therefore impact their health? Research could address these questions. The Strategy should document existing outreach to and research on Gulf Region coastal communities to evaluate and describe strategies for enhancing these efforts.

Research on risk perception and communication related to oil spills is also inextricably related to environmental justice research. Educational materials and advice is needed for all communities impacted by oil spills, but there may be particular needs in subsistence communities. Research on perceptions of populations in these communities is needed in order to better design effective communication strategies.

The draft Strategy is also weak on behavioral and social science research. In the recent review of the 2012 the EPA research budget, the SAB advised the EPA to bring the decision sciences back into ORD and expand its mandate to include the behavioral and social sciences more broadly as an explicit research enterprise. The EPA should carefully consider how the behavioral and social sciences can be added to their research agenda. These research communities are especially pertinent when a particular research question encompasses decision analysis/structuring, risk communication and behavior change. Furthermore, using a systems approach that integrates decision making frameworks, social and behavioral decision science research and research on the impact oil spills potentially have on ecosystems would also address issues of environmental justice.

The SAB notes that in 2006 the Coastal Response Research Center held a workshop that included spill response practitioners and researchers from the social sciences in a discussion of risk communication, coordination in spill response and restoration, environmental ethics, valuing natural resources and the social impacts of spills on communities and subsistence peoples (Kinner and Merten 2006).

3.1.2. Greener Alternatives: Chemistry and Engineering

The SAB recognizes the Strategy's focus on greener alternatives and innovation as a potential strength of the report. However, the focus on greener alternatives and innovation is primarily based on use of green chemistry to develop greener dispersants. The Strategy makes a particular emphasis in several locations that "application of green chemistry principles will provide effective and sustainable products while reducing their toxicity and persistence in the environment." The Strategy thus appears to view green chemistry primarily as developing degradable dispersants that have lessened ecological effect. The SAB recommends the agency should consider green alternatives in a broader (and more appropriate) context that considers issues of sustainability beyond simply the ecological impact associated with deployment of dispersants.

In green chemistry, risk is minimized over the whole life cycle by reducing or eliminating the hazard. The design of greener dispersants should ensure that material and energy inputs and process outputs are as inherently non-hazardous as possible farther upstream in the dispersant's life cycle. For example, the material extraction, material processing and material manufacturing life stages are the upstream life cycle components that should be considered as well as application of dispersants. This better integrates with the EPA's definition of green chemistry: the design of products and processes that reduce or eliminate the use and generation of hazardous substances.

The SAB also recommends that the EPA consider expanding the Strategy to include relevant principles of green engineering. The SAB recognizes that this is a relatively new approach and we commend the EPA for providing particular care on this topic. Green engineering is the "design, discovery and implementation of engineering solutions with an awareness of potential benefits and problems in terms of the environment, the economy and society throughout the lifetime of the design." (Mihelcic and Zimmerman 2010).

Green engineering focuses on avoiding waste wherever practicable and eliminating the waste wherever possible. Accordingly, the SAB recommends that the EPA, even when developing an oil spill response strategy, remain focused as an Agency that it is always a preferred strategy to prevent spills rather than treating or cleaning up spills after they occur. Furthermore, in green engineering, any separation and purification operations that are proposed while responding to a spill should be designed to minimize energy consumption and materials use. End-of-life issues should be considered when developing spill strategies that simply transfer a pollutant to another media that perhaps then requires disposal. In addition, design of oil spill response strategies should ensure that all materials and energy inputs and outputs are as inherently nonhazardous as possible and any material and energy inputs should be renewable rather than depleting.

3.2. Comprehensive Organization to Foster Collaboration

Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?

In some areas, the Strategy is very clear regarding which agency is performing which research (when discussing funded or planned studies). The Strategy is less clear when the discussion focuses on priority research for which no definitive funding mechanism is identified – and inconsistently identifies which agencies are conducting the research. There is need throughout this document for the EPA to clearly define its role and needs as they relate to that role. In so doing, the Agency will facilitate interactions and collaborations with their partners through ICCOPR.

The EPA states that the strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions.

The research is driven by the decision-making needed to prepare for a response to a release. The SAB notes this driver neglects prevention of a release. Perhaps section 1 of the report should provide more detailed information on whom within the federal government or industry is conducting research to prevent the release of oil. Table 1-1 on page 5 states the Department of Transportation has responsibilities to develop regulations for pipeline spill prevention and supporting the maritime industry with guidance and technology in implementing equipment, systems and operations to prevent spills. The Strategy does not present any other agency involved in research specifically on how to prevent spills. Including this discussion in context of the research's focus on response to a release, would make the document stronger in terms of how it integrates principles of green chemistry and engineering into the document.

The draft Strategy is structured to address four themes: dispersants; shoreline, coastal and inland effects; innovative processes and technologies; and human health effects. While the SAB found the document generally well organized along these themes, questions were raised about how the Strategy will be implemented within the new Integrated Trans-disciplinary Research approach under development. The EPA ORD reorganized its research from project-areas, defined by specific problems and media-type, into integrated programs that encompass: 1) Air, Climate and Energy; 2) Safe and Sustainable Water Resources ; 3) Sustainable and Healthy Communities; 4) Chemical Safety for Sustainability; 5) Human Health Risk Assessment; and 6) Homeland Security Research The SAB recommends that EPA incorporate the Strategy into the integrated research approach. For example, in Section 1, a visual graphic could be added that shows how the four research themes of the Strategy fit within the programs identified in ORD's new organization.

3.3. Specific Comments on the Research Themes and Projects

Charge Question 3 addresses science questions and projects described in each of the four research themes. This advisory report provides responses to the three specific questions under each the of the four research themes; dispersants, ecosystem impacts, innovative processes and technologies and human health impacts).

Within each theme:

a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

3.3.1. Dispersants

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

The science questions presented address key issues that can improve future oil spill response activities. However, several high priority science questions are missing from this section. The research on dispersants needs to clearly define the efficacy of a dispersant and the endpoints that are being evaluated. Toxicological studies of sub-chronic and chronic exposures to the variable complex dispersant mixtures are necessary. Transport and fate studies should include the CTAs in conjunction with the particular oils with which they would most likely be used. The SAB elaborates on these additional areas below.

Breadth of Coverage

With improvements in technology, the range of CTAs has increased. Research in this area needs to include a broad range of formulations and examine their interactive effects in conjunction with oils, conditions, and environments (i.e., terrestrial, freshwater, coastal, and marine) as appropriate. Transport, fate, effect and toxicity studies need to include these agents alone, the oil(s) alone and the resulting complex mixtures. Studies may need to include CTAs with proprietary compositions. While the number of permutations may become an issue, modeling could provide an overview while information that is more conclusive would result from follow-up studies.

Efficacy

Unlike other oil spill response actions, dispersants do not reduce the amount of oil in the environment. Instead, dispersants are intended to simply change the transport and eventual fate of the oil, essentially trading off surface and shoreline ecological impacts for those in water column and benthic environments. In certain cases, the use of dispersants is an irreversible option that may restrict other cleanup options (e.g., containment, burning, mechanical recovery). Without clear understanding of the trade-offs and consequence of dispersant use, a rational decision context is unavailable.

Since use of dispersants does not reduce emissions, the definition of the efficacy of dispersants needs to be clearly articulated. A somewhat trivial definition of efficacy is the degree to which additional oil is dispersed into the subsurface by the use of the CTA relative to the non-application. A more comprehensive definition is needed that satisfactorily considers the net ecological and toxicological trade-offs such that overall threat to public health and environmental and natural resource impact can be minimized and the post-spill ecological recovery rate of an affected area is maximized. This more comprehensive definition requires that, among other things:

- response priorities are clearly defined and articulated in advance of a spill;
- a baseline understanding of the pre-spill environment is available;
- oil/dispersant transport, fate and eco-toxicity forecast models are available and appropriately matched for a given spill event to predict chemical effectiveness, operational effectiveness and ecological consequences;
- adequately resolved spatial and temporal monitoring is undertaken; and
- scientifically verifiable assessment methods are used.

A net environmental benefit definition of efficacy requires that non-commensurate factors (e.g., hydrocarbon chemical composition, life stage sensitivity of particular organisms, temperature, spill size, etc.) be examined within a context that allows decision makers a clear understanding of the critical vs. non-critical factors and how these factors influence each other.

An approach that considers ecological and toxicological trade-offs is highly interdependent and complex. Moreover, the response window for dispersant application is often time sensitive, requiring real-time decision making. These situations are often fraught with externalities such as jurisdictional considerations, inadequate information, limited response equipment and regulatory requirements.

Pre-authorization is often now granted to a federal On Scene Coordinator (FOSC) without the requirement for further approval, enabling them to make dispersant use decisions in real-time. This effectively forces the FOSC to make dispersant use decisions without adequate a-priori information. Response teams need information on the various combinations and resulting scenarios, otherwise tactical responses can take precedence over more important strategic goals.

To better evaluate dispersant efficacy, research on simulated spill scenarios can be used to explore likely outcomes as a result of different combinations of events, resources and other factors. A research effort could be undertaken to develop a honed decision tree that identifies specific factors and variables (e.g., surface release vs. subsurface release, deep sea vs. coastal/littoral sites). This decision process should provide an assimilative mechanism to integrate new information as it becomes available so that it provides a more complete picture of the remediation approaches and gaps where information is needed. These data and information should be aligned into categories that correspond to oil spill types and circumstances. The decision tree should assist in predicting the environmental and public health outcomes of specific remediation and restoration decisions. These simplifying assumptions will enable the EPA to define the categories in which to align the research results for use by decision makers. These assumptions should include but are not limited to:

- seasonal consideration (e.g., anadromous fish migrations),
- temporal fluctuations (temperature, weather patterns),
- geospatial considerations,
- geology,
- ecoregions/ecosystems (e.g., salt marsh vs. mangrove, vs. forested swamp),
- oil types (North slope vs. Gulf sweet crude vs. refined products),
- type of release (e.g., benthic, surface, inland pipeline),
- ecosystem recovery, and
- potential consequences of remediation choice

Given the complexity of dispersant efficacy, the dispersant research program should be constructed in a manner that works backward from the endpoint, starting first by defining the metrics by which efficacy is judged. Based on this definition, a critical path for research should be defined that identifies knowledge gaps within the various focus areas and ranks them according to importance. These research topics should then be funded at levels proportional to their usefulness. This process can be iterated repeatedly so that as existing questions are answered other new ones can be examined. Furthermore, this approach should enable responders to efficiently assimilate ongoing scientific research without having to wait for all of the answers.

Transport and Fate

Transport and fate studies should include the CTAs in conjunction with the particular oils with which they would most likely be used. Given the trends in offshore oil production, specific environments that should be addressed immediately include cold, high-pressure conditions to model deep sea applications (such as what occurred with the DWH blowout) as well as cold or under ice applications in or near polar regions.

The conditions of ultra-deep water releases are difficult and costly to reproduce experimentally. Furthermore, the presumably unique interactions of a particular type of oil with a given dispersant would require large permutations of experiments under various environmental conditions. In lieu of an experimental program, an analytical approach involving modeling of molecular interactions can be used to predict dispersant behavior for a given oil type and set of environmental conditions. This can provide a theoretical basis for calculating dispersant-oil dosage control and predicting transport and fate of specific hydrocarbon toxins in subsurface marine environments, instead of just bulk transport models or wave tank experiments.
Currently available spill models such as Automated Data Inquiry for Oil Spills (ADIOS and ADIOS2) are good for surface releases and 2D trajectory modeling, but inadequate for subsurface 3D and 4D transport modeling of dispersed fractions (NOAA 2006). New research programs should be undertaken to develop 3D and 4D deepwater and under ice transport and fate modeling.

Toxicity

Studies of sublethal, both chronic and subchronic, exposures to the variable complex mixtures encountered in oil spills are necessary. These studies should include naturally dispersed oil, CTAs alone and oil mixed with CTAs for a comparison of actions, effects and impacts. Weathered and fresh oils should be employed for all studies, including toxicity studies. Indirect toxic effects should also be considered as should effects resulting from the ethology of native species. Weathered and fresh oils should be used with relevant environmental variables (e.g. UV light, temperature, salinity, energy) that can affect the toxicity and component profile of the complex mixture under consideration. How CTAs affect the bioavailability and subsequent toxicity of these complex mixtures should be included in research designs. Sensitive life stages of both standard test species and native species have been used in the past and their selection in future studies will be an important consideration. Impact areas, such as benthos and shore, should be assessed separately. Adding key population-level effects such as those affecting reproductive success also merit incorporation.

Many biochemical pathways are similar in vertebrates. The information obtained in this testing should be used in conjunction with epidemiology to design human health studies and assess the public health impacts of oil in conjunction with CTAs. Comparing results obtained in these studies to the status of affected areas prior to the spill underscores the value of acquiring baseline data.

Detailed descriptions of the proposed studies of chronic and subchronic exposures need to include the time frames used in the proposed research. Shorter time frames (i.e. day, week, month and year) may be more manageable, but the DWH event led to continuous applications of dispersants for over 2 months. There is a need for a more detailed plan to systematically examine the range of exposures that can be expected from a variable complex mixture of oil and CTAs reflecting both the duration of application and resulting effects.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

Answering the previous Charge questions, the SAB identified new issues and contexts surrounding the dispersant research areas presented in the Strategy. Given the expansion of oil exploration in extreme conditions and the uncertainty of how dispersants and other CTAs perform in those conditions, the SAB did not identify any science questions that should be deleted at this time. The SAB recommends that the EPA develop criteria to periodically evaluate and prioritize research needs. Further, the EPA should update its evaluation and prioritization possibly using an event-based approach discussed in the response to question 3c.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

Event-based Research Strategy

There are notable data gaps regarding the impacts of the use of dispersants and other CTAs. Much of the research described in the Strategy is designed to assist response personnel in deciding if agents should be used and if so, what would be the likely outcomes. To that end, the SAB suggests that the Agency develop an event-based research Strategy (EBRS). This approach allows the agency to organize the knowledge available intramurally as well as that from other agencies as it prioritizes research for those areas in which important information is truly lacking. By including milestones, the questions do not need to be answered simultaneously, but coordinated, integrated research can be conducted that focuses on the needs of the Agency as well as other agencies involved during and in the aftermath of a spill.

In the National Research Council (NRC) report, Understanding Oil Spill Dispersants: Efficacy and Effects (2005) provides an excellent foundation for establishing this research framework. Among the recommendations articulated in this report is the need to “establish an integrated research plan which focuses on collection and disseminating peer-reviewed information about key aspects of dispersant use in a scientifically robust, but environmentally meaningful context.” The report further recommends that this research should:

> "further improve understanding of dispersant effectiveness and the potential impact of dispersed oil at meaningful scales to support decision making in a broader array of spill scenarios, especially those scenarios where potential impacts on one portion of the ecosystem (e.g., water column) must be weighed against benefits associated with reducing potential impact on another (e.g., coastal wetland)."

An event-based dispersant research strategy can be structured according to the basic information that is needed to support response decisions. Along with the basic question of the size of the release, the NRC report suggests the following questions:

- Will a mechanical response be sufficient?
- Is the spilled oil or refined product known to be dispersible? In addition, how long before it becomes non-dispersible?
- Are sufficient chemical response assets available to treat the spill?
- Are the environmental conditions conducive to the successful application of dispersant and its effectiveness?
- Will the effective use of dispersants reduce the impacts of the spill to shoreline and water surface resources without significantly increasing impacts to water-column and benthic resources?

The DWH spill provides a case study of the types of information gaps that could be encountered in responding to an ongoing deep subsurface release in open water. During the spill the answer to each of these questions was generally either 'no', or 'unknown.' Other scenarios such as spills occurring in ice covered conditions, or of biofuels may present similar knowledge gaps.

Another reason for the development of an EBRS is that it facilitates integrated information applications and research priorities within a section of the Agency. With the concurrent generation of these plans, points of integration and overlap could emerge more often. The EPA should review the EBRS approach to develop a list of research areas and prioritize them for research purposes. This prioritization could be a weighting of needs based on the response application, the applications and potential uses and opportunities to integrate overlapping research needs for dispersants and other research areas in the Strategy.

3.3.2. Shoreline, Coastal and Inland Effects Research to Inform Oil Spill Decision-Making

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

To achieve better balance, the focus of the research needs to address combination of issues identified during the DWH and those issues non-DWH scenarios. The strategy should clearly articulate the need for terrestrial and inland research in light of pipeline and transportation spills, (i.e., Enbridge and Yellowstone spills) and work with both short-term and long-term research goals for inland, coastal, and marine spill scenarios. The research strategy needs to integrate new data and resulting understanding of impacts to ecosystem processes from the DWH incident as it becomes available and focus on broader spill response issues as well. It is difficult for the SAB to assess where the priority research needs exist without a more detailed review and evaluation of current findings from previous, major oil spill studies and assessments of new information generated during the DWH incident. Completion of reports and publication of studies initiated during and in the immediate aftermath of the DWH incident and response could alter scientific perceptions of research priorities over the next few years. The EPA research strategy should be flexible enough to incorporate new findings and re-focus as needed.

Although some DWH focus is necessary and justified, the Agency is cautioned not to over-invest in studying a single incident. History suggests that a DWH scenario is a relatively rare event, once in 30 to 40 year scenario, whereas dispersant use in the U.S. Gulf of Mexico has been a once in 3-5 year event. Those oil spill precedents were finite volume spills, 2-5 day local events with the same pressing environmental and response issues as the DWH spill, but at a different scale. It is likely the next catastrophic spill event will be with a different oil type, different oceanographic and ecological settings and a different set of operational and logistical constraints brought into play. The EPA should learn what it can from DWH and then be prepared to apply that knowledge in a more generic way.

In addition, the EPA needs to remain flexible and able to pursue new avenues of research that may only become apparent after the work has begun. Research teams need to be able to adjust their work plans in out years to follow up on unexpected results or new ideas that stem from earlier study.

The EPA is the On-Scene Coordinator (OSC) and agency responsible for inland spill responses and this role may drive assessment activities and other types of research may be needed. The EPA OSCs are responsible for leading response and initial restoration activities for any number of petroleum products, non-petroleum oils, biofuels, alcohols and other liquids transported in bulk by vessel, pipeline, or rail. Spill sites may be terrestrial or aquatic. Research to support these responsibilities will likely require outcomes and results that have broader applicability, as it is not possible to cover all combinations of inland habitats and potential spill products. Research should yield generally applicable results that can be used to characterize diverse environmental fate processes, exposure-response relationships, or environmental transport modes. The EPA is encouraged to think broadly when developing research programs to support the range of activities that might be needed in this area and to work closely with other state and federal agencies in identifying key areas of uncertainty or knowledge gaps that provide the greatest benefit for the investment.

Address a Variety of Constituents and Response Options

Oil spills, particularly blowouts like the DWH spill, contain much more than oil. Other constituents found in formation liquids and gases, such as methane and carbon dioxide, are present in these releases. The Strategy briefly touches on non-oil components, but these can be a significant aspect of a blowout scenario. Attention should be given to potential environmental impacts of these other constituents as part of an overall research strategy. In addition, the Strategy should include investigation of potential impacts on inland, shoreline and coastal communities for the diverse response strategies identified as worthy of consideration (e.g., solidifiers, sorbents, burning, bioremediation treatments), with the same depth of effort as was outlined for dispersants. Acute and chronic toxicity, population and community impacts, fate and transport, biodegradation and bioaccumulation will all be important considerations for any response technology used to prevent oil from reaching an area or as part of a clean-up strategy. The impacts of any spill treatment that is not fully recovered after application will be questioned before and after its use, so the EPA should be proactive in gaining the same level of detail environmental fate and effects for all response technology options as was outlined for dispersants.

Population, Community and Ecosystem Effects Assessments

The inland, shoreline and coastal areas most susceptible to spill impacts support complicated and diverse communities. Understanding of oil fate and effects will require effort at the population level and above — preferably community and ecosystem effects. It will be important to link the broad toxicology studies outlined in the dispersant section of the Strategy with indicators and endpoints that can support impact assessments and risk assessments at these higher levels of ecological organization. The research issues associated with shorelines, coastal and inland spill impacts need to be cast in a population and community perspective, within an associated decision management framework (DMF). The DMF should support endpoints to assess population effects and help risk-based decision-making during an event and as part of restoration efforts. It should consider background conditions, existing contamination, knowledge of local and regional food webs and an understanding of the recruitment and refugia potential for local habitats. The DMF should provide an understanding of population, community and ecosystem recovery capacity. This must be coupled with exposure characterizations that take into account oil type, dispersant type, loading and hydrology; and broader principles that facilitate assessments from diverse spill situations. New research should support assessments of rates of population and community recovery from various chemical exposures to assess spill response, clean-up and restoration trade-offs. These types of considerations will take the EPA in a different –and much needed– direction compared to agency efforts during recent spill events such as the DWH in the Gulf of Mexico and Enbridge pipeline spill in the Great Lakes basin. The EPA responsibilities and capabilities should go beyond a focus on dispersants or single species lab tests for oil toxicity and not rely exclusively on NOAA and trustee agencies for assessments of population and ecological issues. There is a research need and an agency need to enhance scientific capabilities to go beyond simple toxicity benchmark assessments and make risk management and response clean-up decisions based on endpoints of ecological significance.

The Strategy refers to assessing impacts at the ecosystem services level of organization. However this topic needs greater elaboration, defining more specifically the EPA goals for research conducted in this area and the types of work that would be sponsored. The discussion of “ecosystem services” is limited and tenuous. The SAB recommends that the EPA further integrate the Strategy with the ecosystems services components within ORD’s Sustainable and Healthy Communities Research Program. For example, use of population density as an ecosystem service predictor is a weak endpoint for many organisms and ecosystem functions. Wetland function and coastal and inland habitat effects are mentioned as a pressing research need, where efforts could generate data consistent with risk-based decision-making. However, greater detail is needed to assess the direction and value of these research areas.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The SAB identified new issues and contexts surrounding the potential environmental impacts research the EPA included in the Shoreline, Coastal and Inland Effects Research to Inform Oil Spill Decision-Making research area presented in the Strategy. Given the expansion of oil exploration in extreme conditions, issues identified in the other three research areas and the recommendation for better coordination and transparency across the research areas the SAB did not identify any science questions that should be removed from consideration at this time. The SAB recommends that research included in the Strategy needs to be evaluated and prioritized with periodic updating of the evaluation and prioritization.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

The SAB recognizes that not all research responsibilities across federal agencies are tasked to specific agencies. The Strategy is thus limited to identifying key research needs and identifying high priority areas through a rigorous and transparent science integration effort involving all agencies. Identifying research needs is only a start. It is the extent of coordination and leveraging with other research organizations that will lead to efficient and effective use of research funding. Until the details of implementation and coordination are resolved, identification of key research needs remains tentative.

Interactions with Other Agencies

The SAB finds that interaction and integration with other research agencies and institutions that is carefully thought out, transparently leveraged and coordinated, and built on the expertise and capabilities of each party is critical to the success of the EPA research and development program. Details on these planned interactions and collaboration are important in order for others to understand this research strategy. Oil spill sites usually do not have clearly delineated boundaries—what occurs in estuarine and intertidal areas is directly connected to nearshore, coastal waters and all are connected to the open ocean. It will be important that ecosystem studies reflect this connectivity and address it through cooperation and coordination among the agencies and institutions working in these areas. Such multi-agency interactions are especially important for this section of the research strategy, where details on collaboration and leveraging are key to understanding how the EPA investments and activities will advance the diverse uncertainties associated with complex ecological issues.

Better Characterize Exposure and Effects Linkages

Shoreline, coastal and inland effects research should better define exposure conditions (spatial and temporal dynamics) and link exposure to ecological effects. In many cases, these linkages will need to take into account baseline and background environmental conditions and stresses in order to adequately characterize risks from specific spill incidents. Building on key exposure-response relationships from laboratory tests where conditions reflect real world exposures, risk assessments will be better able to inform risk managers regarding true trade-offs imposed by various response and restoration actions. The exposure response data need to be linked to environmental models such as NOAA fate models and National Marine Fisheries Service (NMFS) fish population dynamic models. Other examples of food web and ecological energetics models and tools used by response and restoration authorities to implement plans include Atlantis (Brand et al. 2007) and EcoSim (Ecopath 2011). The EPA needs diverse and integrated models and scenarios for differing ecosystem types and their unique food webs to support rapid to mid-term response decisions. The assessments need to support scenarios with differing types of oils, dispersants and chemical response or clean up agents. Within each scenario, the models should take into account expected background or reference site conditions and a means to understand likely interactions with other common and pervasive stressors (e.g., toxics, nutrients, anoxia; severe events (i.e., hurricanes); invasive species). These efforts can build upon resources such as existing sediment resuspension models for better risk prediction or models of groundwater-surface interactions in coastal areas (e.g., potential contamination of aquifers).

Improved Risk Characterization and Communication

The EPA should support development of risk-based decision-making strategies for spill response, identifying and assimilating necessary risk-characterization data to meet the requirements of the resource managers and then enhance the risk assessment and risk communication process with more efficient and effective processes. This will require some research in the area of best processes for risk assessment and risk communication, as well as enhancing the approaches and tools utilized in risk-based decision-making. The risk decisions outlined in Table 3-1 of the Strategy are policy driven, which is a needed area of emphasis, but this research strategy needs to articulate areas such as the DMF and associated "delisting" criteria and the science needed to fill the gaps for those decisions. Perhaps concepts used in the Great Lakes Water Quality Agreement (International Joint Commission, 1988) such as Areas of Concern and Beneficial Use Impairments would be a useful template.

Proposed research on risk communication and trade-offs will require input from trustee agencies such as NOAA and NMFS as well as work with States. EPA is not a natural resource trustee, but has a role in response technologies and response planning to reduce impacts on environmental resources deemed priorities by resource trustees. The goal would be to avoid excessive and intrusive clean-up efforts in order to achieve the most robust and quick recovery. For example, clean-ups from some historic spills have been driven by visible sheen originating from shoreline oiling in habitats where there may be little support for intrusive clean-up based on habitat destruction, food web contamination and local population's inherent recovery potential from sheen exposures.

Risk characterization is a key area of expertise within the EPA. Research on how to bring together and quantitatively express environmental fate and effects data, generalized and site-specific modeling, exposure and transport assessments to set meaningful and realistic restoration and recovery goals could greatly enhance the EPA's leadership and credibility in this area. It will be important to work with other federal agencies with expertise in modeling, fate and transport, offshore oceanography and other areas to ensure needed and relevant data are available to support risk characterization efforts. the EPA has the experience base and leadership role in pulling the relevant information together and generating meaningful and relevant risk characterizations that could serve as the underpinning of multi-agency risk assessments and risk management decisions during and after spill events.

3.3.3. Innovative Processes and Technologies Development

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

The SAB finds that innovative processes and technologies research should be better focused on the EPA's regulatory role in certifying or approving various new approaches. ORD needs better ways to keep management and policy makers informed of state of the science and to actively work with the oil spill community in the intervals between major spill events. The EPA should engage federal agencies, states and industry to identify criteria applicable to evaluating technologies. If the EPA wishes to encourage the development of new or improved technologies (such as better booms, skimmers, absorbent materials, dispersants and underwater collection methods), then areas of specific interest and required operational criteria (regarding toxicity, biodegrading, discharges, etc.) should be clearly defined and made a part of the review and evaluation process. In this way, companies and inventors can begin to meet specified defined goals or regulatory mandates. This could be partially achieved through the development of a database that more explicitly defines "effectiveness" of existing and new, or developing methodologies and specific areas where improvements need to be made. An example of this would be a new technology for water and oil separation that allows highly efficient large or small scale skimming operations. Specific areas of consideration include operation at very low oil to water ratios, low hydrocarbon residuals in the wastewater and ability to operate over a very wide range of sea states and wave sizes.

An example of the utility of having an information resource defining effectiveness is provided by the experience of the surface oil skimmer termed "*the A Whale*" during the DWH incident. The skimmer is a refitted and converted oil tanker designed to capture and separate 300,000 to 500,000 US gallons of oil per day (the vessel stores the captured crude and returns the processed seawater to the sea) and was tested and evaluated but not used during the DWH response for a variety of reasons. Primary amongst them was that the technology did not work very well as a skimmer, due mostly to encounter rate resulting in recovery of mostly water with little oil proportionally. The discharge of the separated water also did not meet the EPA criteria discharge criteria. Other skimmers also failed to work well or worked only on the densest portions of the spill but even then had to suspend operations or return to port in slightly rough sea conditions.

There are questions concerning technologies designed to enhance worker safety during cleanup operations. Materials applied by spray equipment to stop oil spreading and reduce vapors are available today. Their use has been hindered by lack of comprehensive fate and effects data required to meet approvals. The EPA should not restrict comprehensive testing to dispersants and the fate of the dispersed oil. It should include other technologies such as solidifiers, spreaders and sorbents in its comprehensive testing.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The Strategy references the value of the baffled flask efficacy test on (Page 23). EPA presented this new test and justification for why it is better than the swirling flask test at a spill conference in 2001. However, the agency has not yet adopted this as policy. If the new research and development strategy takes 10 years to impact policy and management decisions after the research has been completed, the EPA will not be seen as a significant source of new science and technology.

In developing "efficacy tests," as well as "toxicity tests," it is important to remember that the focus of the testing schemes determines the outcomes for these tests. Some efficacy tests are used to better mimic what happens in the environment; some are designed to determine how well a product works under low energy conditions, while other tests are designed to see how products will work under high-energy conditions. There is not always a good ability to predict how a product will work under real-world spill conditions based on how the same product worked under a variety of bench test regimes. Whatever protocols or approaches the EPA decides to adopt for efficacy testing, it should make clear the specific parameters of the testing regime and why this regime was adopted by the EPA, whether it be for dispersants (as with the baffled flask and swirling flask tests) or testing protocols developed for other chemical countermeasures.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added

The project area descriptions section of the Strategy are disjointed and could be improved by restructuring the text into a more sequenced net environmental benefit analysis (NEBA) type approach to identify the type of incident and the technological improvements that are required to meet this philosophy. This could also be in the form of a separate implementation plan or NEBA-guideline that minimizes both the spread of the pollution and the deleterious impacts and cost of the clean-up efforts (i.e. a NEBA-type plan).

The Strategy tends to frame various studies (i.e., bioremediation, *in-situ* burning and thermal treatments) in the negative, assessing the potential impacts or downsides of the approaches. Research should assess both positive and negative trade-offs of technologies to provide oil spill responders with information to support the choice of a correct remediation technology under particular conditions. It should be possible to define the potential regulatory and environmental consequences of different technologies and methodologies for what may be a limited number of "standardized generic environments or incident types." Such a NEBA type process should be developed and explicitly implemented in the evaluation of all old, new and improved technologies and methods and their combinations.

A NEBA is specifically designed to address the environmental trade-offs associated with decisions during oil spill response, including the use of alternative response technologies such as dispersants or *in-situ* burning. It was originally developed by Aurand and was focused on assisting oil spill responders and trustee agencies in policy development and planning regarding response options (1995, Aurand et al. 2000). The process was modified from the more quantitative ecological risk assessment model used by the EPA for long-term remediation and cleanup sites. The Strategy states that the EPA will conduct a lifecycle assessment to evaluate physical and chemical treatment approaches including the materials, effectiveness of treatment, by-product management and ultimate disposition. NEBA analysis would develop a clearer total "life-cycle management" ethos. This could include the choice of greener clean up materials and methods, their guidance of utilization (i.e. some materials and methods may be better choices for different types of hydrocarbons or situations than others) and their subsequent greener active disposal by humans or passive degradation in the environment if not fully recovered. This modified NEBA-type life cycle assessment should also look at ecosystem impact during all phases of production, use and end of life or disposal. In the event that public health and safety needs to be addressed as part of a new technology, a mechanism by which these potential risks can be assigned and evaluated for both planning and development and the response to a spill should be developed.

Research on alternative or other innovative response approaches could be reworked and refocused to address many of the research themes identified for dispersants (i.e., toxicity, biodegradation and bioaccumulation) and other CTAs. Data are needed for chemical agents used in solidifiers, bioremediation, herding and surface washing. Fate and transport studies and modeling for these diverse agents are also needed. Dispersants need not be singled out when the EPA may be able to promote more comprehensive assessments of a much broader range of spill response technologies. The impacts of any spill treatment that is not fully recovered after application will be questioned before and after its use. The State of California (California 2010) requires data on fate and effects in the environment of technologies as a part of their oil spill cleanup agent licensing process to begin to address such concerns. The EPA should be proactive in gaining the same level of detail on all response technology options.

A NEBA analysis may conclude that greatly improved on-water spill tracking and mechanical containment and removal technologies would generate a greater net benefit in the long run when compared to wide spread application of dispersants. This may be particularly so in response to large events and the generation of oil dispersant complexes where long-term fate and toxicity is not well understood. Examples of choices for mechanically recoverable systems could include the following examples:

- Better materials or systems that can be easily cleaned in environmentally sensitive way and then reused in a later incident may be more effective. The separated hydrocarbons could be recycled or sent to a suitable power station for disposal. This would include the development of better booms and skimmers that work under a wide range of sea states.
- Technologies made of easily recyclable or reusable materials. Boom materials made of soft recyclable absorbent poly-carbonate plastics in the DWH Gulf oil spill were removed and separated from hard booms. The soft materials where centrifuged clean for re-use and the hydrocarbon waste then handled separately. Hard materials like, the plastic, was melted and densified to be used as plastic components in appropriate manufacturing processes.

- Environmentally low impact absorbent materials, such as peat moss or other natural absorbents, could be used and then disposed of in such a way as to not further impact the environment such as would occur if partially hydrocarbon contaminated materials were either land-filled, openly burnt, or even incinerated. Purposefully (applied absorbents) and accidentally (wetland derived materials) contaminated natural materials may be mostly centrifuged clean, the hydrocarbons recovered and then all the materials either recycled or burnt in a power station with an advanced scrubber system thus generating some power while being disposed.

It should be recognized that the best application of mechanical cleanup methods cannot be 100% effective or feasible under all circumstances so the utilization of dispersants cannot be ruled out as part of a sequence of responses. In areas that are considerably more remote than the U.S. Gulf coast, rapid response or effective waste disposal may be impossible or sea ice may block the deployments of booms or mechanical skimmers. Under these conditions the wide spread use of dispersants and burning may be the only practical NEBA option other than the primary defense of prevention and containing the pollution source at or near the well utilizing subsea collector systems.

Concerns were raised about research needs on the potential catastrophic effects that biofuel spills can have on partially enclosed systems such as lagoons, lakes and river systems. Water-soluble ethanol type fuel additives are particularly hazardous in that they do not evaporate and could lead to devastating effects as eutrophication and anoxia on their break down. Air sparging and other as yet to be developed technologies or methods may be an option under these circumstances.

As part of a NEBA assessment, there could be an assessment of the relative impact of the clean up method over simply leaving the natural system to recover on its own. One example of this would be the positive and negative consequences of wide spread habitat destruction of wetlands to remove small amounts of hydrocarbon contamination in contrast to just letting nature deal with it over a period time.

NEBA-type studies have already been completed by federal and state agencies. The federal Selection Guide (US Coast Guard 2003) outlines the trade-offs associated with many response options. One of the tools that accompanies the Selection Guide is the Alternative Response Tool Evaluation System (ARTES) (NOAA 2010). Several of the Regional Response Teams have modified the Selection Guide to address specific policy use within their regions. California has also completed several NEBAs evaluating the use of dispersants from 3 - 200 miles off the coast of the state. The EPA should, thus, take a look at the work that has been done and see if there are any outstanding areas of need that the agency could/should address.

A Possible Event Management Based Strategy

An example of a staged event management scenario based NEBA approach is provided in Appendix B. This example describes five stages of oil spill response, the integration among agencies and spill response questions that should be considered in each stage.

3.3.4. Human Health Impacts

The Strategy suggests that much of the human health-related oil spill research will be conducted by federal agencies other than the EPA. The Strategy principally identifies National Institute of Environmental Health Sciences (NIEHS) and National Toxicology Program (NTP), but also National Institute of Occupational Safety and Health (NIOSH), Substance Abuse and Mental Health Services Administration (SAMSHA) and Centers for Disease Control and Prevention (CDC). Coordination of research with federal partners is strongly encouraged by the SAB as a means for the EPA to access a broad array of expertise and share costs to mutual benefit. However, the way that the collaboration is addressed in the Strategy makes review of the Strategy challenging. As written, it is often difficult to determine which federal agency is charged with conducting the research in each of the described areas, as well as the level of commitment of the federal partners to complete their portions of the research. Language such as "The NTP is considering further toxicology studies in three main areas …" and "NTP will likely lead research on oil, dispersants, oil-dispersant mixtures and combustions from oil burning." contributes to an ambiguity that is pervasive in this entire section. The EPA has definitive information needs in all of the research areas presented. However, it is not clear whether the research objectives of the EPA and its federal research partners are entirely congruous and as a result, whether research by the partners, even if completed, will fully satisfy the EPA's needs. It is also unclear in the document what would happen if partners decided not to pursue some or their entire portion of described research, for example, due to changing budget priorities within their agency. Would the EPA assume responsibility for that research or would it be dropped from the research strategy?

These problems could be largely eliminated if the document narrative focused first and foremost on human health impact research needs from the EPA perspective, expanding upon the key questions posed in the summary tables derived from the process depicted in Figure 5-1. This should result in a clearer, more coherent description of the research strategy in this area. Planned collaborative research by partner agencies that could meet some of the EPA research objectives is certainly worth mentioning, but as a secondary point at the end of the discussion of each research topic, as appropriate.

3a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.

The science questions presented address key issues that can improve future oil spill response activities. Several high priority science questions are missing from this section including estimating cancer risk, exposure assessment, risk communication, and environmental justice issues.

Estimating Cancer Risk

Oil spills contain carcinogens such as polycyclic aromatic hydrocarbons (PAHs) and many of the decisions about acceptable limits of exposure the EPA needs to make regarding oil spill contaminants are based upon estimation of cancer risk. The cancer risk model used currently by the EPA was developed primarily to assess excess cancer risk from lifetime exposure. As a matter of expediency, cancer risks in situations of short-term or intermittent exposure are assumed to be reduced proportionally to the fraction of lifetime exposed, even though experimental evidence suggests that this may be not valid for most carcinogens (Halmes et al. 2000). Oil spill exposure scenarios typically involve short or intermittent exposure periods. For example, the scenario contemplated by the EPA in developing their risk-based criteria for oil exposure on Gulf beaches assumes a total exposure duration of 90 hours for a child (U.S. EPA 2010b). In situations such as this, reliability of cancer risk estimates using the current risk model is questionable. The SAB notes that this issue is not unique to oil spills, and the EPA is confronted with a variety of situations in which cancer risks must be estimated for individuals with less-than-lifetime exposure. Development of cancer risk models that effectively address these scenarios should be a high priority.

The most extreme case of short-term exposure is a single event. Although there is a general reluctance to consider, let alone quantify, cancer risk arising from a single event, there is a substantial literature demonstrating the production of skin cancer in mice from a single application of a PAH (Calabrese and Blain 1999), raising the question of whether there are some limited duration, high-exposure scenarios associated with oil spills that might lead to elevated skin cancer risk. In order to answer that question, sound potency estimates for skin cancer specifically from short duration dermal contact with PAHs are needed.

Other issues associated with estimating cancer risks from PAHs specifically have been discussed in the SAB review of EPA's *"Development of a Relative Potency Factor (RPF) Approach for Polycyclic Aromatic Hydrocarbon (PAH) Mixtures* (SAB 2010).

Exposure Assessment

The only well-defined area of research related to exposure in this section relates to improvements in monitoring air pollutants related to the DWH spill. Other key questions are missing. With respect to water exposure, for a swimmer, the "risk driver" is most likely to be cancer risk from dermal contact with PAHs. The current EPA model for dermal absorption of chemicals has difficulty with PAHs because they lie outside the "effective prediction domain." (U.S. EPA, 2004). As a result, the agency has been thus far unable to develop risk-based criteria for PAHs for swimmers and human health benchmarks for PAHs remain "under development" (www.epa.gov/bpspill/health-benchmarks.html). There is brief mention of dermal bioavailability research to be conducted by NTP, but specifics, or even mention of which chemicals from oil would be addressed are missing, so it is impossible to determine from the strategy whether planned research would address this key issue.

A related issue with respect to swimming and other potential recreational contact with water is that exposure assumptions such as frequency and duration, as well as incidental ingestion rate of water, are largely guesswork. Exposure assumptions currently are based upon professional judgment rather than data. A similar observation can be made for exposure assessment as it pertains to beach sand and sediment. Population data on exposure frequency and duration for Gulf Coast visitors and residents and measurements of dermal contact and incidental ingestion rates are absent, yet needed to derive risk-based criteria for protection of human health.

Consumption of Gulf seafood is another logical potential pathway of exposure. Current information regarding seafood consumption patterns, particularly by Gulf Coast communities with high or subsistence consumption rates is needed.

Risk Communication

This area is ostensibly included, but is not. There is a section on risk communication in the human health section, but it describes the need for better communication rather than actual risk communication research. Research in this area should be considered a priority, because how the information is presented may have effects on how communities perceive their risk. There has been research conducted in risk communication by Department of Homeland Security (not specifically on oil spills but on how to handle communication during a crisis). The EPA should explore the efforts of Department of Homeland Security (DHS) in this area and select components that may be useful here.

Environmental Justice

Similarly, the issue of environmental justice is not mentioned at all, though many communities affected by oil spills in the past, including those affected by the DWH spill, are environmental justice communities. There are two large social and behavioral studies being conducted by CDC and SAMHSA (as described on page 53). While there is not a lot of detail provided about these two interesting studies, it would appear that, some aspects of environmental justice could be incorporated, depending upon the populations being targeted here. It is good to see social and behavioral research included in this document. Some effort should be made to ensure that environmental justice topics are covered within both studies.

3b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?

The section on risk communication as an activity should be deleted and the section should be re-focused on risk communication research (as discussed above). The problem formulation section discusses three objectives of the EPA research grants program. Presumably, this is referring to the current Science to Achieve Results Request for Proposals. The three objectives are: 1) development of innovative mitigation technologies; 2) development of effective chemical dispersants and 3) understanding ecosystem impacts. These are important research objectives, but are not germane to the human health impacts section. They should be moved elsewhere in the document.

3c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

Many of the key science questions and associated questions are rather general and it is unclear how studies might be designed to address them. For example, one of the key science questions is "What model toxicology systems should be used to evaluate oil spill dispersion?" and the corresponding anticipated outcome is "Identification of the key health effects of these mixtures in model systems will provide information on what health effects such mixtures might cause in humans." The accompanying narrative text is not particularly helpful in describing how projects could be created to answer the specific question – what model systems should be used for toxicology studies of oil and dispersants?

Further, description of proposed research projects is sufficiently vague that their potential contribution to evaluation of human health impacts is difficult to judge. For example, CDC and SAMHSA received $13 million from BP to conduct behavioral health studies (p. 53). Is it all for workers (CDC is specifically for workers but does not indicate population for SAMHSA study)? Another example is on page 55. Is there a research project designed to look at children and fetuses? This is the first mention of these vulnerable populations. No agency is identified. Is this a project or an idea being considered or developed? In general, the topics of community epidemiological studies and susceptible populations are mentioned but there do not appear to be any definitive efforts planned to study them.

Several important project areas could be added (see also response to 3a. in this section). Risk communication research is particularly important. It is stated in the document that more risk communication research is needed, but that is not what is described in this section on pages 60-61. While is important to conduct better risk communication, the means of determining what is "better" is through research. As mentioned earlier, considering what other agencies have done in this area – DHS in communicating risk during a crisis – would be helpful. A description of the DHS work and any additional work being planned or considered by the EPA should be included. The nine grants that the EPA recently awarded to non-profit community-based organizations located in the Gulf Region coastal communities should be mentioned in the document, as these awards represent action on the part of the EPA toward addressing environmental justice community needs. They are not research projects per se, but information generated from these outreach projects might be useful to researchers working on risk perception and communication issues. The objectives of the projects range from translating multi-media scientific data (including air, water and sediment and fish tissue) into plain language to developing training and educational materials about how data are collected, analyzed and interpreted. Complementary research investigating methods for effective communication and measuring perceptions pre- and post- communication would be useful as well.

The section describes developing an effective communication plan, which is important and the projects described above are focused on communication and training, but that is different from conducting research in risk communication. In defining “risk communication,” topics in risk perception and behavior should be included. For instance, what are some barriers preventing communities from trusting government agencies in these instances? Given these barriers, what types of strategies are most effective in building up trust? Some of these issues may be incorporated into the discussion of the social/behavioral studies being conducted by CDC and SAMHSA as discussed on page 52 of the Strategy.

Research on risk perception and communication related to oil spills is inextricably related to environmental justice research. Educational materials and advice is needed for all communities impacted by oil spills, but there may be particular needs in subsistence communities. Research on perceptions of populations in these communities is needed in order to better design effective communication strategies.

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APPENDIX A: EPA's Charge for the Oil Spill Research Strategy Review

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460
OFFICE OF RESEARCH AND DEVELOPMENT

March 25, 2011
MEMORANDUM

SUBJECT: Request for review of the *Draft Oil Spill Research Strategy*

FROM: Cynthia Sonich-Mullin, ORD Coordinator for the BP Spill,
Deputy Director for Management /**Signed**/
National Homeland Security Research Center

TO: Thomas Carpenter, Designated Federal Officer
EPA Science Advisory Board Staff (1400R)

This memorandum requests that the Science Advisory Board (SAB) review and comment on the EPA Office of Research and Development's (ORD) *Draft Oil Spill Research Strategy* dated January 12, 2011. The purpose of the draft strategy is to describe a comprehensive research program that would enable EPA to continually improve in meeting its mission to prepare for and respond to oil spills.

Background

EPA has authority and regulatory responsibility for multiple aspects of preparing for, preventing and responding to spills of petroleum and other oils under several laws and regulations. One major EPA responsibility is stipulated in the Oil Pollution Prevention regulations (40 CFR part 112), requiring onshore and offshore non-transportation related facilities to have spill prevention, control and countermeasure (SPCC) plans and facility response plans, where applicable. Another major regulation, the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR part 300), covers responses to oil releases and assigns primary response roles to EPA (generally for inland zone discharges) and the Coast Guard (generally for coastal zone discharges). The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, formerly Minerals Management Service) is generally responsible for operations on the outer continental shelf.

The Oil Pollution Act of 1990 (OPA 1990; 33USC2701-2761) was passed in the wake of the Exxon Valdez spill to establish, among other things, liability for releases and a fund for responding to oil releases as well as restoring natural resources. Section 2761 of OPA 1990 authorizes research and development (R&D) in multiple federal agencies, establishes the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR; www.iccopr.uscg.gov) and authorizes up to $22 million per year among the federal agencies subject to appropriation. ICCOPR published multi-agency research and technology plans in 1992 and 1997 and is presently developing a third update. The research focus of each agency in the 1997 plan generally aligns with its legal and regulatory authorities, although in some cases, OPA 1990 assigns particular R&D roles to specific agencies.

Prompted by the Deepwater Horizon spill in the Gulf of Mexico and its aftermath, ORD assembled a team to develop a draft research strategy that would comprehensively address the scientific and technical questions that could enhance EPA's ability to carry out its mission with respect to oil spills both in the short- and longer-term. The draft strategy is framed to identify (1) anticipated decisions that spill responders and policy developers will be required to make; (2) science questions within those identified decisions; (3) research that would address the science questions; and (4) research outcomes that can be used to inform future decisions. The draft strategy is structured to address four themes: dispersants; ecological effects; innovative processes and technologies; and human health effects. Research priorities that are principally the responsibility of other agencies are not included in this draft strategy, but will be fully considered in ICCOPR planning (see Figure 1-2 in the draft strategy).

The draft strategy is deliberately not constrained by resource levels. Our intent was to develop a strategy that would address the scientific and technical questions that are central to EPA's mission, recognizing that the research could be conducted by various members of the ICCOPR, researchers funded by BP, and others. Implementation of the strategy would entail coordination with those entities to ensure appropriate collaboration and leveraging.

Specific Request

ORD requests that the SAB comment on the scope, proposed science questions, research activities, and research outcomes outlined in the *Draft Oil Spill Research Strategy.* Comments from the SAB will be considered during the development of the final strategy document.

We appreciate the efforts of the SAB to prepare for the upcoming review of the *Draft Oil Spill Research Strategy*, and we look forward to discussing the plan in detail on April 11-12, 2011. Questions regarding the enclosed materials should be directed to Patricia Erickson at erickson.patricia@epa.gov or 513-569-7406.

Charge Questions

1. Does the draft Oil Spill Research Strategy encompass the most important research needed to enable EPA to better carry out its mission to prepare for and respond to oil spills, including future challenges such as biofuels discharges? Does the draft strategy appropriately address greener alternatives and innovation?
2. Is the research strategy organized appropriately to frame the questions in a comprehensible manner and to foster collaboration with outside entities as appropriate? If not, how can it be better organized?
3. Within each of the research themes:
    a. Do the science questions address key issues that can improve future oil spill prevention and response activities? Please identify additional high priority issues or science questions that should be addressed.
    b. Should any of the science questions be deleted based on sufficient existing knowledge, low impact on decision-making, or for other reasons?
    c. Are the proposed project areas described adequately to design research projects to achieve the anticipated outcomes? Please identify any project areas that should be refined or important project areas that should be added.

APPENDIX B: An Example of a Staged Event Management Based Strategy Using a NEBA Approach

Portions of the Strategy, especially the Technology section, could be improved by the inclusion of a net environmental benefit analysis (NEBA) for a series of scenarios involving generic environments. It is anticipated that this process would result in a guidance document that would describe several stages with different lead agencies for the various stages. The limited example given here would be most relevant to a Gulf Coast DWH Scenario.

Stage 1- Primary Close to Source Containment and Mitigation. For deep-water blowouts, the primary and most cost effective defense is preventing and containing the sources of the trouble before the hydrocarbons disperse and cover large areas of open ocean and coastline. Under ice, this may be the only practical way to mitigate problems. While beyond the mandate of the EPA (i.e. presumably a Bureau of Ocean Energy management Regulation and Enforcement (BOEMRE) concern) it seems clear that, excellent well management practices need to be followed and regulated, the blow out preventer (BOP) operation must be greatly improved under all likely adverse conditions and their correct installation monitored and that the BOP and sub-sea collector systems over the well or other surrounding blow-out regions should be coupled to facilitate rapid deployment. Can, for example, the BOPs be designed so the well can be temporally or permanently capped, the hydrocarbon plume be physically contained, collected and processed in an environmentally and economically sensitive way within days of the initial event?

It is also possible that the immediate problem will spread beyond the local wellhead area. As one worst case example, what happens if the blowout breaks the geological formations around the well, resulting in a totally unconstrained blow out and a long-term distributed leak system over several square kilometers of seabed? The oil may become heavier than seawater or quickly becomes heavier than seawater through association with sediments. In such an event, a successful relief well would presumably eventually stop the blow out. Usually this works with one relief well, but the process can take months.

Stage 2- Near Event Containment and Mechanical Skimming- This would presumably be coordinated by USCG and NOAA but physical materials and dispersant life cycle issues would be of direct relevance to the EPA interests. Very large regions of ocean surface (100's km^2) and ultimately shoreline became contaminated during the DWH event. If primary subsea containment at the wellhead is not immediately effective, can secondary physical containment and physical removal at the surface be made more effective to minimize contaminant spread? For example, if boom placement or operation was not optimal, why not? How much oil reached the surface outside the booms? Was the issue not enough booms available in a timely manner, or plenty of booms but not good information where to put them? Could a combination of oceanographic and contaminant plume monitoring and modeling allow the initial ocean surface impact region (initially probably only in the region of a few10s km^2 or less) to be predicted based on ocean current and weather conditions and then more effectively physically contained? Is this, when combined with improved physical skimming resulting in almost total removal of the oil, the most cost effective and environmentally safe methods when compared to the utilization of dispersants?

In addition, how much oil that reached the water surface went through or under booms? Were there gaps in booms through which surface oil escaped? Did oil go under or around booms placed on the surface? Currently boom technology is designed to address oil that is on the water surface; perhaps containment technology should be developed specifically to more efficiently capture oil that is coming from below the water surface. Additionally, boom failure, through entrainment and other physical forces, is a reality of oil spill response. Perhaps boom designs can be modified to make them more effective, reducing the forces of entrainment and addressing other mechanisms of boom failure, even under poor sea state and weather conditions.

How dangerous are deep-water plumes and are they associated with the generation of oxygen depleted dead zones? – A subsurface deep-water plume of certain volatile components seems to have existed in the DWH incident but do they need special attention, monitoring and mitigation? How are they generated (i.e. are solubility effects or are dispersants involved?)? Are they a result of dispersant use? Without applying dispersants, do more pollutants that are volatile make it to the water surface where they can be dealt with or naturally broken down? How are deep-water plumes to be dealt with if they are dangerous and not generated by dispersants? Dead zones already occur in the U.S. Gulf due to other factors such as eutrophication and resulting anoxia. Would adding oxygen and further nutrients to a Gulf type system help or make things worse? Again, this presumably would be a multi-agency endeavor (i.e., EPA, NOAA, USCG).

Stage 3 –Poorly confined hydrocarbon open water mitigation of hydrocarbons (i.e. dispersants, skimmers, absorptive materials etc.). In the unlikely event that open water and near shore containment strategies are 100% successful then existing and improved technologies will have to be applied over large open regions of water before the pollution hits the coastline regions. Once again, improved monitoring (sea, air and space based), can play a role in managing and observing the pollutants distribution and the efficacy of the different mitigation methods such as the application of dispersants. Can advanced techniques such as spectral analysis for surface hydrocarbon distributions and composition play a role? Under these conditions, there may, for example, be an important trade-off between improving aerial coverage and effectiveness for mechanical skimmers and the utilization of safer dispersants.

Stage 4 – Shore, wetland and estuary and clean up strategies. This is largely addressed in Section 3.3.2 (Shoreline, Coastal and Inland Effects Research to Inform Oil Spill Decision-Making). A clearer description of the current methods and potential areas where the most improvements are thought to be easily made would be helpful. Is it just the utilization of low impact green materials that is the main areas of improvement? In lagoons and estuaries is there a problem with partially degraded oil deposits on the seabed or is it just removal from beaches and wetlands that needs to be addressed? Would adding nutrients to a U.S. Gulf type coastal system help or harm a system already suffering from eutrophication and anoxia.

Are booms effective enough in near shore environments and if not can they be made more effective? Is the building of temporary sand berms to exclude oil from wetlands an effective and environmentally sensitive method? Generally sorbents and solidifiers relying on “natural materials” sounds good but historical issues regarding preferential rates of biodegradation and oxygen consumption reduce the practicality of these resources (applies to open water as well as coastal applications). Additionally, it is important to keep in mind the “natural materials” being used as sorbents, human hair, hay, corn cobs, saw dust absorb water as well as oil. Some products preferentially absorbed water, making these products more akin to “sinking agents” which is not allowed by the EPA requirements (although sorbents are exempted from NCP listing requirements). Additionally, products like peat moss are acidic and can change the pH of the systems, if there is not sufficient flushing.

Is the physical/chemical removal of oil from solids/equipment (perhaps even soils?) a way to go? It is possible to utilize steam or supercritical water to clean things very well but it gets expensive. Could you centrifuge soils, sand and wetland materials to get the hydrocarbons out and then replace the materials back where they came from? Thermal sorption technology, sand cleaning technologies utilizing hot water/steam in closed systems (such as the technologies used at Grand Isle in the Gulf Spill) can be effective. Sometimes a deflocculant is needed if there are fines in the soils.

Questions were also raised about the potential catastrophic effects that biofuel spills can have on partially enclosed systems such as lagoons, lakes and river systems. Water-soluble ethanol type fuel additives are particularly hazardous in that they do not evaporate and could lead to devastation such as eutrophication and anoxia on their break down. Air sparging and other yet to be developed methods may be option under these circumstances.

Stage 5 – Post-event natural system restoration and recovery strategies and associated monitoring. This is a highly complex area in itself but certainly, the US Gulf has suffered both physically over the years with coastal wetland destruction (partially associated with sediment supply issues) as well as biological network destruction/degradation on and offshore. Restoration is going to have to focus on the system as a whole in an integrated way and efficient monitoring will have to be in place to evaluate the effectiveness of such efforts.

In addition, could relatively energy efficient methods such as increasing sediment supply from the Mississippi River (which due to canalization now ends up in deep water) help rebuild wetland and marsh habitats with little human intervention other than sediment diversion in the delta region?