Appendix E

DISPERSANTS WHITE PAPER:
OVERVIEW OF PROTOCOLS AND POTENTIAL EFFECTS

Table of Contents

Figures & Tables

Attachments

1.0 Introduction

Dispersant use is one of four immediate methods of responding to an oil spill; the others are no response, mechanical response (skimming), and burning response. Although the use of dispersants is the main oil response technique in Europe, it has not historically been relied upon to the same degree in the United States. However, oil spill response plans in the United States are increasingly identifying the use of dispersants as a response option (NOAA 2010).

This white paper provides an overview of the use of dispersants as a response option in the event of an oil spill that reaches the marine environment. Specifically, this document provides sections aimed at defining dispersants and identifying the regulatory authority allowing their use. A section listing federally approved dispersants is provided along with sections on how they are applied, monitored and tested. The potential impacts caused by dispersant use are discussed, followed by a short history of their use in the United States and around the world. The last section describes the recent BP Deepwater Horizon oil spill and the use of dispersants in combating this spill.

The decision whether or not to use dispersants poses challenges. This is captured in the following statement by the National Research Council (NRC) report on Oil Spill Dispersants: Efficacy and Effects (NRC 2005).

> One of the most difficult decisions that oil spill responders and natural resources managers face during a spill is evaluating the environmental trade-offs associated with dispersant use. The objective of dispersant use is to transfer oil from the water surface into the water column. When applied before spills reach the coastline, dispersants will potentially decrease exposure for surface dwelling organisms (e.g., seabirds) and intertidal species (e.g., mangroves, salt marshes), while increasing it for water-column (e.g., fish) and benthic species (e.g., corals, oysters). Decisions should be made regarding the impact to the ecosystem as a whole, and this often represents a trade-off among different habitats and species that will be dictated by a full range of ecological, social, and economic values associated with the potentially affected resources. Comparing the possible ecological consequences and toxicological impacts of these trade-offs is difficult. First, each oil spill represents a unique situation and second, it is often difficult to extrapolate from published research data into field predictions, especially regarding the possibility of long-term, sublethal toxicological impacts to resident species.

The information provided here is drawn from existing documents, including the California State Oil Spill Contingency Plan (OSPR 2010a) and the California Dispersant Plan and Federal On-Scene Coordinator (FOSC) Checklist for California Federal Offshore Waters (Dispersant Plan) (CDFG 2008), which are available on the internet at: http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=16612 and http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=15889 respectively. Its purpose is to inform decision-makers about current issues involving use of dispersants. This white paper is not intended to advocate whether or not dispersants should be used in a spill or the conditions of their use, both of which are the responsibility of California's oil spill responders, nor to reach conclusions that the impacts associated with dispersants are beneficial or adverse, a challenge faced by natural resource managers.

2.0 Definition

Dispersants contain molecules that reduce the surface tension between water and oil and create a molecule chain with both water and oil droplets. Wind or wave energy act to break up the oil slick into smaller chains of water and oil droplets, effectively dispersing the oil slick to greater depths (NOAA 2010). The chemicals that comprise dispersants act to break up the concentration of oil, such as an oil slick, and dilute it, thereby spreading the newly reformed oil droplets more evenly from the surface into deeper reaches of the water column.

3.0 Authority

This section identifies the regulatory authority allowing dispersant use in both California State and Federal offshore waters.

Regarding State offshore waters, pursuant to California Government Code Section 8670.7(f), the administrator, who is appointed by the Governor, has the state authority over the use of all response methods, including but not limited to, in situ burning, use of dispersants, and any oil spill cleanup agents in connection with an oil discharge. Section 8670.4 states that the administrator shall be a chief deputy director of the California Department of Fish and Game (CDFG). The Administrator oversees the Office of Spill Prevention and Response (OSPR) and is responsible for implementing the California State Oil Spill Contingency Plan (see Attachment A) (CGC 2010, OSPR 2010a, CDFG 2005).

Regarding Federal offshore waters, pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan, California is in Region IX within the Federal response system. The Region IX Regional Response Team has approval authority for use of chemical dispersants; however, the Regional Response Team primarily provides planning, policy and coordinating guidance to the Federal On-Scene Coordinator through a Regional Contingency Plan. The Federal On-Scene Coordinator, a pre-designated official approved by the U.S. Environmental Protection Agency (EPA) and U.S. Coast Guard (USCG), may authorize the use of dispersants upon concurrence of the EPA and California's representative to the Regional Response Team, and in consultation with the U.S. Departments of Interior and Commerce (National Response Center 2010, CDFG 2005, OSPR 2010b). The three USCG Captains of The Port (COTP) are the pre-designated Federal On-Scene Coordinators in their respective COTP zones (CDFG 2008).

The California Dispersant Plan establishes the policy under which approved dispersants may be used by Federal On-Scene Coordinators in Federal waters off California (see Attachment B). The Dispersant Plan also authorizes and provides guidelines for dispersant use in both Dispersant Pre-Approval Zones and Regional Response Team Approval Required Zones.

3.1 DISPERSANT PRE-APPROVAL ZONES

In the event of an oil spill, the Dispersant Plan is designed to assist the Federal On-Scene Coordinator in making the determination as to whether or not a dispersant will be applied. The Dispersant Plan provides a worksheet and checklist to assist and document the Federal On-Scene Coordinator's decision-making process (CDFG 2008). These documents are described below.

Dispersant Assessment Worksheet

This worksheet assists the Federal On-Scene Coordinator in gathering and organizing relevant information, such as:

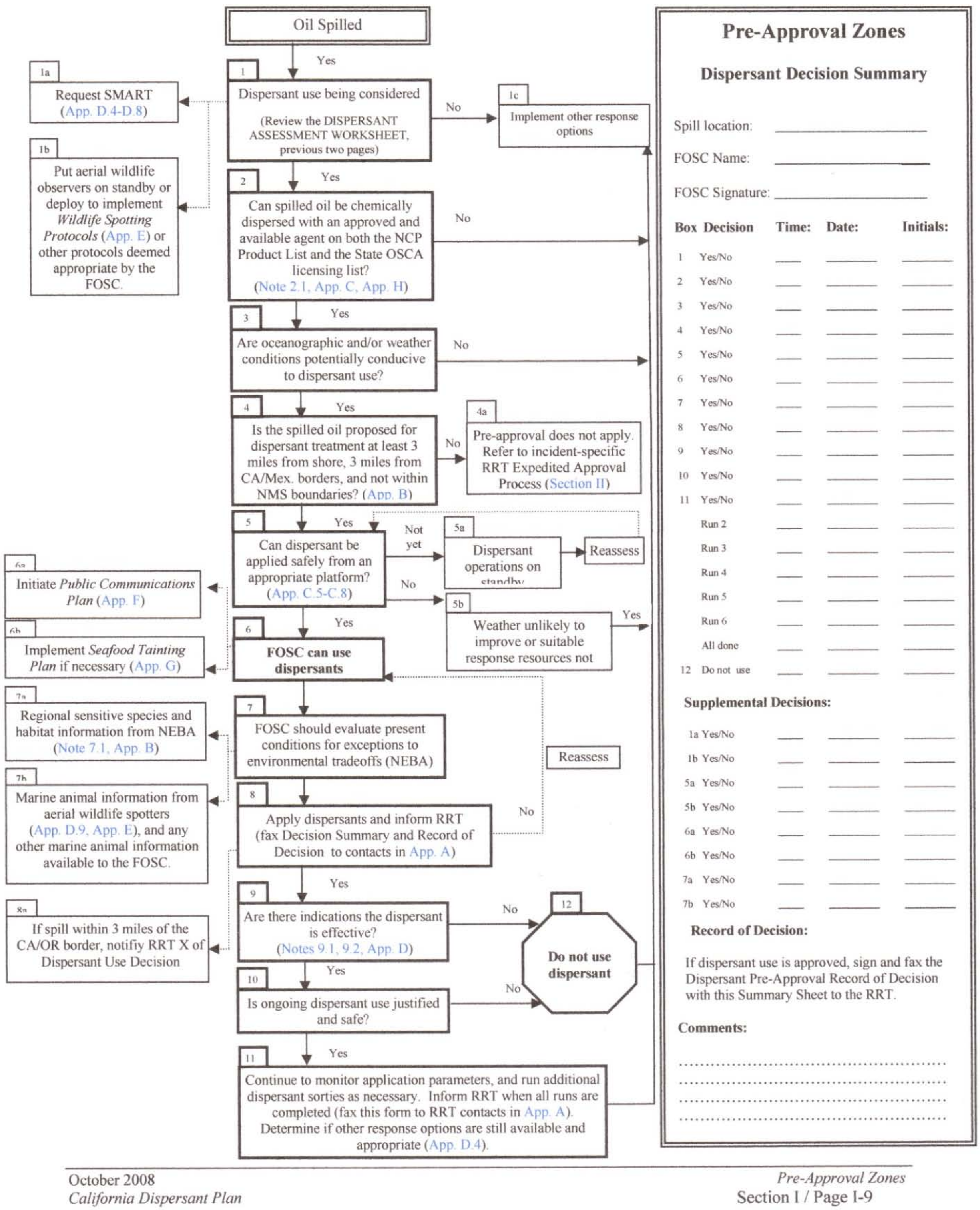
1. General Spill Information: date, location, source, cause, amount and flow rate;
2. On-scene Weather, Currents and Tides: wind direction and speed, slick speed, visibility, and tidal times;
3. Predicting Spill Movement: estimating distance and time to shore;
4. Estimating Oil Spill Volume: spill length and width, and estimated slick area;
5. Potential Resource Impacts: description of areas; and
6. Dispersant Spray Operation: contractor name, delivery platform, and implementation time.

Pre-Approval Zone Dispersant Use Checklist for Federal Waters (see Figure H-1)

This flowchart is used in conjunction with the Checklist Documentation and Support Form, Box Numbers 1 - 12 (see Attachment B), as a worksheet designed to guide the Federal On-Scene Coordinator through the decision-making process by listing the following pertinent questions/directives:

1. Is dispersant use being considered?
2. Can spilled oil be chemically dispersed with an approved and available agent on both the National Contingency Plan product list and the State oil spill cleanup agent licensing list?
3. Are oceanographic and/or weather conditions potentially conducive to dispersant use?
4. Is the spilled oil proposed for dispersant treatment at least 3 [nautical] miles from shore, not within National Marine Sanctuaries boundaries, and not within 3 [nautical] miles of the California/Mexico border?
5. Can dispersant be applied safely from an appropriate platform?
6. Federal On-Scene Coordinator can use dispersants.
7. Federal On-Scene Coordinator should evaluate present conditions for exceptions to environmental tradeoffs (Net Environmental Benefit Analysis).
8. Apply dispersants and inform Regional Response Team.
9. Are there indications the dispersant is effective?
10. Is ongoing dispersant use justified and safe?

Figure H-1 Pre-Approval Zone Dispersant Use Checklist (CDFG 2008)



Pursuant to the checklist in Figure I-1, a negative response to questions # 9 and # 10 would result in the decision not to apply dispersants. If a decision to use a dispersant is made, the Federal and State On-Scene Coordinators must sign, date and fax to the Regional Response Team the Dispersant Pre-Approval Record of Decision (see Attachment B), along with the completed dispersant use checklist. Checklist item # 11 requires the FOSC to continue to monitor dispersant applications.

3.2 REGIONAL RESPONSE TEAM APPROVAL REQUIRED ZONES

Regarding the Regional Response Team Approval Required Zones, the Dispersant Plan provides a similar worksheet and checklist as provided in the Dispersant Pre-Approval Zones. The only differences involve determining whether the spill is within three nautical miles from shore and whether the dispersant can reasonably be expected to have a net environmental benefit. Further, unlike the pre-approval process, Federal On-Scene Coordinator authorization requires the concurrence of the Regional Response Team Co-Chairs (USCG and EPA) and State representatives to the Regional Response Team, in consultation with representatives of the U.S. Departments of Interior and Commerce. The Regional Response Team provides a response to the Federal On-Scene Coordinator's approval request within two hours (CDFG 2008).

4.0 Approved Dispersants

Pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan, the EPA has prepared a product schedule that lists authorized dispersants, surface washing agents, surface collecting agents, bioremediation agents, and miscellaneous control agents (see Attachment C). The product schedule lists 14 authorized dispersants:

- Corexit EC9527A
- Neos AB3000
- Mare Clean 200
- Corexit EC9500A
- Dispersit SPC 1000
- JD-109
- JD-2000
- Nokomis 3-F4
- Biodispers
- Sea Brat #4
- Finasol OSR 52
- SAF-RON Gold
- ZI-400
- Nokomis 3-AA

The EPA has also released a product schedule technical notebook that summarizes technical information on each of the authorized products (see Attachment D) (EPA 2010c, EPA 2010d).

5.0 Application, Monitoring, & Testing

In general, dispersants are most effective on lighter oils and when used within the first few hours to one day after an oil spill. If applied during this period, there is an increased chance that water-in-oil emulsions and tar balls will be prevented from forming or will be severely reduced in size and number (NOAA 2001).

Dispersants are generally delivered to the targeted oil slick by airplane, helicopter, and/or boat. When possible, infrared detectors are used by spotter planes to pinpoint the location of spilled oil. Since a certain amount of energy (wave and wind) is required to activate the chemical reaction, moderate weather is optimal. On the other hand, high waves and heavy winds make it more difficult – even dangerous – for aircraft to target the oil and deliver the appropriate amount of dispersant (NOAA 2010).

Depending on the size, location, weather conditions and type of oil spilled, differing combinations of droplet size, concentration, and rate of application are administered. Once dispersants are applied, dispersed oil laterally spreads while dropping down the water column between one and ten meters (three and 30 feet). As a result, dispersant use is limited to waters deeper than ten meters (30 feet) in order to avoid possible sea floor contamination.

The USCG, assisted by the National Oceanic and Atmospheric Administration (NOAA), monitors dispersant applications to determine their efficacy and impacts to the marine ecosystem. The Special Monitoring of Applied Response Technologies (SMART) program was developed to bring together dispersant-monitoring components for use by these agencies. SMART uses small, mobile teams to collect and transmit real-time data through the use of easy-to-use, portable and rugged instruments (NOAA 2010).

One of the instruments used is a fluorometer, which measures the fluctuation of a chemical or compound's wavelength or emitted light, i.e., fluorescence. Using this technique allows monitors to locate an oil plume and, under certain circumstances, determine the degree to which the oil has been broken down. A laser-induced particle size analyzer may also be employed to determine the size of the oil droplets and their dispersion rate (EPA 2010a).

Another aspect of dispersant use that is monitored is the potential toxicity of their use. Identifying a dispersant's toxicity effects on living organisms allows responders to calibrate the degree of dispersant application. This can be accomplished by employing a standardized rotifer test. Rotifers are sensitive, small invertebrates, which are exposed to water collected at different distances from the oil spill. Rotifer survival rate comparisons are made between those exposed to clean water versus impacted water (EPA 2010a). Depending on the results of the testing, the use of dispersants is curtailed or continued.

6.0 Potential Effects

In addition to ecological damage, spilled oil can have a devastating effect on the local and regional economy by negatively impacting tourism, recreation, commercial and sport fishing, and those businesses dependent on these industries. Oil is considered to be very toxic, can impact sensitive environments such as coastal wetlands, mangrove swamps, and coral reefs, and is dangerous to seabirds and marine wildlife, such as sea turtles, sea otters, and other fur-bearing marine mammals.

When an oil spill occurs, a decision must be made whether to do nothing—and let nature takes its course—or employ one or a combination of the common immediate mitigation responses, which are skimming, dispersant use, and burning. Unfortunately, there is no definitive evidence that oil spill mitigation methods, on the whole, are more or less damaging to the environment than doing nothing. At this time, not enough field studies have been conducted that conclusively point in one direction or the other.

That said, some experts consider oil to be more toxic than dispersants, which, according to the EPA, is a strong reason for using dispersants in events such as the BP Deepwater Horizon oil spill. In lab tests conducted by the EPA, none of the dispersants tested and approved for use displayed biologically significant endocrine-disrupting activity or proved to be more toxic to aquatic life than oil. NOAA (2010) and EPA (2010a) report that the concentrations of dispersed oil gradually reduce the deeper the water mark and significantly drop after a few hours due to currents and wave energy; within approximately four weeks, depending on factors such as water temperature, oxygen content, and the presence of micro-organisms, the dispersed oil is broken down to naturally occurring substances and processed by the marine ecosystem. Note, however, that although dispersion can affect plankton and early life stages of fish during the first day of application, dispersants are intended to prevent oil from reaching the shore, thereby minimizing the long-term impacts to shoreline habitats, such as beaches, swamps and archeological sites (NOAA 2001, NOAA 2010, NOLA 2010).

7.0 History

Historically, mechanical response, extensive shoreline cleanup, and bird and wildlife rehabilitation have been the main response methods to oil spills off the coasts of Washington, Oregon, California, and Baja California. However, dispersion field trials conducted in the 1970s underscored the need for further research and testing. In the 1980s, dispersants were used in two California oil spills, but the results on efficacy were equivocal due to limited operations. Studies conducted in the last 20 years suggest that dispersants could be more suitable as a response option than previously considered (NOAA 2001). In the past 15 years, dispersants have been applied to small spills off the coasts of Louisiana and Texas.

The application of dispersants as an oil spill response method overseas has been greater than in the United States. In 1996, as part of a larger response to the release of 72,000 tons of light crude oil from the Sea Empress in South Wales, 118,000 gallons of dispersants were used to combat the spill. Edwards (1999) discussed the environmental impact and recovery of this spill and found that, in general, environmental impacts were less severe than initially anticipated. The study stated that: (1) factors including time of year, wind direction, dispersant use, and speed of response minimized the impacts; (2) use of dispersants (by air) resulted in 24 percent of the oil being dispersed; and (3) dispersants combined with natural dispersion and evaporation resulted in only five to seven percent of the oil reaching the shore (Edwards 1999).

More recently, in 2009, 50,000 gallons of dispersants were used on the West Atlas (Montara) oil spill in Australia (EPA 2010a). In June 2010, a report detailing the results of an investigation into the oil spill was provided to the Australian government, but the findings have not yet been made public.

In 2005, the NRC issued a report regarding oil spill dispersants and their efficacy and effects. A key finding in this report stated that more information is required to determine dispersant effectiveness on different oil types and environmental conditions. The report also suggests that Federal, state and industry partners need to establish an integrated research plan and increase laboratory and field research (NRC 2005).

8.0 BP Oil Spill

On April 20, 2010, the British Petroleum (BP) Deepwater Horizon platform in the Gulf of Mexico exploded, causing the largest oil spill in U.S. history. As the Federal On-Scene Coordinator, the USCG authorized the use of the dispersant Corexit 9500 on the water's surface and subsurface at the source of the leak. Table 1-1 shows the chemical components of Corexit 9500.

Table H-1 Corexit 9500 Components

CAS Registry Number	Chemical Name
57-55-6	1,2-Propanediol
111-76-2	Ethanol, 2-butoxy-
577-11-7	Butanedioic acid, 2-sulfo-, 1, 4-bis (2-ethylhexyl) ester, sodium salt (1:1)
1338-43-8	Sorbitan, mono-(9Z)-9-octadecenoate
9005-65-6	Sorbitan, mono-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivs.
9005-70-3	Sorbitan, tri-(9Z)-9-octadecenoate, poly(oxy-1,2-ethanediyl) derivs
29911-28-2	2-Propanol, 1-(2-butoxy-1-methylethoxy)-
64742-47-8	Distillates (petroleum), hydrotreated light

Notes: i) Chemical component Ethanol, 2-butoxy- is not included in the composition of Corexit 9500; ii) These are also the components of Corexit 9527.
Source: EPA 2010a

The use of a dispersant underwater at the source of a leak is unprecedented. As of July 12, 2010, more than 1.07 million gallons of surface dispersant were used and more than 735,000 gallons of subsea dispersant were used, making it the largest application of dispersants in U.S. history. Expectantly, the short-term and long-term effects on aquatic and human life through bioaccumulation via the food chain are unknown (EPA 2010a).

On May 10, 2010, as part of a monitoring and assessment directive, the EPA identified the following criteria to determine whether the subsea dispersant should be shut down:

1. A significant reduction of dissolved oxygen;
2. The results of rotifer toxicity tests; and
3. The evaluation of the conditions above plus other factors, including shoreline, surface water, and other human health and ecological impacts (EPA 2010a).

As a cautionary measure, on May 26, 2010, the EPA directed a decrease in the overall volume of dispersant use by 75 percent and the cessation of the use of surface dispersants. This would have resulted in a maximum allowance of 15,000 gallons per day of subsea dispersant. In response, BP reduced the amount of dispersant use by 72 percent from their peak levels. Initial monitoring and analysis to that point indicated the dispersant was having a positive effect with no significant ecological impact. However, the EPA required BP to study the dispersant and determine whether there was a less toxic and equally effective alternative (EPA 2010a, EPA 2010b).

Dissatisfied with BP's testing, on June 30, 2010, the EPA released its own preliminary studies confirming that Corexit 9500 and seven alternative dispersants did not display biologically significant endocrine disrupting activity (see Attachments E & F). According to these studies, all of the dispersants fell within the range of practically non-toxic to slightly toxic, and Corexit 9500 and JD-2000 were the least toxic to small fish. Additional research found that compared to oil in its natural state, oil in the presence of the dispersant Corexit 9500 increased the rate of biodegradation by almost 50 percent. Subsequently, the EPA directed BP to continue the use of dispersants responsibly and as sparingly as possible (EPA 2010b, EPA 2010e, EPA 2010f, EPA 2010g).

As noted earlier, a spill of this magnitude had never before occurred in the United States. Mitigation procedures and cleanup efforts are fluid and ongoing, and the extent to which oil spill contingency plan protocols were followed is not known. An ongoing official inquiry into the response may shed light on this matter.

9.0 References

California Department of Fish and Game (CDFG). 2005. California Oil Spill Dispersant Plan – Achievement Through Cooperation. Sacramento, CA: Prepared by Addassi, Y.N., Faurot-Daniels, E.; 2005.

___ 2008. California Dispersant Plan and Federal On-Scene Coordinator (FOSC) Checklist for California Federal Offshore Waters. Final, October 2008. http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=15889. Accessed on July 29, 2010.

California Department of Fish and Game, Office of Spill Prevention and Response (OSPR) 2010a. California State Oil Spill Contingency Plan. http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=16612. Accessed on July 29, 2010.

___ 2010b. About. http://www.dfg.ca.gov/ospr/About/. Accessed on July 13, 2010.
California Government Code (CGC). 2010. Title 2, Division 1, Chapter 7, California Emergency Services Act, Article 3.5. Oil Spills. Revised January 2010.

Deepwater Horizon Response (DHR) – The Official Site of the Deepwater Horizon Unified Command. 2010. Operations and Ongoing Response – July 13, 2010. http://www.deepwaterhorizonresponse.com/go/doc/2931/778111/. Accessed on July 13, 2010.

Edwards, R, White, I. 1999. The Sea Empress Oil Spill: Environmental Impact and Recovery.

Environmental Protection Agency (EPA). 2010a. EPA Response to BP Spill in the Gulf of Mexico. http://www.epa.gov/BPSpill/dispersants.html#appl1. Accessed on July 13, 2010.

___ 2010b. Testimony of Lisa P. Jackson, EPA Administrator, Before the Subcommittee on Commerce, Justice, Science, and Related Agencies, Committee on Appropriations, United States Senate. July 15, 2010. http://epa.gov/ocir/hearings/testimony/111_2009_2010/2010_0715_lj.pdf. Accessed on July 29, 2010.

___ 2010c. News Releases from Headquarters. EPA Releases First Round of Toxicity Testing Data for Eight Oil Dispersants. June 30, 2010. http://yosemite.epa.gov/opa/admpress.nsf/. Accessed on July 13, 2010.

___ 2010d. National Contingency Plan Product Schedule. July 8, 2010.

___ 2010e. National Contingency Plan Product Schedule Notebook. July 8, 2010.

___ 2010f. Comparative Toxicity of Eight Oil Dispersant Products on Two Gulf of Mexico Aquatic Test Species. June 30, 2010.

___ 2010g. Analysis of Eight Oil Spill Dispersants Using *In Vitro* Tests for Endocrine and Other Biological Activity. June 30, 2010.

National Oceanic and Atmospheric Administration (NOAA). 2001. Dispersing Oil Near Shore in the California Current Region. Seattle, WA: Prepared by Mearns, A., Watabayashi, G., Landford, J.; 2001. CalCOFI Rep., Vol. 42, 2001.

___ 2010. Dispersants: A Guided Tour. http://www.response.restoration.noaa.gov/. Accessed on July 9, 2010.

National Research Council (NRC) 2005. Oil Spill Dispersants: Efficacy and Effects. http://dels.nas.edu/resources/static-assets/materials-based-on-reports/special-products/oil_spill_dispersants_key_findings_final.pdf. Accessed on July 28, 2010.

National Response Center. 2010. National Response System. http://www.nrc.uscg.mil/nrsinfo.html. Accessed on July 13, 2010.

New Orleans Louisiana (NOLA). 2010. Dispersants' Effects on Wildlife Vary Little Among Brands, EPA Finds. June 30, 2010. http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/06/dispersants_effects_on_wildlif.html. Accessed on July 29, 2010.