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**THE BP OIL SPILL: HUMAN EXPOSURE AND
ENVIRONMENTAL FATE**

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Health Effects of Oil Spills: Air Quality

Oil spills destroy ecosystems and kill wildlife, but people's health is directly affected too. As the disaster in the Gulf Coast continues to unfold, the local communities and workers must be protected.

Oil is semi-volatile, which means that it can evaporate into the air and create a vapor that under some weather conditions stays near the surface - in the human breathing zone. A report from the National Academy of Sciences (NAS) estimated that: "Within a few days following a spill, light crude oils can lose up to 75 percent of their initial volume and medium crudes up to 40 percent."¹ Figure 1, adapted from the NAS report, shows the evaporation rates of various petroleum products, including crude oil. The evaporation process may spare the ocean slightly, but it poses a host of hazards to anyone who breathes the air.

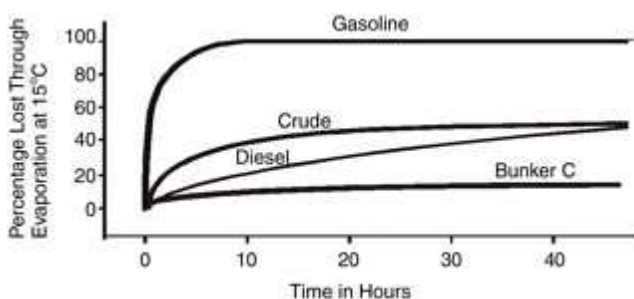


FIGURE 1: Evaporation rates of different types of oil at 15°C (adapted from Fingas, 2000).

Even some of the oil that does not evaporate can end up in the air. When winds whip up oily sea water, the spray contains tiny droplets - basically an aerosol, which is small enough to be inhaled deep into the lungs. We know that evaporation, and maybe also aerosol formation, is happening in the Gulf Coast, because people are reporting a heavy oily smell in the air. If the oil is burned, it generates particulate matter (PM) which is an additional respiratory hazard.

Crude oil contains a mixture of chemicals. The main ingredients are various hydrocarbons, some of which can cause cancer (eg. the PAHs or polycyclic aromatic hydrocarbons); other hydrocarbons can cause skin and airway irritation. There are also volatile hydrocarbons called VOCs (volatile organic compounds) which can cause acute health symptoms as well as cancer and neurologic and reproductive harm. Specific VOCs that cause health concern include benzene, toluene, ethylbenzene, and xylene (BTEX). Oil also can release hydrogen sulfide gas, and it contains traces of heavy metals such as mercury, arsenic, and lead.

Inhalation hazards are mostly from the VOCs, hydrogen sulfide gas, and some of the semi-volatile PAHs. The heavier PAHs and the metals do not get into the air, and are mostly a human health hazard because of long-term contamination of fish and shellfish.

Health Effects of Oil Vapor Inhalation

"I live on the Northshore of New Orleans, less than a mile from Lake Ponchartrain. Many of us have noticed a smell in the area and a very slight filminess in the air or on skin at times. I have been suffering from headaches for the past few weeks and have had several people tell me the same or that they have a scratchiness to their throats or eyes burning. I walked my dog the other day of the lakefront and came home with a pounding headache. Could the oil or dispersants be affecting us here?" Maria, May 19, 2010.²

There have been numerous reports from clean-up workers and from people in the coastal communities of nausea, headaches, dizziness, cough and difficulty breathing. These types of symptoms are what might be expected from the oil vapors. The CDC warns:

Inhalation of fresh crude oil could result in inhalation of associated volatile hydrocarbons. Symptoms including headache, dizziness, confusion, nausea, or vomiting, may occur from breathing vapors given off by crude oil.³

EPA lists the health symptoms that are generally associated with VOCs as:

Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue, dizziness.⁴

CDC also put out a consumer fact sheet which says the following about the "smells" along the Gulf coast:

People may be able to smell the oil spill from the shore. The smell is similar to what you can smell at a gas station. It comes from "Volatile Organic Compounds" (VOCs) in the oil. You can smell these VOCs at levels well below those that would make you sick (sic). VOCs are also in the gas you burn in your car every day and can include benzene, toluene, ethylbenzene, xylene and naphthalene.

Exposure to low levels of VOCs may cause irritation of the eyes, nose, throat, and skin. It is possible that people with asthma may be more sensitive to the effects of inhaled VOCs.

The VOC smell may give you a headache or upset stomach, so you should stay indoors to limit your exposure, close windows and doors, and set your air conditioner to a recirculation mode. The smell may become stronger if the wind or weather change.⁵

I do want to add a comment about CDC’s claim that people can smell VOCs at levels “well below those that would make you sick”. Table 1 lists the odor thresholds and the toxicity levels for some of the major chemicals in crude oil vapors. It’s clear that some of the chemicals in oil vapors are hazardous to human health at levels below those that trigger odor complaints. In fact, benzene is hazardous to health at levels more than 1000-fold below the odor threshold. This is an important fact, since it is not appropriate to assure people that what they are smelling is not hazardous.

Chemical	Odor Threshold (average, ppm)	NIOSH REL 8hr (ppm)	ATSDR MRL (ppm)
Benzene	97	0.1	0.009
Toluene	7.6	100	1
Ethylbenzene	0.6	100	10
Xylene	0.73 - 5.4	100	2
Naphthalene	0.038	10	0.0007 (Chronic)
Hydrogen sulfide	0.02	N/A	0.07
2-butoxyethanol	0.1	5	6

ppm = Parts per million

NIOSH = National Institute of Occupational Safety and Health

REL = Recommended Exposure Limit for worker populations

ATSDR = Agency for Toxic Substances and Disease Registry

MRL = Minimal Risk Level for community residents

Sources

Odor Thresholds:

<http://nepis.epa.gov/Exe/ZyNET.exe/2000BHG5.txt?ZyActionD=ZyDocument&Client=EPA&Index=1991%20Thru%201994&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C91THRU94%5CTXT%5C00000004%5C2000BHG5.txt&User=ANONY&MaximumDocuments=10&FuzzyDegree=0&ImageQuality=r105g16/r105g16/x150y150g16/i600&Display=p%7Cf&DefSeekF>

Note that range for xylenes is due to isomers: ortho-, meta- and para- xylene

Odor Threshold for H2S: <http://www.osha.gov/dts/sltc/methods/validated/1008/1008.html>

NIOSH RELs: <http://www.osha.gov/web/dep/chemicaldata/>

MRLs: http://www.atsdr.cdc.gov/mrls/mrls_list.html

The good news for the general public is that the EPA network of air monitors along the Gulf coast has so far mostly indicated that there is not a likelihood of long-term health effects. The CDC analysis of the EPA air quality data concludes: “The levels of some of the pollutants that have been reported to date may cause temporary eye, nose, or throat irritation, nausea, or headaches, but are not thought to be high enough to cause long-term harm. These effects should go away when levels go down or when a person leaves the area. The low levels that have been found are not expected to cause long term harm.”⁶ I have been independently reviewing the EPA air monitoring data. There are numerous things EPA could be doing to improve their monitoring, but overall I concur with the CDC and EPA conclusions that there is no reason for panic about the air quality on shore. I list recommendations for improving the EPA air monitoring program at the end of my testimony.

Skin Toxicity from the Oil

Oil is irritating to the skin and can cause potentially severe skin rashes. The CDC states the following:

“some people are especially sensitive to chemicals, including the hydrocarbons found in crude oil and petroleum products. They may have an allergic reaction, or develop dermatitis or a skin rash, even from brief contact with oil. In general, dermal contact with oil should be avoided....Prolonged skin contact with crude oil and petroleum products can cause skin erythema (reddening), edema (swelling), and burning. The skin effects can worsen by subsequent exposure to sunlight, because trace contaminants in the oil, such as the PAHs, are more toxic when exposed to light. Skin contact can result in defatting of the skin, increasing the possibility of dermatitis and secondary skin infections.

Some persons may be, or may become, sensitive to the crude oil. Depending on the amount and duration of exposure, skin contact with crude oil may be mildly to moderately irritating; in a sensitive individual, the skin effects may be more pronounced after a smaller or shorter exposure.”⁷

People should absolutely avoid any direct skin contact with the oil. This means no swimming in waters that may be contaminated with oil. Reports from Mississippi have indicated that Governor Barbour has been encouraging people to go swimming despite the oil spill.⁸ In fact, CNN reported that children were swimming in oil-contaminated water along the Gulf coast.⁹ That is a serious mistake both because of direct skin toxicity, and because children’s skin is far more permeable to toxic chemicals than adult skin, so they can absorb some chemicals into their bodies that could lead to more serious health effects.

Worker Health

“My Husband he is on site where the oil leak working to stop the leak they have to wear a respiratory mask and they are coughing and have scratchy throats doctor told them not to worry that there is no long term health effect once they are away from the job breathing the fresh air they will be fine and they will be breathing normal again i am very worried about my husband they are on the ship weeks and weeks working to stop the leak what is the risk on their long term health?” Maria, May 22, 2010.¹⁰

Over the past few weeks, fishermen who have been involved in the spill clean-up have begun to come forward with complaints about their health. Some clean-up workers have been hospitalized with respiratory problems, chest pain, nausea, and other symptoms. Treating physicians have diagnosed some of the workers with exposure to “inhaled irritants”, such as from oil or dispersants.

There are also disturbing photos that have been posted on the internet and in the LA Times, showing clean-up workers on beaches in regular street clothes without even the benefit of gloves. These people are in contact with the weathered oil (as opposed to fresh oil bubbling up from the continuing leak). Weathered oil is considered less dangerous than fresh oil because the toxic vapors have dissipated, but it is not benign. Skin contact with even the weathered oil is very damaging, so gloves should be required. In addition, the oil can contaminate shoes and clothing, and could then be worn home where it could pose a risk to young children.

We have received dozens of requests for respirators from fishermen involved in the clean up effort. They certainly didn't get any from BP. Instead, BP officials told the fishermen that the air quality is fine out where they are working to clean up the oil, but they have not released enough of their data on air quality for me to assess whether the BP claims are correct or not.

Hidden on its website, BP posted a document with no title and no author that includes a general summary of the "Offshore Personnel Sample Results" conducted between April 28 and May 13 2010 for benzene and total hydrocarbons.¹¹ The document provides no information on the sampling method, the location the samples were taken, the duration or time of sampling, or the raw data behind the graphs. In addition, the data is classified into rough cut-offs that make it difficult to interpret the actual health risks. The majority of samples (128 out of 187) in the summary had detectable levels of total hydrocarbons and 28 had levels greater than 10 ppm, the level of concern EPA has identified for its onshore monitoring of Volatile Organic Compounds (VOCs). In contrast, the BP summary cites an action limit of greater than 100 ppm. 11 samples had detectable levels of benzene with measurements up to 0.5 ppm. This range encompasses the National Institute of Occupational Safety and Health Recommended Exposure Limit (REL) for occupational exposure to benzene of 0.1 ppm. From the data presented it is impossible to ascertain how many of the samples taken exceeded this health based value intended to prevent cancer. The document contained no data at all on hydrogen sulfide, naphthalene, dispersant chemicals, and other air pollutants that are harmful to health and that workers are likely to be exposed to. BP's document concluded that the monitoring data, "demonstrate that there are no significant exposures occurring". However, the data summarized in this document do not substantiate these assurances and raise significant questions about what the fishermen are being exposed to.

BP should release all of their air monitoring data - or the federal government should do independent measurements of air quality offshore and release it to the public. Fishermen are falling ill. Something is in the air, and we need to know what it is.

Dispersants

"My son has gone through some extensive tankerman training and knows his chemicals and he's been asking for the MSDS's on some of the chemicals being used to spray the oil with from the boat and having no luck receiving (sic) any info on any of the chemicals." Comment from Nickie, May 25, 2010.¹²

Several weeks ago, the EPA told BP that it must identify a safer and more effective dispersant within 24 hours, and must switch to safer dispersants within three days. This was a good idea for health and the environment. BP should be required to use the safest and most effective approaches possible, rather than the most convenient or cheapest products. There are dispersants that have already been approved by EPA that appear to be both much safer and more effective than the ones BP has chosen.¹³

I looked into the toxicity of the Corexit 9500 and 9527 products that BP has been using, and had concerns, especially for worker safety and for the health of fish and marine mammals. The ingredients in these products - even the 2-butoxyethanol which worries me most - might not be a problem if used in small amounts. But the use of over 700,000 gallons of even modestly toxic chemicals can become a serious problem.

I'm not an expert on the pros and cons of dispersants, or on their effects on marine life. But I do have some expertise on human health, and I also have some common sense. One important principle in medicine is that you pick the drug that is the most effective and has the fewest side-effects to treat the disease. As hundreds of thousands of gallons of dispersant was poured into the Gulf, I began to wonder if that principle was being considered here.

When BP released their response¹⁴ to the EPA order on dispersants, the flaws of the U.S. chemical safety system became clear. BP refused to switch dispersants because, among other reasons, they say there's not enough information about their safety.

Tables in the BP memo contain a row that is supposed to list: "Persistence, bioaccumulation, and chronic effects, and endocrine disruption" for the various dispersants, but the boxes in that section contain the words "Proprietary mixture" for almost all the products. That means that the public has no access to the full ingredients lists of these products, or any ability to independently verify their safety. Amazingly, neither, apparently, does BP.

In fact, the BP memo complains about the information gap and cites this as a reason for not switching to other dispersants. But the information gaps don't stop there: Major portions of BP's memo have been redacted, so the public can't even review much of BP's analysis of the alternatives.

These information gaps have their root in the Toxic Substances Control Act (TSCA)'s broad protections for "confidential business information". It is a continuous source of frustration to me as a physician and an environmental scientist - I need to know what the hidden ingredients are in products in order to protect my patients and the public. Right now we definitely need to know what's in these alternative dispersants in order to understand the risks and trade-offs. Now is the time to require chemical manufacturers to disclose their trade secrets. The dispersant debacle is proof enough that it's time for change.

Seafood Contamination

Crude oil contains traces of heavy metals such as lead, mercury, and cadmium. It also contains large amounts of polycyclic aromatic hydrocarbons (PAHs), some of which are environmentally persistent. In the near term, various hydrocarbons from the oil itself will contaminate fish and shellfish, so there is an immediate need to assess seafood safety and assure that contaminated fish and shellfish do not reach people's tables. But the problem will not go away when the obvious oil dissipates in the water. The persistent chemicals – the metals and PAHs - will remain in the sediments of the Gulf, and will accumulate in the food chain for years, and likely for decades.

Furthermore, the drilling mud that BP used in an attempt to plug the leaking oil could have human health impacts through the leaching of persistent organic compounds and heavy metals that can also accumulate in the food chain. Information is not publicly available on the make-up of the specific drilling fluid utilized by BP; in fact, many of the specific chemical components of drilling fluids are not well known.¹⁵ However, some studies have demonstrated the potential for metals to accumulate in marine organisms which are harvested for local and commercial consumption. When EPA modeled contaminant concentrations in shrimp after the use of synthetic drilling fluids they projected some contamination with mercury, lead, and polyaromatic hydrocarbons.¹⁶ Additional studies have found that drilling fluid consisting of barite and bentonite also has the potential to leach heavy metals into the environment.^{17 18}

The chemicals in the oil and the drilling mud have the potential to bioaccumulate in seafood and could pose a human health risk when higher trophic levels (eg. large, carnivorous fish such as swordfish or king mackerel) are consumed, particularly for populations which rely substantially on Gulf seafood as a large portion of their diet.

Recommendations:*Improve Response to Community Complaints*

Oil spill-impacted communities have been experiencing odors and health complaints and not receiving adequate attention. EPA should be responding to these complaints as quickly as possible to conduct the appropriate monitoring and communicate the results. To facilitate this, EPA should dedicate a portion of the website to providing information on how to report a complaint, locate the results of any monitoring conducted in response to a complaint, and related relevant information on odors and health effects.

Monitor Wind Patterns to Estimate Most Impacted Areas

Meteorological data on wind conditions and weather patterns should be assessed to evaluate the degree to which existing fixed monitoring stations are capturing the areas of highest impact. The results of this assessment should be updated regularly and posted on the website. In the event this modeling reveals areas of potential impact that are not included in the current monitoring network, EPA should develop an expanded monitoring plan to address these areas.

Obtain All Relevant Data on Pollutant Releases

Efficient and comprehensive monitoring plans would be greatly assisted by accurate and complete information on the location and quantity of pollutant releases. This should include up-to-date monitoring of the spill and also all applications of dispersants. In particular, the location, quantity, and application method for all airborne dispersant applications should be reported to the public. This should include data on the chemical make-up of the crude oil, dispersant, and oil-dispersant mixture. This information can inform onshore air monitoring and the development of offshore buffer zones to keep clean-up workers and communities safe.

Ensure Public Disclosure of All Air Monitoring Data

All data collected on air quality, both offshore and onshore, should be made public regardless of where it originated. EPA is the agency best suited to be a clearinghouse for this data and make it available to the public. This should include information on both the oil-related compounds and the dispersants. It is essential that the public, and medical providers in particular, have access to health relevant information on all chemicals released into the environment.

Require Testing and Public Release of Information About All Dispersants Used

Manufacturers and processors of dispersant chemicals should provide data sufficient to determine the potential for these chemicals or their breakdown products to persist or accumulate, or contribute to adverse effects on human health or the environment. Ingredients of dispersant products should be made publicly available for independent scrutiny. EPA should reassess these chemicals to assure their safety and efficacy for their intended uses.

Communicate Monitoring Results Effectively

Data on air quality onshore and offshore are difficult to access and poorly presented. A web-based clearinghouse should facilitate queries by specific location. Also, all data files should include enough information to enable a user to determine what was sampled, where it was sampled (latitude, longitude, city, county, state), when it was sampled (date and time) what method was used for the sample collection and analysis, and the relevant limits of detection. In addition, the EPA and the Coast Guard should conduct community forums to explain the monitoring efforts and results to community members. Such forums should be conducted in collaboration with local community groups and should include presenters from relevant agencies and outside experts.

Protect Worker Safety and Health

The Department of Labor should strongly enforce OSHA's Hazardous Waste Operations and Emergency Response standards requiring personal protective equipment, including respirators as required under Respiratory Protection standards. All air monitoring relevant to worker exposures should be publicly released, and data should be obtained in places where workers may be exposed to vapors from the oil. The Department of Health and Human Services should conduct a Health Hazard Evaluation of workers, and should design and conduct a health surveillance program for clean-up workers.

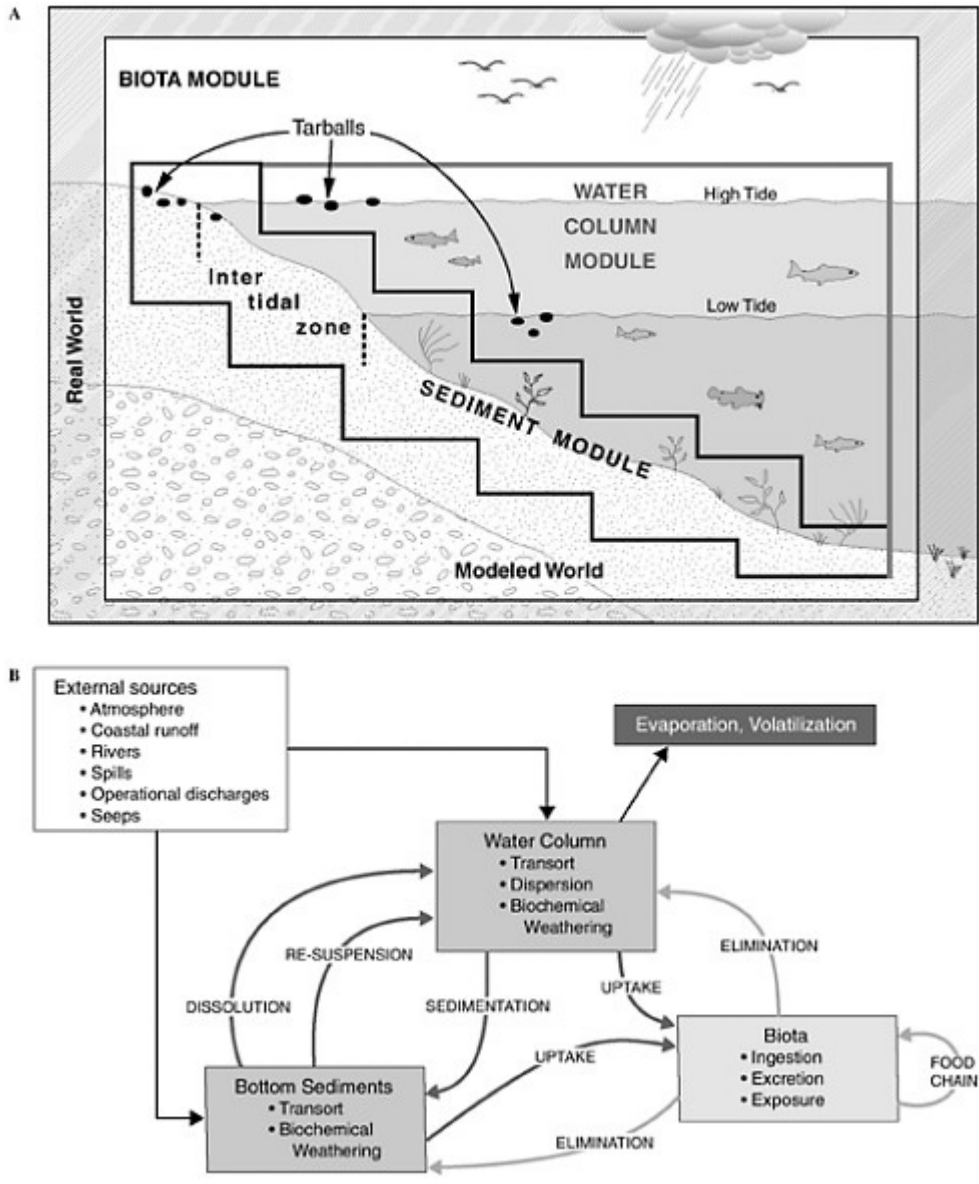


FIGURE 2 Graphic representation (A) and detailed interactions (B) of a conceptual model for the fate of petroleum in the marine environment. Various modules depicted are often included as significant components of computer models attempting to simulate or predict behavior and fate of petroleum compounds. From NAS "Oil in the Sea III: Inputs, Fates, and Effects, 2003.

¹ Committee on Oil in the Sea: Inputs, Fates, and Effects. Oil in the Sea III: Inputs, Fates, and Effects. National Academies Press (2003) p. 90.

² Comment posted at: http://switchboard.nrdc.org/blogs/gsolomon/the_gulf_oil_spill_human_health.html

³ CDC. Light Crude Oil Information for Health Professionals. http://www.cdc.gov/nceh/oil_spill/light_crude_health_professionals.htm. May 19, 2010.

⁴ http://www.epa.gov/iaq/voc.html#Health_Effects.

⁵ CDC. Information for Coastal Residents. http://www.cdc.gov/nceh/oil_spill/information_residents.htm#3. May 5, 2010.

⁶ <http://epa.gov/bpspill/odor.html>, visited on June 7, 2010.

⁷ [http://www.epa.gov/iaq/voc.html#Health Effects](http://www.epa.gov/iaq/voc.html#Health_Effects).

⁸ EMILY WAGSTER PETTUS and MELINDA DESLATTE. Miss., La. gov's contrast in responses to oil spill, May 14, 2010. http://www.google.com/hostednews/ap/article/ALeqM5i_a92gz92-2O6BM4YU2SYmlG6fcAD9FMFFK04.

⁹ <http://edition.cnn.com/video/data/2.0/video/us/2010/06/02/lok.zarella.oil.alabama.cnn.html>. 6/2/2010

¹⁰ Comment posted at: http://switchboard.nrdc.org/blogs/gsolomon/the_gulf_oil_spill_human_health.html

¹¹ http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/incident_response/STAGING/local_assets/downloads_pdfs/monitoring_summary_report_may20_2010.pdf

¹² http://switchboard.nrdc.org/blogs/gsolomon/oil_spill_clean-up_workers_get.html

¹³ <http://blogs.edf.org/nanotechnology/2010/06/06/another-bp-leak-%e2%80%93this-time-its-their-2009-gulf-of-mexico-oil-spill-contingency-plan/>. June 7, 2010.

¹⁴ <http://www.epa.gov/bpspill/dispersants/5-21bp-response.pdf>. May 20, 2010

¹⁵ <http://www.endocrinedisruption.com/chemicals.fracturing.php> (see drilling mud additives like aluminum tristearate and EZ Mud)

¹⁶ US EPA. Environmental Assessment of Final Effluent Limitations Guidelines and Standards for Synthetic-Based Drilling Fluids and other Non-Aqueous Drilling Fluids in the Oil and Gas Extraction Point Source Category. 2000. <http://www.epa.gov/waterscience/guide/sbf/final/env/finalenvpart1.pdf>

¹⁷ Neff, Jerry M. Estimation of bioavailability of metals from drilling mud barite. 2008. Integrated Environmental Assessment and Management. 4(2) pp. 184–193

¹⁸ C. Terzaghi, M Buffagni, D. Cantelli, P. Bonfanti, M. Camatini. Physical-Chemical and Exotoxicological Evaluation of Water Based Drilling Fluids used in Italian Off-Shore. 1998. Chemosphere, 37(14 15) pp. 2859-2871