April 22, 2017

A Lawrence Anthony Earth Organization Science and Technology Advisory Committee Report[i]

Risk Reduction and Cost Savings Through Enzymatic Bioremediation Oil Spill System and Spill Countermeasure Plans

The information presented herein will demonstrate to insurance companies and their insured clients how to mitigate risk and reduce costs associated with oil/fuel spills.

Insurance companies, Protection & Indemnity (P&I) clubs, and parties that pay high premiums are doing so based on the excessive costs associated with using inadequate spill response systems. All concerned have a huge stake in how an oil spill is responded to and should seek to aggressively demand improvements in this system.

Conventional oil spill response methods are woefully inadequate at removing the vast majority of oil/fuel spills from the environment and some have ended up creating more damage than that caused by the spill itself. Existing methods have not changed for 35 years despite better technology and systems being available.

Moreover, in many instances major oil/fuel response contractors in the U.S. (Oil Spill Response Organizations [OSROs]) will invoice against the absolute maximum amount of labor and material possible for a given response in order to maximize revenues. For decades, the responsible parties and their insurers have assumed the high cost of inadequate mechanical and chemical response methods.

The attached document entitled ***Oil Spill Comparative Analysis*** provides details and documentation on the conclusions summarized herein and substantiates that high costs associated with oil spill cleanup would be substantially reduced while also bringing better environmental protections, clean up effectiveness and mitigated liabilities.

Analysis Methodology:

- We used the categories of oil spill response methods listed on the National Contingency Plan (NCP) published by the U.S. EPA as of June 2016.

- We then evaluated viable cleanup options listed on the NCP Product Schedule for each of seven (7) oil spills referenced in the scope of this analysis. (7=Dallas, San Diego, Refugio, Kirby, Nigeria, Yellowstone and Deepwater Horizon spills.)

- Options reviewed in this analysis were: 1) OSE II-the *recommended* method, 2) *alternatives to OSE II* (these represented what method were actually used or alternatives outside of OSE II and 3) a *Cost Estimate Model* for further comparison.

- Information was collected around actual response methods used (referred to as *alternative methods* in this analysis*)* for the 7 scoped oil spills and other viable response alternatives used in this analysis.

- The information collected was then processed through a *Cost Estimate Model* prepared by Environmental Research Consulting, an unaffiliated third party.

- We then reviewed the *alternative/actual* cleanup methods employed and documented the actual costs or best estimates available if all costs have not yet been incurred or reported.

- After actual costs were documented, we proceeded to look at all viable alternative cleanup options for each specific spill according to the NCP product list.

- Costs and realistic remediation percentages were then estimated for each viable option using all information available for each spill.

- Logic for all cost assumptions is embedded with traceable links included in the Model.

- Costs to remediate each spill using Oil Spill Eater II (the Enzymatic Bioremediation Category method) were then added to the analysis using historical actual costs with adjustments based on each spill's unique circumstances.

- The final product is a summarization of all spills in the scope comparing costs in total and on a per gallon basis as well as the overall remediation success of the spill clean up.

The Recommended Spill Cleanup Technology:
Oil Spill Eater II (OSE II)

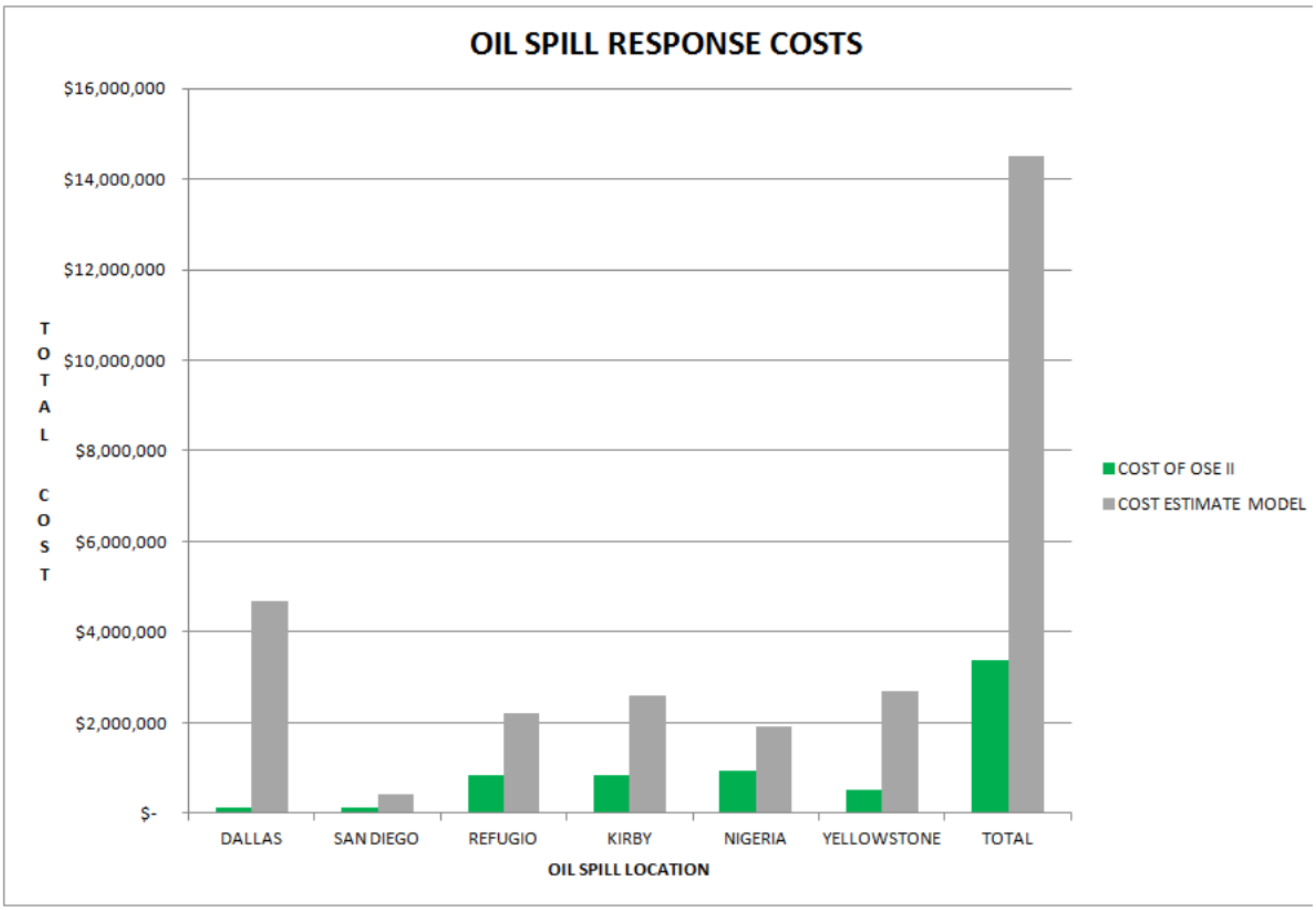
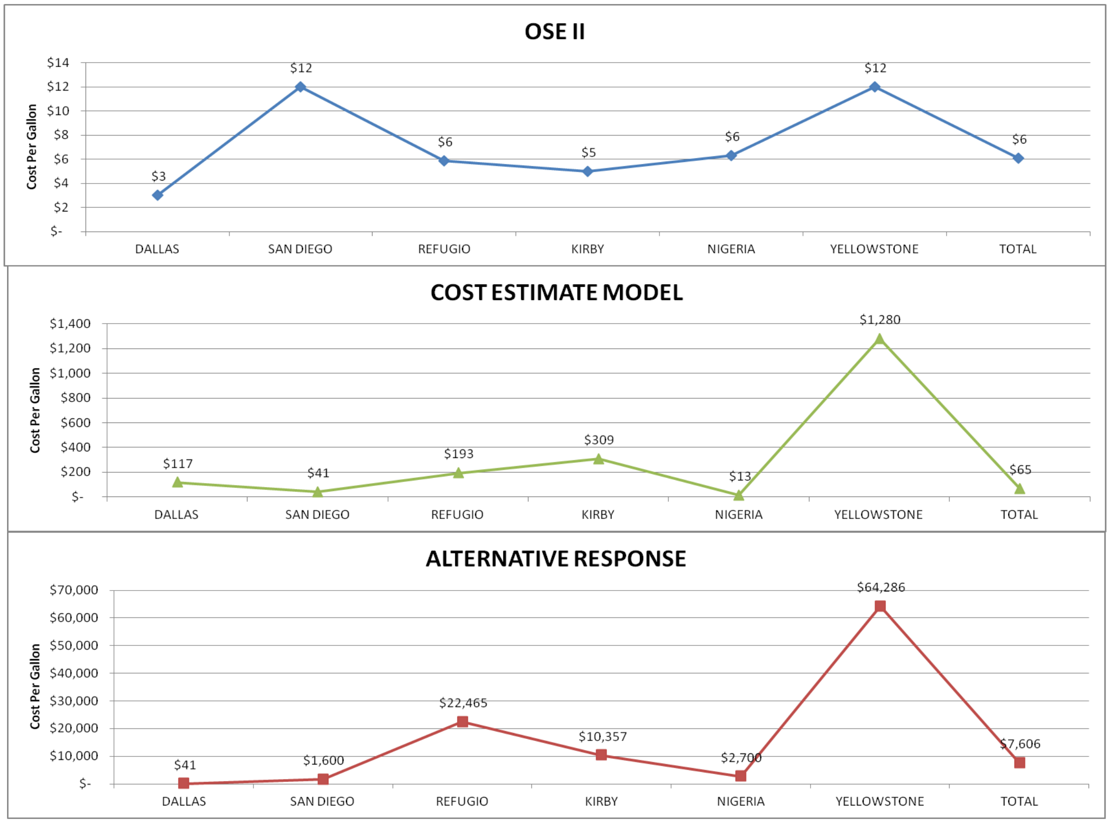


Chart: The grand total for the clean up of these 6 major spills would have been 77% less expensive using the OSE II method.

(Note that Deepwater Horizon is excluded from the charts because the Cost Estimate Model was not designed to assess a spill of this magnitude.)

Comparative cost to clean up one gallon of oil spill



One of numerous charts in this cost analysis clearly indicate that OSE II is approx. $6 per gallon cleaned up on average compared with $65 under the *cost estimate model* and over $7,600 (actual costs of recent spill clean ups) using existing alternative methods.

Overpriced Oil Spill Response:

The 2010 BP/Deepwater Horizon (DWH) Gulf of Mexico oil spill, and other subsequent spills, have demonstrated just how inadequate and over-costly an oil spill response can be. As illustrated throughout this financial analysis you will find there are safe and efficient means for removing 100 percent of a spill rather than relying on conventional response methods that remove only a fraction of a spill thus leaving the responsible party open to future liabilities and risks for new damage claims and fines.

The 2010 BP/DWH spill response utilized multiple methods including mechanical clean up, chemical dispersants, and in situ burning—all proven to be questionable in terms of safety and effectiveness. These conventional response choices left

substantial lingering volumes of oil behind that persist in the environment for decades.
(Documentation at: https://theearthorganization.org/oil-chemical-spill-solutions/

The BP/DWH response alongside several other recent major spills have been used in this study to develop a framework that highlights the true costs associated with each available response method while quantifying the impact of inherent inefficiencies that fail to remove a large portion of hazardous chemical spill from the contaminated environment.

The attached model titled: ***Oil Spill Comparative Analysis***, indicates which response method (s) were employed for seven recent major spills, the efficiency of the cleanup, the incremental costs associated with the chosen response measures, along with a comparative study of all available response alternatives.

In many instances oil/fuel emergency response contractors (Oil Spill Response Organizations [OSROs]) will employ the absolute maximum amount of labor and material they are able to invoice within their response in order to maximize profits. For decades, the responsible parties and their insurers have assumed the high cost of inadequate mechanical and chemical response methods. Global leaders and oil spill response professionals continue to take action to reduce use of chemical dispersants that are inherently toxic. Not only do chemical dispersants fail to effectively cleanup spills, they exacerbate the problem by introducing yet another harmful substance to the contaminated environment. Documentation to this effect can be found in published science journals.[1]

Mechanical clean up is generally the first choice response solution during a spill. According to US Coast Guard reports, mechanical clean up methods will only remove 2 to 8 percent of the oil in calm seas, leaving 92 to 98 percent of the oil remaining. The lingering oil leaves the insurer and the responsible party culpable for significant damages that could have been avoided if a more comprehensive response solution had been utilized. Mechanical skimmer clean up typically produces more collected seawater than oil. The seawater then needs to be transported and properly disposed of adding to the cost of an already expensive and incomplete response. Astonishingly, skimmed water is collected and disposed of at a rate of more than 9 to 1 over collected oil using mechanical oil spill response methods. If 10,000 gallons of oil were skimmed, then approximately 92,000 gallons of water will be skimmed along with the oil. This process creates an enormous amount of waste that is both costly and damaging to the environment.

[1] See Section-Chemical Dispersants and the Clean Water Act with citations at: https://theearthorganization.org/wp-content/uploads/delightful-downloads/2016/09/a-call-for-a-twenty-first-century-solution-in-oil-spill-response-.pdf

Fortunately, there is a tried and true technology available today that has been effective in oil spill clean up for more than 25 years turning $85 million dollar cleanups into 2 million dollar cleanups with no adverse environmental impact.

*Note: The attached *Oil Spill Comparative Analysis* document *is a* cost comparison of each available cleanup method. The excel document depicts a cost comparison between the main types of spill responses deployed globally. The comparative model further illustrates how much oil is actually removed from the environment giving the stakeholder a true cost picture on a per gallon basis. The comparisons analyze data from recent spills making a compelling case for an alternative response solution that mitigates both cost and the risk of further environmental damage.

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[i] In alignment with our *Cooperative Ecology* philosophy, LAEO identifies and validates environmental solutions and teams up with innovative companies, scientists and individuals to implement best available technologies.

By way of example, our long-standing association and collaborative work with *Oil Spill Eater International (*OSEI Corporation*)* is changing the oil spill response paradigm globally. OSEI CEO Steven Pedigo – a brilliant scientist in this field, provided information for our analyst team so that we could compare his enzyme-based clean up agent, *Oil Spill Eater II,* with other conventional methods. Several of our staff and advisers then produced an objective and independent analysis using industry models and actual oil spill clean up events and data providing valuable insight into all available conventional options for addressing oil spills. Mr. Pedigo is thanked for his invaluable participation in this study.

(Note-LAEO has no financial ties of any kind to, nor does it receive any financial benefit from, companies that manufacture and/or sell the bioremediation oil clean up products we advocate for.)

Addendum – Oil Spill Cost Comparative Analysis-April 22, 2017

References, Definitions and Notes:

1. The US CLEAN WATER ACT
2. Types of Oil Spill Response -- A summarization of available oil spill response options
3. HOW DOES OIL SPILL EATER ENZYMATIC BIO REMEDIATION WORK, HOW IS IT DIFFERENT? https://theearthorganization.org/wp-content/uploads/delightful-downloads/2016/09/bioremediation-techniques-category-definitions-and-modes-of-action-in-marine-and-freshwater-environments.pdf
4. A Response plan for implementing EA type first response plan with the US CLEAN WATER ACT approved, holistic, safe, and non-toxic response solution that protects both humans and marine life, see link http://osei.us/wp-content/uploads/Attachment-B_Concise-Bioremediation-Response-Plan.pdf
5. INDEPENDENT COST ESTIMATE MODEL: http://www.environmental-research.com/erc_papers/ERC_paper_2.pdf

1. Clean Water Act:

The US Clean Water Act requires that any response utilized must remove oil from the environment. The Act also indicates that a pollutant cannot be used on a pollutant.

What does adding a pollutant to a pollutant mean? If the oil/fuel spilled is a pollutant and one adds an agent that increases the toxicity level or modifies the chemical make up leaving any toxic components behind, then this would constitute adding a pollutant on a pollutant. Using this approach as a response is subject to fines as unlawful under the US Clean Water Act. Ref: https://www.epa.gov/laws-regulations/summary-clean-water-act

2. Types Of Spill Response:

The US EPA has categorized spill response options on the NCP list noted below:

- *Bioremediation agents--Three Categories*
- *Dispersants*
- *Sorbents*
- *Surface Collecting Agents*
- *Surface Washing Agents*
- *Miscellaneous Oil Spill Control Agents*
- *Mechanical clean up*

Bioremediation Agents

There are three categories of bioremediation agents that can be deliberately introduced into an oil discharge named by the U.S. EPA: 1) enzyme additives [EA] (note that Oil Spill Eater II-OSE II- is the only EA type currently listed, 2) nutrient additives [NA], and 3) microbiological cultures [MC]. US EPA testing has shown the MC and NA categories are unsuitable for water clean ups. EA--Enzymatic Bioremediation OSE II, significantly increases the rate of biodegradation to mitigate the effects of a discharge in fresh water and ocean marine environments.
See technical paper on categories at: https://theearthorganization.org/wp-content/uploads/delightful-downloads/2016/09/bioremediation-techniques-category-definitions-and-modes-of-action-in-marine-and-freshwater-environments.pdf

Dispersants

Dispersants are chemical agents that emulsify, disperse, or solubilize oil into the water column. Dispersants can also promote the surface spreading of oil slicks facilitating the distribution of the oil into the water column.

NOTE: The US EPA fails to mention that dispersants do not remove oil from the environment within their product definitions. Dispersants merely sink and disperse oil into the water column, which causes the original spill to be pushed into a secondary area. This process exacerbates the impact of the spill. A portion of the oil found a resting place on both sea beds and on shore after the use of dispersants in the Ixtoc, Valdez, and Deepwater Horizon spills along with countless others. When the EPA describes dispersants as being an "effective" solution, it does not imply that a layman would accept dispersants as effective in removing the spill from the environment. Wittingly or not, the EPA is actually saying the dispersant was effective at sinking 45 percent of the oil into the water column with essentially NO removal! This is in direct opposition of the US Clean water Act.

Shown below is a quote from the EPA website discussing the use of dispersants in the Deepwater Horizon spill:

Q: What effects could the use of dispersants have on marine life?

A: It's important to understand that the use of dispersants is an environmental trade-off. We know dispersants are generally less toxic than the oils they breakdown (Corexit dispersants can be up to 52 times more toxic than the oil). We know that surface use of dispersants

decreases the environmental risks to shorelines and organisms this was proven to be untrue during the BP Macondo spill) at the surface and when used this way, dispersants breakdown over several days (The Valdez spill still coats the shorelines 26 years later). However, the long term effects on aquatic life are unknown, which is why the EPA and the Coast Guard are requiring BP to implement a robust sampling and monitoring plan.
https://archive.epa.gov/bpspill/web/html/dispersants-qanda.html

Sorbents

[Note**:** Sorbents are characterized in the National Contingency Plan (NCP) Subpart J, but the regulation does not require their inclusion in the NCP Product Schedule. Manufacturers may submit a letter with confidential business information to the EPA. Manufacturers will then receive a letter stating whether their product meets the regulatory definition of a sorbent.]

A sorbent is essentially an inert and insoluble material that is used to remove oil and hazardous substances from water. This process is performed through adsorption or absorption. In adsorption, the oil or hazardous substance is attracted to the sorbent surface and then adheres to it. In absorption, the oil or hazardous substance penetrates the pores of the sorbent material, and in certain instances, will adhere to the material in concert. Sorbents are generally manufactured in particulate form ready to be spread over an oil slick as sheets, rolls, pillows, or booms.

The hyperlink below provides definitions from the US EPA website:

https://www.epa.gov/emergency-response/product-categories-under-national-contingency-plan-subpart-j

There are a number of different types of sorbents or absorbents. While the sorbents remove oil from the environment, they are merely moving the problem to another area. This turns into an expensive proposition. The absorbed material needs to be stored in a hazardous waste container, transported, and then disposed of at an acceptable facility.

Surface Collecting Agents

Surface collecting agents are chemical agents that form a surface film to control the layer thickness of the oil

Once again, the collecting agent will need to be skimmed from the ocean, containerized, stored, and transported to a disposal facility. Further complicating *their use is the fact that many of these agents come in powder form making real world application, such as in windy conditions, extremely difficult.*

Surface Washing Agents

A surface-washing agent is any product that removes oil from solid surfaces. Surface washing agents are applied directly on surfaces such as beaches and rocks through a detergency mechanism. Surface washing agents are not used to disperse or solubilize oil that has shifted into the water column.

Detergents are to a large extent soaps that may have added solvents or agents to facilitate the breakdown of oil. Unfortunately, this process merely moves the oil from one location to another providing no real value or gain to the clean-up effort.

Mechanical Response

A mechanical response typically begins with attempting to contain a spill with some type of booming operation. This method has been shown to be very ineffective in the oceans once a spill exceeds 20,000 to 30,000 gallons. The spill simply travels too fast to be contained. In concert with the booms, mechanical skimmers of some type are generally brought out to collect or recover as much oil as possible as part of a well-documented solution. Most spills require vessels to travel several hours after the spill has occurred making it difficult, if not impossible, to contain.

Additional Dispersant Information

Also called dispersants, these chemicals used in spill cleanups contain surfactants and/or solvent compounds that act to break apart petroleum oil into small droplets that are then broken down further in the water.

The hyperlink below displays search results for dispersants within all areas of the US EPA website:
https://search.epa.gov/epasearch/epasearch?querytext=dispersants&x=0&y=0&fld=&areaname=&typeofsearch=epa&areacontacts=comments.htm&areasearchurl=&result_template=epafiles_default.xsl&filter=sample4filt.hts

The US National Response Team Officials have admitted there are trade-offs with the use of dispersants.

The US EPA has been quoted numerous times stating that dispersants have been effective during a spill. The EPA's term "effective" does not however coincide with how a layman would define an adequate response solution. What the EPA means is that, based on dispersant test protocol, the dispersant is effective if it can sink 45 percent of the oil in 30 minutes with no criteria for permanent removal. As a result, NOTHING IS REMOVED!

Dispersants have been used several times in the US with disastrous results. The 1979 Ixtoc spill utilized chemical dispersant Corexit 9527 on the oil. A total of 493 aerial missions were flown, treating 1,100 square miles of oil slick. Dispersants were not used in the United States area of the spill because of the dispersant's inability to treat weathered oil. Eventually the on-scene coordinator requested that Mexico stop using dispersants north of 25°N. (http://www.whoi.edu/oil/ixtoc-I)

Although the exact amounts are unknown, the U.S. EPA states that 1–2.5 million gallons of dispersants (COREXIT products primarily, including the now deemed too toxic for use COREXIT 9527) were sprayed during approximately 500 aerial flights over the surface oil slick. The aerial spraying was followed in October by vessel spraying. Initially, the spraying was 20–25 miles from shore; However, spraying was eventually occurring near beaches, lagoon mouths, and the well site during the fall. The quantity of dispersant used is unknown, but information from PEMEX indicates at least 9,000 metric tons were used.

(http://www.joyeresearchgroup.uga.edu/public-outreach/marine-oil-spills/other-spills/ixtoc)

The Clean Gulf conference held in Tampa in November 2016 brought together professionals in science and academia alongside US federal agencies and Industry members. An inarguable consensus from the conference was that there are still lingering adverse effects from the spraying of Corexit 9527 dispersant.

Chemical dispersants were initially utilized during the Exxon Valdez spill until a powerful storm arrived in the affected area impacting approximately 745 miles of coast line. Oil can still be found under the rocks 26 years later. Equally dismaying is the fact that 90 percent of the responders have died from exposure to the toxic component 2 butoxy ethanol in Corexit 9527.

In another disheartening event, a class action suit including more than 200,000 victims was filed as a result of exposure to Corexit 9527 and Corexit 9500 after 2.5 million gallons were applied during the 2010 BP Macondo spill. The enormity of the spill covered more than 1,200 square miles of seabed with oil resulting in spill costs that have exceeded $61 billion USD.

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