Incorporating Green Alternatives into Emergency Response Waste Management Programs: Examples from the Deepwater Horizon Response

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ABSTRACT

This paper delivers an overview of the Green Alternatives Program that was part of the waste management strategy during the Deepwater Horizon (DWH) response in the Gulf of Mexico. The Green Alternatives Program was designed to minimize waste generation and to develop a comprehensive recycling, reuse, and recovery approach.

A variety of materials were generated during the response, many of which could be recycled or reused. Hard and soft containment boom, absorbents, and segregated plastics could be sent to waste-to-energy (WTE) facilities or recycled into new plastic products. Individual components of hard boom, such as steel cables and chains and aluminum and stainless steel connectors were segregated and recycled. Tar balls and oiled sand have the potential for beneficial reuse as a matrix admixture to asphalt products. Recovered oil and oily liquids were typically the most readily recoverable material via oil recovery and reclamation activities; these can be reclaimed as a marketable refined product. Each potential media stream generated during an emergency response event needs not only to be evaluated by a proof-of-concept pilot test but also to undergo a comprehensive permitting and regulatory review. Incorporating green alternatives into the response made a positive contribution to the environment and local communities by preserving critical landfill space, creating new products, and generating energy.

Although each emergency response event is unique in size, scale, material released, and situational logistics, this paper is intended to provide individuals involved in pre-planning activities with ideas for incorporating green alternatives into effective waste management strategies.

1.0 Introduction

A Green Alternatives Program was developed as part of a comprehensive waste management strategy during the DWH (also known as MC 252) response. The Green Alternatives Program was designed to minimize waste and develop a comprehensive recycle, reuse, and recovery approach. Such a program presents an opportunity to positively affect the environment and local communities by preserving critical landfill space, creating new products, and generating energy.

A variety of materials are generated during a response action, many of which can be recycled or reused. Hard and soft containment boom, absorbents, and segregated plastics can be sent to WTE facilities or recycled into new plastic products. Individual components of hard boom, such as steel cables and chains and aluminum and stainless steel connectors were segregated and recycled. Tar balls and oiled sand have the potential for beneficial reuse as a matrix mixture to asphalt production. Recovered oil and oily liquids are typically the most readily recoverable material via oil recovery and reclamation activities; these products can typically be reclaimed as a marketable product. Implementation of such green alternatives was accomplished only after a thorough permitting and regulatory review, a comprehensive cost/ benefits analyses, and often a proof-of-concept test.

Although each emergency response event is unique in size, scale, material released, and situational logistics, this case study is intended to provide individuals involved in pre-planning activities with ideas for incorporating green alternatives into effective waste management strategies. Waste management strategies are outlined in approved Waste Management Plans and recycling strategy documents. These strategies will assist with managing potential long-term environmental liabilities and the public's perception of the incident.

2.0 Overview of the DWH Green Alternatives Program

Within the challenging environment of an active spill response, there is a unique opportunity to positively affect the environment, local community, and reputation of the responsible parties by recycling as much of the response-generated material as reasonably possible. With pre-planning and existing logistical and infrastructure support, many of the conventional solid and liquid wastes generated from an oil spill can be recycled or incorporated into beneficial reuse products. During the DWH response, more than 9.5 million pounds (4,750 tons) of material were recycled or reclaimed by the Green Alternatives Program.

The key benefits of recycling/reuse and green alternatives include the following:

- Preserving critical landfill space
- Creating useable products
- Creating energy value
- Demonstrating a commitment to the community

The Green Alternatives Program required the collaboration of many individual contributors, consultants, and contractors in specialized multi-discipline teams. To centralize the effort and elevate the importance of the responsibilities, a Green Alternatives Program Manager role was developed and was placed in the Environmental Unit of the Planning Section. The individual reported directly to the Unified Area Command's Waste Program Manager.

2.1 DWH Recycling Strategy

Management of wastes and recycling and reuse efforts were directed by the *MC 252 Waste Management Plan* that was developed during the response and approved by the Incident Command Structure. In general, the Waste Management Plan called for waste stream identification and characterization; required the use of approved waste-handling facilities; and provided guidance related to handling, staging, transporting, and tracking of waste, as well as the integration of recycling and reuse alternatives.

In addition to the *MC 252 Waste Management Plan*, a comprehensive *MC 252 Recycling Strategy* document was developed. The document presents an overview of the evaluation to define candidate recyclables and recycling options, and describes the supply chain that could be used to complete the recycling process.

Early in the response, integration of recycling and reuse activities was challenging; managers addressed these challenges by developing approved recycling facilities identified in the Waste Management Plan and handling large volumes of wastes quickly so as not to impede response activities. Logistics related to recycling and reuse activities helped to drive the Green Alternatives Program forward.

2.2 Potential Candidate Waste Streams

Five main categories of spill response materials were considered potential candidates for recycling and reuse alternatives: oil and oily liquids, hard (containment) boom, soft (sorbent) boom and pads, tar balls and oiled sand, and segregated recyclables.

Oil and Oily Liquids – Recovered oil, emulsion, and other oily liquids can be reclaimed as a marketable refined product. Under federal and state regulations, oily liquids destined for recovery are not solid wastes until reclamation or recovery is complete; therefore, such materials have significant potential for reclamation.

Hard Boom – Most hard boom material generated from a response is containment boom that is damaged or no longer useable. It is typically constructed of a polypropylene (PP) or polyethylene (PE) foam core, with a polyvinyl chloride- (PVC-) coated polyester fabric curtain in lengths of 100 feet (ft). A variety of metal components connect the boom segments, and a steel chain along the bottom of the boom provides a dead load to keep it vertical. Almost all of the components of hard boom can be recycled.

Soft Boom and Pads – Soft (sorbent) boom is typically composed of 10-ft lengths of PP and PE plastic foam material that are covered with cotton or nylon netting and held together with a nylon rope or cord. Sorbent pads are composed of PP fibers that also are recyclable, and snare booms (also known as “pom-poms”) are typically composed of PP strips tied to a nylon rope—also 100 percent recyclable.

Tar Balls and Oiled Sand – Recovered weathered oil (i.e., tar balls) and oiled sandy material generally have a low percentage of crude oil mixed with sand, shells, and beach debris (e.g., plastic, paper, wood, and shells). With proper screening, segregation, and approvals, tar balls and oiled sand can be beneficially reused in the manufacture of asphalt, in lieu of traditional landfilling.

Segregated Recyclables – Segregated recyclables include gloves, plastic bags, protective personal equipment, and similar plastics used by workers during clean-up operations. In addition, traditional recyclables such as paper, cardboard, styrofoam, plastic bottles, glass, and ink cartridges can be segregated and managed under the existing recycling programs of waste contractors.

2.3 Options for Recycling and Reuse

Several broad reviews were conducted by consultants and contractors with the objective of evaluating the pros/cons, available facilities, and potential effectiveness of various recycling and reuse alternatives. The study concluded that, in lieu of landfilling solid wastes, several recycling and reuse options were viable alternatives and should be evaluated further. The study also helped to identify facilities and contractors in the Gulf Coast area that could be leveraged in the response for recycling and reuse activities. Summarized below are the likely green alternative options.

Waste Streams	Recycling Options
Oil and oily liquids	• Oil recovery / reclamation / refining • Waste to energy
Hard boom	• Manual disassembly into segregated recyclable streams • Waste to energy
Tar balls / oily sand	• Asphalt projects (roads, parking lots, bike trails) • Landfarming, composting, biopiles • Landfill (alternate daily cover)
Soft boom and pads	• Liquid removal • Plastics recycling (polypropylene, polyethylene) • Waste to energy
Segregated recyclables (personal protective equipment, paper, plastics)	• Established recycling programs (paper, plastics) • Waste to energy

2.4 Facility Approval Process

Each facility used to manage waste underwent a standard site evaluation and approval process. The steps of the review and approval process included site identification, site evaluation through site audits and desktop review, and final scoring and rating. Depending on a number of factors (e.g., the type of facility and its compliance history), compliance audits were conducted prior to use of the facility and its inclusion in the Waste Management Plan as an approved facility.

Three types of audits were used: review of existing CHWMEG® audits, on-site audits, and limited-scope audits.

Review of Existing CHWMEG® Audits – CHWMEG® is a non-profit, world-wide trade association comprised of numerous industry clients that jointly finance auditing of commercial facilities used to treat, store, dispose of, recycle, or transport waste. These audits are comprehensive, independent reviews that are schedule to be conducted months in advance. Existing CHWMEG® audits are available for members to review on line. Due to the time required to schedule and plan for these audits, typically only those that have previously been completed can be used during a response.

On-Site Audits – An on-site audit was conducted for those facilities with elevated risk and exposure and for which a CHWMEG® audit was not available. This determination was based on the type of facility, history of the facility, type and volume of material handled, and the duration of time the facility was expected to be used by the response. The audits included physically visiting the site, conducting interviews with site operators, reviewing on-site records and data, and contacting the appropriate regulatory agencies.

Limited-Scope Audits – The limited-scope audit was designed as a screening-level assessment to quickly determine whether the proposed facility was appropriate to include in the program. These audits were similar to the on-site audits in content but did not include a site visit. The review was largely based on publicly available records, data supplied by the site, and data collected from telephone interviews with regulatory agencies and site personnel.

Following the site evaluation, collected information was evaluated and ranked to determine whether the facility was approved for use during the response. If the site was approved, it was added to the list of approved facilities included in the Waste Management Plan.

3.0 Proof-of-Concept Testing

To effectively integrate green alternatives as part of the waste management strategy for the response, proof-of-concept pilot tests were often conducted. Data were collected to assist in determining whether a waste stream could be converted into a usable green product or serve as a source of energy, while not significantly complicating response recovery operations. Numerous proof-of-concept tests were conducted during the response; however, the programs related to the following four media streams are described in detail in this presentation:

- Reclamation of skimmed emulsions for fuel blending and oil recovery;
- Recycling/recovery operations for hard boom using component recycling and WTE alternatives;
- Recycling/recovery operations of soft boom plastic recycling; and
- Beneficial reuse of weathered oil and sand mixtures collected during shoreline clean-up operations as feedstock in the manufacturing of asphalt.

3.1 Emulsion Reclamation

On-water skimming operations were a vital component of oil recovery operations during the DWH response. These operations generated hundreds of thousands of barrels of oily water, weathered oil, and emulsion mixes that needed to be managed. The wide range in the composition of the recovered oil and emulsion was due, in part, to the residence time that the emulsion was on the surface of the water and the length of time the fluids had been stored after collection. The longer the emulsified oil remained on the ocean surface, the more degraded the quality became, which increased the challenge to create a marketable product. This type of weathered emulsion was highly viscous, making it extremely difficult if not impossible to pump.

According to the U.S. Code of Federal Regulations (CFR) (40 CFR 261.2), oily liquids/emulsions destined for recovery are not classified as a waste until reclamation activities are complete and the generator declares that the material is a waste. Also, per the definition in 40 CFR 261.4(b)(5), the majority of waste streams generated during the DWH response were exempt from hazardous waste regulations due to their classification/association with exploration and production activities that have a separate regulatory classification.

3.1.1 Initial Evaluation and Assessment

Multiple existing onshore commercial oil recovery/reclamation facilities were sent emulsion samples in order to evaluate the material against their specific equipment and processes. These facilities were operating and permitted prior to the incident and typically used heat, emulsion-breaking agents, settling, and centrifuging to process emulsions. Because of the length of time required to establish and permit a new or temporary reclamation facility, only existing facilities could be used. These initial assessments focused on identifying a technology and process that could reduce the emulsion's water content in addition to modifying the oil's physical and chemical characteristics in order to generate a more marketable product.

At the conclusion of this initial phase, some of the facilities were successful in converting the emulsions to a marketable product, and some were not. The key was to identify a list of facilities that could technically handle the emulsion and were approved for listing in the Waste Management Plan.

3.1.2 Comprehensive Program Development

Once it was confirmed that the skimmed emulsions could be successfully reclaimed, a multi-discipline team (the Emulsion Management Team) was established to manage handling and processing of the covered fluids. The team consisted of individuals with various skill sets who were located across the globe. Figure 1 illustrates the roles and responsibilities for various team members.

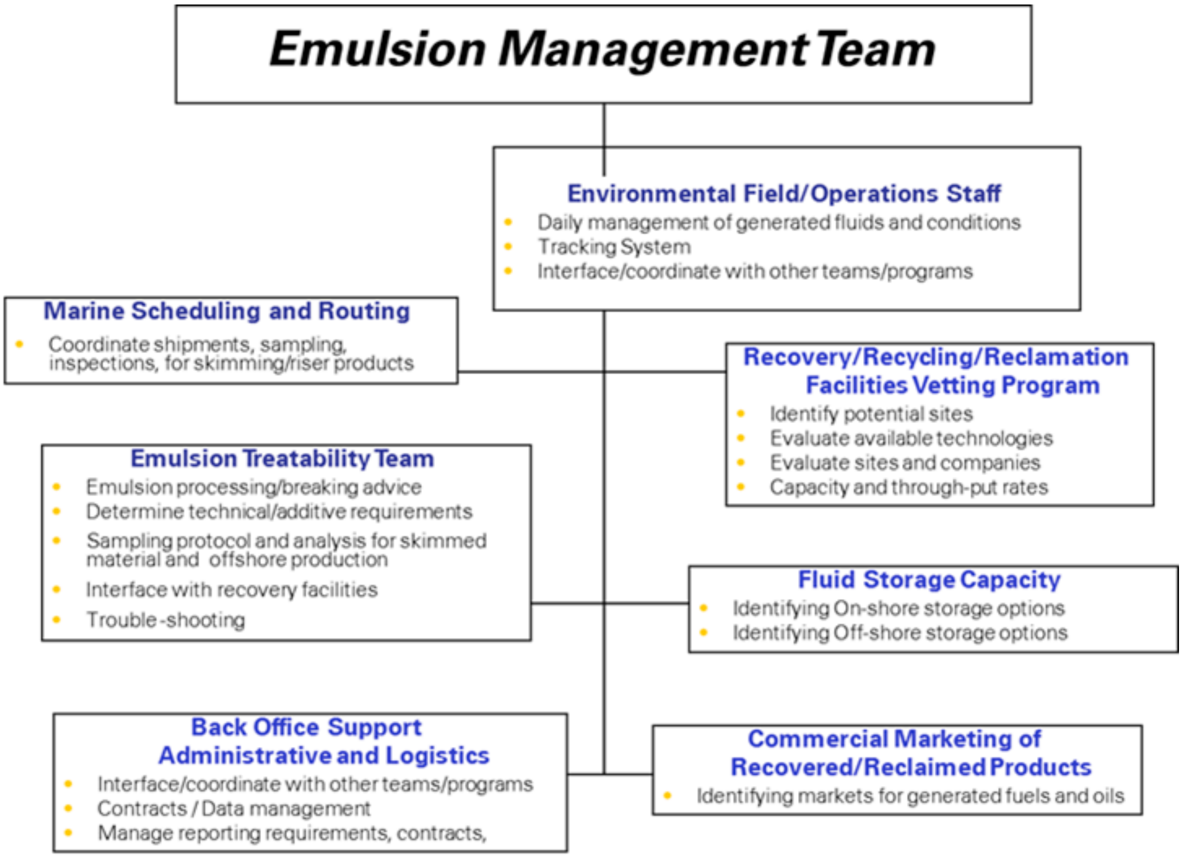

Figure 1 - Roles in the Emulsion Management Team

Each barge filled with material recovered during the response was a unique mixture of seawater and weathered oil. The contents varied from light products that were easy to pump to heavy emulsions that were difficult to pump. Debris intermixed in recovered fluids complicated processing. As oily liquid was being skimmed offshore and stored in off-shore barges, inspectors were sent out to visually inspect the vessel compartments and to gauge the liquid, emulsion, and solid layers. Pre-sampling was critical to understanding the composition of the material in each barge and whether the fluid could be successfully processed into a marketable commercial product.

Samples were collected from each barge and analyzed to facilitate the effectiveness and efficiency of the reclamation process. The facilities used many different types of analyses, such as viscosity, pour point, total solids, hydrogen sulfide (H_2S), water content, and density testing, to better understand the composition of the emulsion. Analytical results, generator knowledge, capacities of available facilities, compliance with reclamation facility permit conditions, and other pertinent information available at the time were used to determine the destination of each individual barge load of emulsion. Figure 2 illustrates the process flow of skimmed fluids and materials from their off-shore collection, through oil recovery, to a final treatment or disposal facility.

As skimming operations completed filling a barge, tracking information was compiled that included the barge identifying number, location, status, volume of material, and other supplemental information. The information was reported to the appropriate Incident Command Center on a daily basis and was discussed during a regularly scheduled Emulsion Management Team telephone call. This daily call established regular communication lines between the teams delivering the barges of skimmed emulsion into the program and the teams responsible for managing the fluids.

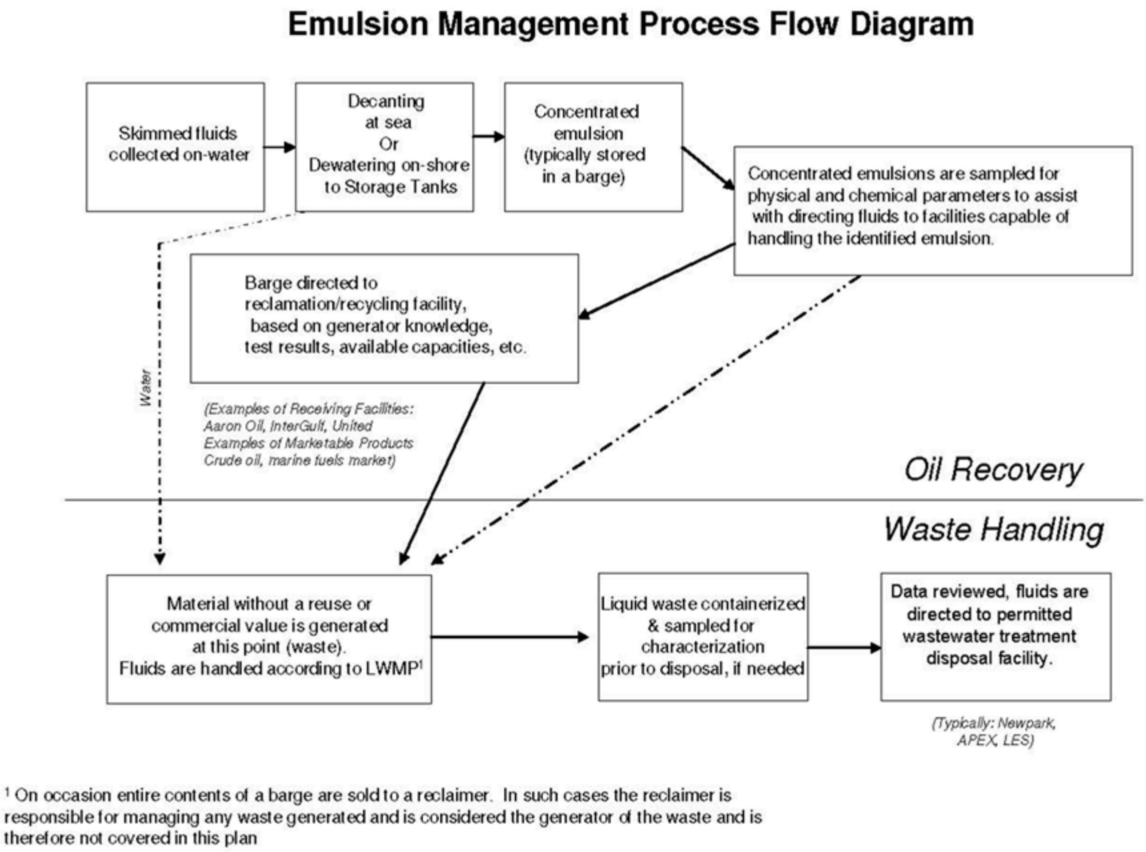

Figure 2 - Emulsion Management Process Flow Diagram

The process that was eventually used to process the emulsion typically consisted of three main components: heat application, de-emulsification, and centrifuging. Numerous attempts often were needed to customize the temperatures and centrifuge speeds. The following is an example of the process that was used:

- Raw emulsion was pre-heated to initiate the de-emulsification process in order to separate the water from the emulsion.
- Heated emulsion was then sent to a centrifuge, where any remaining solids or water could be removed.
- The final hydrocarbon product was containerized and sampled before being marketed to hydrocarbons outlets. Final characterization sampling often included analysis for American Petroleum Institute gravity, water content, flashpoint, sulfur content, and British thermal unit value.
- Wastewater generated by the process was treated by a wastewater treatment system or transported offsite for treatment and/or disposal.

Although the treatment process may have varied slightly from one reclaimer to another, the processes used were similar. Reclaimers varied the operating conditions of their equipment, (e.g., temperature, type of de-emulsifier, dosing, and centrifuge g-force) to find optimum production results. The desired quality for the final product was <2 percent basic sediment and water. In the beginning, throughput of the reclaimers was hundreds of barrels per day. With continuous improvement, they later averaged thousands of barrels per day. The separated products from the centrifuging process were wet sediment (a mixture of solids and water), oil, and water. The contents of each barge were highly variable but, on average, the inbound emulsion barges typically held approximately >60 percent water, ~35 percent oil, and 2 percent solids.

3.1.3 Summary

The program’s success demonstrated that the technology could be used on a wide range of emulsions and was scalable to handle larger volumes. It should be noted that the marketable hydrocarbon products that can be reclaimed via this process are highly dependent on the properties of the petroleum product being recovered. Fortunately, the oily liquid recovered from DWH skimming operations had a relatively high (>140 ºF) flash point and a low (<1 percent) sulfur content. These physical and chemical properties allowed the oil recycling contractor to generate a finished product that could be marketed to their existing client base.

The challenges to a successful emulsion management program included extensive regulatory limitations and limited existing facilities that were capable of handling the type and volume of material. Processing rates at the existing facilities were often full, and the amount of storage capacity that would be needed and the duration of use were unknown. These challenges were met by developing a diverse project team to focus on the issues. The project team included individuals with expertise on the issues, existing process facility operators with relevant skills and knowledge, and research and development laboratories. Overall, the program managed approximately 250,000 barrels of emulsions, of which approximately 40 percent was processed into marketable hydrocarbon products.

The following key points relate to the emulsion management reclamation processes:

- Environmentally green alternatives to traditional waste management can be incorporated into spill response efforts through collaboration with specialty oil recycling and reclamation contractors capable of treating oily liquid/oily wastewater streams.

- The proximity of existing reclamation facilities is important to handling recovered emulsions. In the DWH response, the existence of such a facility within the area of the response was fortunate. As the distance to these types of facilities increases, their usefulness and ability to be efficiently used may decrease because of logistical complexities.
- Specialty contractors may be needed to explore alternative technologies for this unique material. The existence of such contractors within the area of response for the DWH event was fortunate.
- The general recycling/reclamation process can be performed on a variety of oily liquids and emulsions recovered by skimming operations and can be scaled up to handle large volumes of recovered material, with some constraints for managing the wastewater.
- The marketable products recovered through the recycling and reclamation process are highly dependent on the characteristics of the crude oil or petroleum spilled. These characteristics significantly affect the types and locations of end-uses for the saleable products.

3.2 Hard Boom Recycling

During the DWH response, approximately 3.8 million feet of hard (containment) boom was deployed throughout the Gulf of Mexico. After the well was permanently capped, most of the deployed boom was retrieved, decontaminated, and placed in long-term storage. Damaged and unsalvageable boom was a potential logistical challenge for the Waste Management Team. Multiple options that were evaluated included two green alternatives for the hard boom in lieu of landfilling: (1) shipment to WTE facilities; and (2) manual disassembly and segregation of various parts of the boom (metals, plastics) and shipment to existing recycling facilities.

3.2.1 Initial Evaluation and Assessment

WTE facilities were initially evaluated as a method to rapidly handle large volumes of hard boom because the boom could be shipped directly from the field without extensive decontamination. Using WTE facilities to manage waste streams is seen as a viable green alternative and beneficial reuse alternative for processing hard boom. Typically, WTE facilities use municipal solid waste streams as fuel in the creation of renewable energy (steam and electricity) from waste.

A proof-of-concept pilot study was conducted to evaluate the handling and transportation logistics needed to transport and process the hard boom. An existing Covanta Energy facility in Huntsville, Alabama (adjacent to the U.S. Army Redstone Arsenal) was selected. Here, the boom would be comingled with municipal solid waste from the area and burned as a fuel for boilers, to generate steam for use at the adjacent facility. This trial used two roll-off boxes of hard boom (one oily boom and one algae-covered boom).

The pilot study determined that the material could be rapidly collected from forward operating areas, did not need segregation, could be comingled with appropriate waste streams, and was easily transported. A significant finding was that the typical 100-ft sections of boom needed to be cut into smaller pieces for processing. This issue was resolved by placing a small skid steer loader equipped with a hydraulic sheer on the tipping floor of the WTE facility to cut the incoming boom into smaller more manageable lengths. The study concluded that WTE recycling/reuse was a viable alternative to landfilling and could be cost effective under certain conditions.

Manual disassembly of hard boom into recyclable components (PVC skirt, steel chain and cables, aluminum connectors, and foam noodles) was also evaluated. An initial field trial consisted of processing approximately 3,000 ft of hard boom. The intent was to document the processing rate and volume of materials generated for recycling. This would assist in developing a better operational understanding of process and cost estimates for full-scale operation. The findings suggested that nearly 100 percent recycling was feasible, including 40 percent metals, 33 percent PVC fabric, and 26 percent plastics (with roughly 1 percent trash), at a processing rate of 450 ft per man-hour. Although technically and logistically feasible, this method was not integrated into the response on a full scale due to complicating transportation logistics, slow processing speeds, a labor-intensive process, safety concerns compared to WTE, and overall cost.

3.2.2 Comprehensive Program Development

After successful completion of the initial proof-of-concept testing, it was determined that Covanta's WTE facilities in Huntsville, Alabama and in Tulsa, Oklahoma were the preferred facilities for use due to favorable costs and logistics. Operational scheduling and logistics were critical components of this project, as it was necessary to avoid overloading the facilities with excess shipments from the response. Typically, four to five roll-off boxes of hard boom per day could be handled by each facility. This throughput rate allowed good mixing with existing municipal solid waste streams, while minimizing down time caused by backlogs and excess facility maintenance.

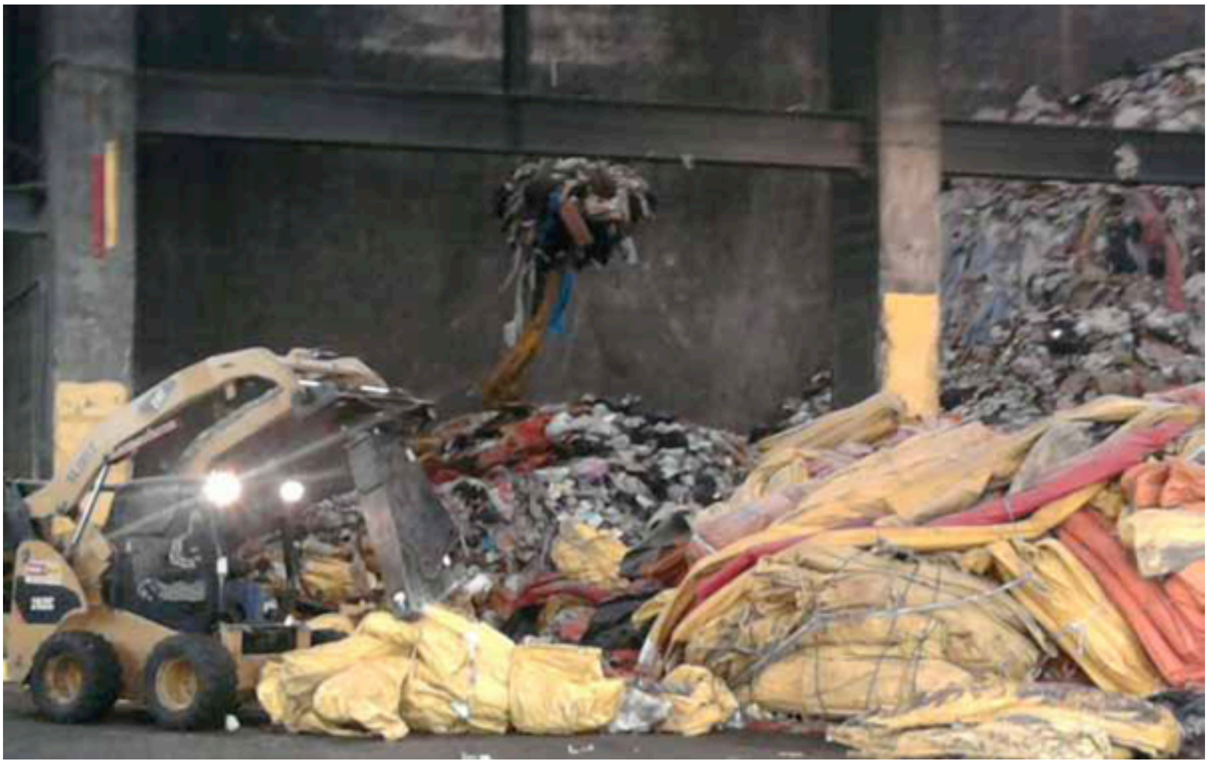

Figure 3- Hard boom being processed on the tipping floor at a WTE facility

Figure 3 shows hard boom being processed at a WTE facility. A video of the hard boom recycling at Covanta's Huntsville, Alabama facility was developed to promote (1) the collaborative effort between BP, Covanta, and Waste Management, Inc.; and (2) the benefits of recycling/reuse of the boom material via WTE in lieu of landfilling. A link to the video is provided at http://bp.concerts.com/gom/wasterecovery_102210.htm.

3.2.3 Summary

Because of the need for prompt movement and processing of the recovered boom after the well was capped, the WTE option became one of the primary green options for disposal of hard boom and an effective way to divert materials commonly used in responding to oil spills from being landfilled. Most green alternatives require additional transportation and handling that result in increased costs. The key to the success of this green alternative was the ease of integrating existing WTE facilities into the waste management program

3.3 Soft Boom Recycling

During the course of the response, approximately 9.7 million ft of soft (sorbent) boom was deployed throughout the Gulf of Mexico. After retrieval, this material was disposed of in approved landfills or sent to WTE facilities. Considerable efforts also were made to identify and implement options for recycling or reuse of the soft boom.

3.3.1 Initial Evaluation and Assessment

Because the main component of soft boom is polypropylene (PP), the Waste Management Team decided to undertake a study to identify viable green alternatives for managing this material. The review focused on manual disassembly and segregation of various parts of the boom (metals, plastics) and shipment to existing recycling facilities.

A 14-day pilot study was designed to evaluate: (1) processes to remove liquids from sorbent boom; and (2) processes to recycle the boom's PP filler. The study included an evaluation of processing rates in the field, a cost/benefits analysis, and a review of potential available vendors who would be interested in teaming with the response.

The recovered soft boom absorbs fluids when deployed in the field; therefore, the initial step during the pilot study was to determine how to efficiently remove fluids from the boom. Multiple methods were evaluated, but the most successful was a mobile centrifuging process unit mounted in a box truck. Use of this platform also enabled moving the pilot study closer to collection and storage points in the field. Fluids that were separated from the soft boom were containerized and disposed of as a waste or incorporated into oily water reclamation activities.

After the fluids had been separated from the soft boom, the PP core was manually cut out of the plastic netting that formed the boom. The recovered PP was segregated and containerized for transport to existing plastic recycling facilities, where the material could be converted into a variety of products. A video of the pilot study is available for viewing at: http://bp.concerts.com/gom/green_recycling_waste_082910.htm.

The pilot study was deemed successful and approximately 65,000 ft of sorbent boom was processed during the 14-day field trial. This yielded approximately 22 tons of material for recycling. The maximum processing rate of soft boom was approximately 10,000 ft per day by an eight-person crew using two centrifuges.

3.3.2 Comprehensive Program Development

With the success of the pilot study, this green alternative was incorporated into the waste management program for the response. Significant amounts of the recovered soft boom were routed into this program.

Soft boom typically is recovered by a dedicated on-water recovery team; therefore, segregation of this material stream was easier to incorporate into field operations than other green alternatives. Typically, the soft boom returning from the field arrived in large plastic bags that could be easily handled by the work force.

Once the liquids were removed and the PP was separated from the soft boom, the material was containerized and transported to existing plastic recycling facilities outside of the area of the response. The plastic recycling facilities densify and compound the material into an injection-moldable polypropylene resin, which can be blended into a variety of types of plastic options for items such as plastic picnic tables, automobile parts, packaging pallets, and assorted types of containers. Figure 4 illustrates the work flow process for handling soft boom.

Process flow diagram of soft boom recycling into plastic parts

Figure 4 – Process Flow Diagram of Soft Boom Recycling into Plastic Parts

3.3.3 Summary

Although the soft boom recycling program proved to be effective in diverting the materials commonly used in responding to oil spills from landfills, a significant percentage of the total amount of soft boom deployed was landfilled due to operational needs. Most green alternatives, including this one, require additional transportation and handling that result in a slower process. Consequently, the operational need to move materials quickly and not impede the speed of recovery and clean-up efforts sometimes superseded the desire to use a green alternative.

Similar to the hard boom program, the basis of the success of this rather simple green alternative was the presence of existing operating facilities within the theater of operations. Existing plastic recycling programs, experienced vendors, and an available market for the recycled media were key factors that contributed to the success of the program. The main recipient of the recycled polypropylene material was General Motors, Inc. (GM). GM worked with multiple existing vendors and developed a collaborative process to convert soft boom into automobile parts. Several YouTube videos highlighted the program, and the links are provided below:

http://www.youtube.com/watch?v=svQM9Q_IjOg (GM, December 21, 2010)
http://www.youtube.com/watch?v=yDwVqyjUP3Y (GM, January 20, 2011)
http://www.youtube.com/watch?v=40qgRCMIt_M (CNN Money, March 23, 2011)
http://www.youtube.com/bp#p/u/21/R_OGxoSlIMY (BP, Apr 25, 2011)

This project also was selected as one of five semi-finalists for the SAE (Society of Automotive Engineers) International Environmental Excellence in Transportation (E2T) Award, in conjunction with the SAE 2011 World Congress in Detroit, Michigan. GM delivered a technical paper on the project at a meeting entitled "Automotive Engineers Developing Sustainable Technologies for the Gulf of Mexico Oil Spill." In addition, the project was highlighted in several publications, including *Forbes* and *Money Magazine* (December 2010).

3.4 Oiled Sand and Tar Balls to Asphalt

Shoreline clean-up operations generated a variety of soil/sand/shell and oily mixtures. This type of material was one of the largest volumes of waste generated during the DWH response. Initial evaluations of this waste stream indicated that the media would be a good candidate for possible handling via a green alternative. Of the potential options, beneficial reuse for asphalt projects was determined the most practical and promising alternative, and significant efforts were made to evaluate its efficacy. Initially, samples of stockpiled material were analysed to verify their composition and characteristics. Then a detailed regulatory review was conducted to better understand the beneficial reuse programs at the state level in order to determine whether the concept could be approved within the existing regulatory framework. The review identified that, although beneficial reuse programs were found in each state, some states presented fewer barriers.

Bench-scale studies selected the use of a “warm”-mix asphalt process as the preferred method over the more typical “hot”-mix asphalt process. Only a limited number of asphalt plants in the theater of operations had the specialized equipment required for this method.

A review of available asphalt vendors along the Gulf Coast was conducted to determine potential partners. Initially, vendors were screened for facility size, capability, financial strength, geographic location, and warm-mix capability, in addition to the vendor’s interest in partnering. In the end, only a handful of companies, including Superior Asphalt, had the warm-mix technology and expressed interest in partnering.

Pre-screening of the response-generated feed stock materials that would be added into the warm asphalt process was necessary in order to homogenize and remove debris such as seaweed, shells, and trash. Other complex issues to be resolved included logistical and equipment demands on field operations, the need for a transportation network, the potential need for additional segregation and handling steps, and identification of areas needed for staging and stockpiling material. These factors contributed to the long lead time to complete the proof-of-concept study.

3.4.1 Initial Evaluation and Assessment

After numerous unsuccessful attempts to conduct a full-scale proof-of-concept study within the Gulf Coast, the Mississippi Department of Environmental Quality indicated that they would approve the reuse concept, with limited conditions. A proof-of-concept demonstration was held at the Superior Asphalt facility in Gulfport, Mississippi. Numerous officials from various state environmental and transportation departments, including the Mississippi Department of Transportation (MDOT), attended the event.

During the proof-of-concept demonstration, a batch of asphalt was successfully produced using oily sand from beach recovery operations. During the demonstration, the material was loaded into the warm-mix equipment, the mix was processed, and a final asphalt product was produced. The material was then transported to an on-site test paving area approximately 150 ft by 150 ft, spread with a typical highway paving machine, and further compacted by a heavy rolling machine. Thus, the entire manufacturing and installation process for the material was demonstrated. Figure 5 shows a test plot of asphalt being installed during a proof-of-concept test. Results of the demonstration and follow-up testing verified that the process would produce asphalt suitable for use on roadways regulated by the MDOT. During the full-scale proof-of-concept demonstration, it was confirmed that a 2 percent mixture of a sand and weathered oil matrix mixed into the fractured reclaimed asphalt pavement feedstock resulted in a final product that met state standards for use on local highways. Product and geotechnical testing supported these findings.

Figure 5 Test plot of asphalt being installed during proof-of-concept test

3.4.2 Comprehensive Program Development

The oiled sand and tar balls to asphalt concept did not develop into a comprehensive program during the DWH response due to numerous issues. By the time the program was accepted by the regulatory community, the volume of material being recovered had diminished significantly, to the point that the program was not sustainable. In addition, the need for significant amounts of asphalt to be manufactured was not present in the marketplace. Therefore, the program was not integrated as a waste management alternative for the response.

3.4.3 Summary

The concept of incorporating oily sand into the production of asphalt seems to offer a reasonable, practical alternative to landfilling; however, it is a difficult process that involves a number of complex issues. Although the technical concept of converting recovered oily sand into asphalt was successfully proven, the concept was not integrated into the Waste Management Plan for the response. Complicated regulatory and advocacy processes were challenges that prolonged the length of time required to complete the proof-of-concept testing. Approximately 6 months were needed to obtain regulatory approval in order to conduct the initial study. Factors to consider for implementation of this concept include:

- Accurate forecasting for each material within specific geographic locations
- Regulatory advocacy and approvals
- Review and approval of available vendors

The challenges to a successful oily sand and tarballs to asphalt program included extensive regulatory limitations, the need for rigorous waste segregation programs during collection of the waste stream, limited existing facilities that were capable of producing a warm-mix asphalt product, availability capacity for asphalt production at existing facilities, and the inability to project storage capacity or duration of use needs for the facilities.

4.0 Cost/Benefits Analysis Post Proof-of-Concept Testing

Conducting a true cost/benefits analysis of implementing green alternatives vs. standard waste management methods during an emergency response event is a very complicated process. Accurate costs and projections are difficult to develop, especially given the dynamic nature of response events. Consequently, financial comparisons must be evaluated qualitatively, not quantitatively. Some of the factors that can increase the cost of managing wastes by implementing a green alternative include transportation, segregation of recovered media, general operating costs, and establishment of end markets for recycled products. These issues are discussed below.

Transportation **–** When collected media needs to be transported to various processing steps, additional transportation costs are incurred. Due to the remote location and lack of convenient transportation infrastructure associated with most emergency response events, transportation costs can be a significant percentage of the overall cost. Green alternatives typically involve more transportation, handling, interim storage, and processing than other waste disposal methods.

Segregation of Recovered Media – Media entering into a green alternative process typically needs to be segregated from other debris that is initially collected in the field. Separating these media streams can be a costly and time-consuming process, both during collection in the field and at the off-site processing facilities established for the activity.

General Operating Costs **–** Because the processes are unique, additional regulatory requirements may be placed on green alternative processes. This can include requiring additional analytical laboratory studies, additional data tracking and management, more frequent monitoring and sampling events, more stakeholder engagement, and additional project management time.

Establishment of End Markets for Recycled Products – Because of the sudden nature of an emergency response event, the likelihood of existing end markets for materials generated by the response is low. Even if a market exists and is well established, the sudden and dynamic shift in supply and demand can result in financial effects on the green alternatives program, the existing market, and any cost/benefits analyses that are conducted during the response.

5.0 Potential Technologies for the Future

During the DWH response, many companies proposed new bio-energy conversion technologies to address waste generated by the response. Some ideas were initially triaged using the DWH Alternative Response Technology Evaluation System (ARTES) process. Because of the rapid response requirements, the associated costs and limited resources necessary to continue testing, and various compliance and permitting issues, few technologies were tested further during DWH.

Research indicates that future technologies for handling oily waste from spill response activities are currently focused in the area of thermal treatment technologies. Thermal treatment technologies include proven options such as incineration and thermal desorption, as well as newer technologies such as WTE, pyrolysis, and gasification. Pyrolysis and gasification systems are more likely to be modular and mobile units that could be transported to a spill site.

Waste to Energy – WTE technology is the process of creating energy in the form of electricity or heat (steam) from incineration of wastes. Incineration, or combustion of organic wastes, is the most common form of WTE implementation and is commonly used to process municipal solid wastes at WTE facilities worldwide.

WTE plants typically are heavily permitted and are required to meet strict emission standards, including those for nitrogen oxides (NO_x), sulphur dioxide (SO_2), heavy metals, and dioxins. Modern WTE facilities differ vastly from old incineration plants, some of which recovered neither energy nor materials. Modern incinerators reduce the volume of the original waste by 95–96 percent, depending on the composition and degree of recovery of materials, such as metals from the ash for recycling.

Pyrolysis – Pyrolysis is a thermochemical transformation of organic material at high temperatures without oxygen. In general, pyrolysis produces gas and liquid products and leaves a solid residue very high in carbon content. Extreme pyrolysis, leaving mostly carbon residue, is called "carbonization." Processing of certain industrial wastes using pyrolysis is well established, and increasing numbers of facilities are being built worldwide to process solid wastes in lieu of landfills. Processing and disposal of oil spill wastes using pyrolysis, although believed feasible, has not been attempted on a large-scale response basis.

Gasification – Gasification is a process that converts organic materials into a useable fuel gas via high temperatures using advanced pyrolysis, controlled oxygen, and/or steam. The power derived from gasification of biomass and combustion of the resultant gas is considered to be a renewable energy source that can power vehicles, industrial facilities, and electric grids. Several waste gasification processes have been proposed, but few have become operational. Gasification of oil spill wastes, although believed feasible, has not been attempted.

Should these technologies prove successful, some benefits may include the following:

- Eliminating landfill disposal and preserving landfill space for natural disasters
- Eliminating potential long term liabilities associated with new landfills
- Creating beneficial reuse products (energy, fuel, fertilizer)
- Reinforcing commitment to the environment
- Improving public perception of the commitment of the responsible parties

These technologies may warrant further evaluation and could have significant value in developing a sustainable waste management strategy for future oil spills, responses to natural disasters, and day-to-day waste management activities.

6.0 Conclusions

Although each emergency response event is unique in size, scale, material released, and situational logistics, it is possible to integrate green alternatives into the waste management strategies for the event. This was successfully proven during the DWH response. The DWH Green Alternatives Program was able to seamlessly support on-shore and off-shore recovery efforts related to waste management and to demonstrate a commitment to sustainable environmental solutions during an emergency response event.

The following key factors should be considered when incorporating green alternatives into emergency response waste management activities:

- The decision and scale of a Green Alternatives Program is best resolved prior to an event. Pre-planning activities such as understanding transportation logistics, permitting/regulatory issues, and end markets for recycled materials should be supported and completed prior to their need.

- Green alternative strategies should be included as practical in the Waste Management Plan for a response.
- Finding end-use markets for recycled/reuse/reclaimed materials is critical to the success of a Green Alternatives Program.
- A cost/benefits analysis is useful to fully understanding the financial commitment; green alternatives typically are more expensive than direct landfilling of materials.
- Developing a thorough understanding of regulatory conditions and permitting requirements for proposed green programs is crucial to their success.
- Establishment of a Green Alternatives Program Manager within the Environmental Unit will enable the Waste Management Team to focus on the primary mission of directly supporting recovery operations. This role can also help with internal and external messaging of the Green Alternatives Program.