Water Column Injury Ephemeral Data Collections:
NRDA Cruise 4 – Jack Fitz 3 Water Sampling Plan
Deepwater Horizon Oil Spill (DWHOS)
June 11, 2010

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Proposed Cruise dates: June 11, 2010 – June 18, 2010

Objectives (Tier 1-3 excerpted and adapted from Ephemeral Data Plan)

Deep and intermediate waters of the offshore Gulf of Mexico, as well as surface waters (upper mixed layer and potentially other deeper near-surface waters) are and will continue to be exposed for a period of time to entrained oil droplets and dissolved soluble to semi-soluble hydrocarbons (aromatics primarily) resulting from:

A. Surfacing oil plumes from deepwater releases and horizontal transport of surfaced oil and the associated oil droplet plume rising from the release sites, with soluble to semi-soluble aromatics already dissolved from the droplets;
B. Dissolution of aromatics from the surface floating oil (after transport to other areas) into the wave-mixed layer (thickness variable with wave height, about 1m deep)
C. Natural entrainment of floating oil (primarily when winds exceed 12 kts) and dissolution of soluble to semi-soluble aromatics into the surface mixed layer (i.e., to 20-40m deep; with more exposure in the upper 1m)
D. Chemical dispersant-induced entrainment of oil and dissolution of soluble to semi-soluble aromatics into the surface mixed layer (i.e., to 20-40m deep; with exposure highest in the upper 1m but potentially extending deeper than for natural entrainment)
E. Transport of oil droplets and dissolved soluble to semi-soluble aromatics in surface advective flows, including in eddies, along fronts, etc.

Objectives of this study plan:

The objective of this sampling plan is to document physical and chemical conditions of deep waters and to characterize the deepwater oil plumes. In addition, conditions in surface waters near the spill source area will be sampled. Components include:

A. Conductivity, Temperature and Depth (CTD) for characterizing the density structure and pycnoclines;
B. Surface boat-mounted ADCP to measure surface currents in the upper ~300ft (91m) of the water column;
C. UV fluorescence measurements to detect subsurface oil (*in situ* sensor packaged with the CTD, a Turner C3 fluorometer equipped with a crude oil sensor which is capable of detecting crude oil and chlorophyll A.

D. Whole water samples for measurement of the following chemicals in accordance with the NOAA Analytical Quality Assurance Plan (QAP):
    - Extended PAH (parent plus alkylated PAHs),
    - BTEX,
    - TPH,
    - Dispersant concentrations by LC/MS/MS,
    - Oil droplet size by microscope and video microphotography
    - Toxicity (objective for ENTRIX only)
E. Filtered water samples isolated with Payne Environmental Consultants, Inc. (PECI) Portable Large Volume Water Sampling System (PLVWSS) to examine dissolved and particulate/oil phases for:
    - Extended PAH (parent plus alkylated PAHs),
    - TPH
F. Underwater digital holography to quantify oil droplet size distribution together with plankton and other particles
G. Surface oil photography and oil samples for weathering analysis

Locations to be sampled:

Sampling and physical oceanographic data will be collected at stations placed in areas of deepwater oil plumes and surfacing oil from these plumes. The design will be to sample near the wellhead down-current from the source. The directions from center will be focused between bounds defined by:

A. The down-current direction, as indicated by the surface ship-mounted ADCP, the ADCP at the Wellhead, and the ADCP array deployed at 2.5 km NE of the Wellhead.
B. The combined down-wind and down-current direction, as calculated by the vector sum of surface current plus 2% of wind speed directed 0^{o}-20^{o} to the right of downwind.
C. Any available aircraft support as to surface oil locations from USCG, Ocean Imaging, or other over flights (possibly completed in support of response operations).

In view of the 2-km exclusion zone and 5-nmile safety zone imposed by the Incident Command Response Group (ICRG), the sampling stations will include locations between the 2-km and 5 nmile circles, as well as locations outside the 5-nmile circle. Sampling of the freshly-rising oil plume will be focused near the 2-km circle in the down-stream direction unless currents are strong at the time of sampling. The vessel will coordinate with SIMOPS as it approaches the area on 11 June, according to current guidance received from SIMOP as of 9 June 2010.

Samples will also be taken at a reference location outside the plume, in clear waters without surface oil while en-route to the area near the Wellhead. We plan 6 days of sampling, 1-2 stations per day sampling a range of depths covering the entire water column. We estimate up to 200 discrete water samples (whole water) and approximately 40 filtered water samples will be taken. In addition, to these samples ENTRIX will collect samples for their toxicity analyses at selected locations (approximately 4 stations) with as little impact to the primary mission as possible. ENTRIX's objective for collection of samples for toxicity assessment is to obtain a

representation of significant oil/dispersant contamination (including at depth), the surface sheen, and a reference location. In addition, toxicity assays using bacteria and/or rotifers (e.g., Microtox®, Rotox kit M^{tm}) may be performed by ENTRIX on board.

Methodology:

1. Physical oceanographic data collection upon arriving at each station:

A. **CTD and in situ fluorometer measurements**

Conductivity Temperature and Depth (CTD) will be conducted to determine water column stratification or other physical oceanographic parameters that will help determine depth of samples collected. The Seabird CTD probe will have a dissolved oxygen (DO) sensor, as well as an *in situ* Turner C3 fluorometer that will be used to delineate the vertical extent of subsurface oil. A J-frame or larger, a hydrowire (at least 300ft long) and Niskin and/or Go Flow bottles will be used for sample collection.

B. **Current**

A ship-mounted ADCP will be used to measure surface currents in the areas sampled. Other ACDP units are deployed in the area of interest. Data will be applied to this monitoring effort, as appropriate.

2. ROV deployment, video camera and digital holography:

The ROV will be deployed from the surface to the seabed with a live-feed video TV camera and black lights, BFDFOQMark oil quantification grid, complete CTD package, six Go Flow bottles, and digital holography system; all packaged together in one unit (on the ROV and Tether Management System (TMS)). Droplet sizes will be quantified with the BFDFOQMark oil quantification grid and holographic images. Discrete water samples (see below) will be taken with the Go-Flows at depths where oil droplets are seen or other features indicate potential presence of oil.

The holography will be performed using the Holocam, built by Cabell Davis (WHOI), Nick Loomis (MIT), and Mark Benfield (LSU). Their proposal is attached. Previously, the holocamera housings were rated to 1000m; however, a new housing has been manufactured for operations to 1500m by the WHOI (Falmouth, MA) machine shop. The holocamera will measure the size distribution of the oil droplets in holograms ranging from 12 μm to 14 mm. The scientific team will also process, identify and count plankton and particles as observed in the holograms. Deployment is by attachment to an ROV. The Holocam is autonomous, does not need its own hydrowire, and data will be downloaded between deployments.

3. Water column sampling and collection:

Samples will be taken to test for the presence of dispersed oil and droplet sizes. Water samples at depth will be taken with a rosette sampler or the ROV package, both of which can collect multiple samples at various depths and collect large enough samples for chemical analysis. The samples for dispersant measurements will be collected in 1 L plastic or Teflon bottles. Droplet size will be determined for the discrete samples using high resolution microphotography and a

LISST particle sizer. Microscopic analysis (with a digital camera mounted to the microscope) will be used to identify particle types and to ground-truth the other instruments.

Water samples will be collected for analytical chemistry in accordance with the NOAA Analytical QA plan: Table 1.1a (extended PAH and saturate biomarkers),; Table 1.1b (alkane/isoprenoid and TEH); Table 1.1c (volatile aromatic hydrocarbons); Table 1.1d (petroleum biomarkers); and dispersant concentrations Two types of samples will be taken, and in both cases remaining sample water will be saved or used for other on-board analyses:

A. A Portable Large Volume Water Sampling System (PLVWSS) (Payne et al., 1999) will be employed to separate the particulate/oil phase trapped on a 0.7 μm glass fiber filter and capture the dissolved phase (filtrate) in 3.8 L (1 gal) I-Chem Certified Clean amber glass jugs. The PLVWSS requires ~3.5 L of sample (for enhanced detection limits above the usual 1 L sample size), so before filter processing the bulk of the sample, duplicate 40 mL aliquots will be drained from the Go Flow bottle directly into pre-acidified VOA vials for analysis of BTEX and other alkylated benzenes. Then, after the majority of the rest of the sample is processed through the PLVWSS, the remaining 400-500 mL will be saved unfiltered for LISST and microscopic analysis for enumeration of droplet sizes and number density.

B. Whole water samples will be taken in 1L I-Chem Certified Clean amber glass jars. . A separate 1-L sample will also be collected for total suspended solids (TSS) and organic carbon, hydrogen, and nitrogen (CHN), clearly labeled for this dual intent. The CHN analysis will be conducted after the non-destructive TSS analysis using an elemental analyzer (micro-Dumas method). Organic carbon:nitrogen ratios in seawater typically dominated by biogenic organic matter (e.g., C:N <10) should substantially increase as nitrogenous compounds (e.g., amino acids, proteins, and polypeptides) are diluted by crude oil, which is devoid of such compounds. An additional unfiltered sample in 1L I-Chem Certified Clean amber glass jars will be taken for PAH/TPH analysis. Remaining sample water will be saved unfiltered for microscopic and other instrumentation for enumeration of droplet sizes and number density.

Water samples will be collected at multiple depths in 5 or 10 L Go Flow Bottles mounted on the Tether Management System (TMS) of the ROV or by using a conventional hydrowire with 5 L Go Flow Bottles and a rosette sampling array with pre-programmed sampling depths. The depths will be selected based on *in situ* CTD, LISST, and fluorometric results and review of video taken by the ROV.

In addition, a Nisken bottle containing a video micro-photographic camera will be deployed on the hydrowire at selected stations to obtain in situ microphotography for oil droplet size analysis.

4. Surface oil samples for weathering analysis:
Surface oil samples will be taken and placed in (cleaned) amber 125 mL bottles. Digital photography will be used to document surface oil appearance and thickness. Surface oil samples will be measured for water content (i.e., mousse); whole oil analysis (C3 to C44) to document losses of the lower molecular weight components; alkane/isoprenoid and PAH content; and saturate biomarkers. Surface sheen and very fluid fresh oil samples will be collected with pre-cleaned Teflon nets attached to fishing weights by casting from the leeward side of the *Jack Fitz* with a conventional fishing pole. After the Teflon nets have been dragged through the sheen, they will be sealed in 125-mL glass jars for shipment to the laboratory (Alpha Analytical). Water content on mousse samples will be completed at the laboratory via Karl Fischer titration. Organic chemical analyses will be conducted in accordance with the NOAA Analytical QAP.

NOTE:
Sample collection methodology, handling, chain of custody and decontamination procedures will follow accepted standards to ensure the highest quality data will be collected. Discrete samples will be tested at an approved laboratory or laboratories.

Limitations:
To accomplish the mission, it may be necessary to send a supply boat to bring samples back to shore for shipping to meet holding time requirements. If so, chain of custody must be maintained. An at sea transfer protocol memo has been prepared as an attachment to this plan. Please refer to that document for guidance on the additional contingencies and protocols for the at sea transfers. The at sea transfer is scheduled to take place in the evening on day four or the morning day 5 of the mission so as to minimize interruption to sampling.

Equipment needs:
Boat to accommodate 5 NOAA contractors (1 chief scientist James Payne, 1 ASA staff for video microphotography and LISST work, 1 ASA Staff for dissecting scope work and to assist with LISST work and in taking water and oil samples plus QA/QC recording; and 2 Holocam operators – Cabell Davis and Nicholas Loomis); 2 ENTRIX employees. Boat and personnel will be prepared for approximately 8 total days dedicated to cruise activities, including 2 partial days of transit time, a partial day for at sea transfer activities and at least 6 full days of sampling activities. The cruise plan will be: day one - mobilization and departure, days 2-4 - sampling, day 4 or 5 - at sea transfer, days 5-7 sampling, day 7 - return to port, day 8 - demobilization; hopefully occurring June 11-18, 2010. Total Scientific crew – 7. One Industrial Hygienist (supplied by BP).

Sampling deployment gear to sample up to 5,000 ft nominally CSA
Seabird CTD with dissolved oxygen and in situ fluorescence CSA
ROV with live-feed video camera and capability to collect water samples with attached Go Flow Bottles CSA/MAKO
Niskin and/or Go-flow bottle samplers CSA
Dissecting Microscope with camera fitting (rented from LSU) for droplet size measurements

LISST (for droplet mid-sized measurements)
Video micro-photographic camera in Niskin bottle sampler Dr. Yong Kim NOAA
Holocam system Dr Cabell Davis, WHOI

200 1 L wide-mouth ambers for unfiltered PAH and TSS analysis ENTRIX
100 1 L plastic wide-mouth bottles for dispersant analysis ENTRIX
100 125 mL jars for filters and oil samples ENTRIX
64 2.5 L ambers for toxicity samples ENTRIX
Coolers & Glassware ENTRIX

>200 1 L amber glass jars for oil and water samples NOAA
54 2.5 L amber glass jars for oil and water samples NOAA
64 1-gallon (3.8L) amber glass jugs for PLVWSS-filtered water samples NOAA
Pre-acidified VOAs for BTEX samples (min 72; 144 optimal)
Coolers & Glassware NOAA

Personnel
5 NOAA contractors
2 ENTRIX employees
4 CSA personnel
3 Mako Technologies (ROV operations) personnel
1 Industrial Hygienist (supplied by BP)

Vessel
All operations will be completed on the M/V Jack Fitz (165 ft) operated by Coastal Marine Logistics out of Golden Meadow, LA. This vessel has been chartered by CSA International, Inc. It is based in Golden Meadow, LA and is available at this time.

Estimated Costs

Jack Fitz Cruise #3: Estimated Costs				
Category	**Unit Cost**	**Units**		**Total Cost**
		Type	Number	
Mobilization Costs	$ 58,000.00	Quantity	1	$ 58,000.00
Vessel Costs	$ 32,857.14	Days	8	$ 262,857.10
Video CTD Array (Rental & Additional Insurance)	$ 2,000.00	Per Cruise	1	$ 2,000.00
Microscope Rental (LSU)	$ 1,322.50	Quantity	1	$ 1,322.50
Holocam Costs less Labor costs for 2 operators -see attached proposal)	$ 30,698.10	Per Cruise	1	$ 30,698.10
NOAA Contractor Costs – Holocam operators	$ 45,000.00	Per Cruise	1	$ 45,000.00
NOAA Contractor Costs	$ 9,285.71	Days	8	$ 74,285.68
Estimated Total for Jack Fitz Cruise #3				**$ 474,163.38**

NOAA's Holocam contractor costs for this cruise include $14K of the proposed cost for staffing of the Holocam and $3,000 in travel for the cruise and $28K in labor for data processing.

Safety Plan
A full operations and safety plan will be prepared for review and approval before any planned operations. In addition, the NOAA incident site safety plan (which all NOAA employees and contractors must sign prior to the cruise) is attached.

Transfer of the shared electronic media in the onboard equipment to each of the party's hardware for retention and use.

Upon return to port, the vessel Operations Manager shall produce identical copies of the raw and processed electronic media generated during the cruise and deliver one of those copies each to NOAA (or its QA contractor) and to ENTRIX.

Laboratory
All filtered water chemistry samples for PAH and SHC will be sent to Alpha Analytical Laboratories in Mansfield, MA. The RP may take additional unfiltered and toxicity water samples at selected locations, which are not part of the cooperative sampling. These samples will be sent to a laboratory of their choosing or processed on board the *Jack Fitz* for range-finding toxicity assays using Microtox®, and Rotox kit M™.tests. ENTRIX will provide all related sampling supplies for their samples. Some of these unfiltered water samples may also be used for TSS/CHN, PAH/TPH, and dispersant analyses, and if completed, the data will be shared with NOAA and other trustees.

Distribution of Laboratory Results

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LAPD) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana and to ENTRIX (on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the completed LAPD, will also be delivered to the secure FTP drop box maintained by the trustees' Data Management Team (DMT). Any preliminary data distributed to the DMT shall also be distributed to LOSCO and to ENTRIX. Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Quality Assurance Project Plan, after which time the validated QA/QC'd data shall be made available to all trustees and ENTRIX. Any questions raised on the validated QA/QC results shall be handled per the procedures in the Quality Assurance Project Plan and the issue and results shall be distributed to each party. In the interest of maintaining one consistent data set for use by all parties, only the validated/QA/QC'd data set released by the DMT shall be considered the consensus data set. The LADP shall not be released by the DMT, LOSCO, BP or ENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for these data prior to validation/QA/QC, any released data will be clearly marked "preliminary/unvalidated" and will be made available equally to all trustees and ENTRIX.

Reference:

Payne, J.R., T.J. Reilly, and D.P. French, "Fabrication of a Portable Large-volume Water Sampling System to Support Oil Spill NRDA Efforts," in *Proceedings of the 1999 Oil Spill Conference*, American Petroleum Institute, Washington, D.C., pp. 1179-1184, 1999.

Attachments:

Attachment 1. PLVWSS sampling protocols in support of the NRDA Cruise 2.pdf
Attachment 2. Quality Assurance Guidelines 2010-05-30 UPDATE
Attachment 3. Water Sample Handling Procedures 2010-06-11 copy
Attachment 4. VideoSystem-2010Mar14-1.pdf
Attachment 5. Holocam array description and budget
Attachment 6. microscopeletter.pdf
Attachment 7. 2010-05-21 05-28-15 pm.pdf
Attachment 8. NOAA Site Safety Plan for Deepwater Horizon Incident
Attachment 9. *M/V Jack Fitz* NRDA Cruise 3 HSE Plan Rev 003 Final
Attachment 10. M C 252_Incident_SIMOPS_Plan_
Attachment 11. At sea sample transfer memo
MC 252 incident reporting document
MC 252 Analytical QAP V1

Water Column Injury Ephemeral Data Collections:
Cruise 2: Surface Water Sampling Plan
Deepwater Horizon Oil Spill (DWHOS)
June 11, 2010

Approvals

Approval of this work plan is for the purposes of obtaining data for the Natural Resource Damage Assessment. Each party reserves its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan.

Federal Trustee Representative

Lisa DiPinto (NOAA)

Date 6/11/10

BP Representative

NRDA Specialist

Date 6/11/10