Mississippi Canyon 252 Incident

NRDA Tier 1 Sampling Plan

Reconnaissance Survey of Hard-Ground Megafauna Communities in the Vicinity of the Deepwater Horizon Spill Site

Deepwater Benthic Communities (Deepwater Coral) Technical Working Group

October 19, 2010

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.

APPROVED:

Jennifer Baca 10/19/10

Department of Commerce Trustee Representative: Date

Joyce Mikey 10/19/10

BP Representative: Date

DRAFT

Reconnaissance Survey of Hard-Ground Megafauna Communities in the Vicinity of the Deepwater Horizon Spill Site

NRDA Sampling Plan & Fall 2010 Cruise Plan

Deepwater Benthic Communities (Deepwater Coral) Technical Working Group

October 19, 2010

Prepared by: Drs. Charles Fisher, Harry Roberts, James Brooks, Bernie Bernard, and Ian MacDonald (TDI-Brooks Int'l and our MMS/NOAA Science Team for *Lophelia-II* and *Chemo-III* Projects)

Proposed Cruise Dates

R/V Gyre – October 25-November 5, 2010 (Tentative)

Summary:

This NRDA sampling plan identifies sites nearest to the spill site with the potential for significant hard-ground megafauna communities (principally deep-sea coral or chemosynthetic seep communities). It also identifies sites that, based on currently available data and NOAA models,[1] are projected to be most likely to have been exposed to deepwater oil. The Deepwater Benthic Communities Technical Working Group (TWG) reviewed and selected all sites to be surveyed. An approximately 10 day cruise with 7 days of around the clock operations will take place, utilizing a drift camera to survey predicted hard-ground areas and obtain visual determination of the presence of megafauna communities. Identifying the existence and location of these communities in relation to potential exposure to oil, dispersants, or other chemicals associated with the Deepwater Horizon incident, if any, will guide subsequent Natural Resource Damage Assessment (NRDA) studies of these communities, if such studies are warranted.

This plan was developed by the Deepwater Benthic Communities (Deepwater Coral) Technical Working Group (TWG) in close cooperation with the Water Column TWG.

[1] BP's approval of this work plan shall not be construed as an admission of the accuracy of the NOAA models or data interpretations relied on in selecting sites for drift camera surveys.

Background/Justification:

Hard-bottoms or hard-grounds are relatively uncommon relative to soft-bottoms in the northern Gulf of Mexico (GOM), but have distinct associated communities that are notable for their biodiversity and complexity. Megafaunal communities associated with hard-bottoms include chemosynthetic seep communities (e.g., communities including foundational species such as tube worms with life spans that can exceed 250 years), deepwater mussels (Fisher et al. 2009), deep-sea coral communities (e.g., framework-forming coral species such as *Lophelia pertusa or Madrepora* spp.), and associated black and gorgonian corals, sponges, and other taxa (Brooke and Schroeder 2007; CSA 2007).

Using existing geophysical and geological data and methods employed on previous joint Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE – formerly Minerals Management Service)/National Oceanic and Atmospheric Administration (NOAA) Gulf of Mexico deepwater studies, members of the Deepwater Benthic Communities TWG identified areas of potential hard-grounds nearest to the spill site. Based on currently available empirical data and NOAA models, TWG members also identified sites projected to be most likely to have been exposed to deepwater oil. Because seabed structural faulting and the migration of hydrocarbons to the sediment surface have been previously related to the presence of significant biological communities in the deep GOM (see references contained in NRDA Tier 1 for Deepwater Communities Sampling Plan), TWG members used these natural conditions to identify sites for field surveys. Such analyses can only indicate the likelihood of specific types of communities. Confirming whether such communities are or are not present in a particular area and determining a site's specific location on the sea floor requires field surveys for groundtruthing. Therefore, this plan calls for a reconnaissance cruise to survey potential sites with the intent of identifying the existence of potentially exposed communities.

Relationship to Future NRDA work:

Sites with confirmed hard-ground communities and/or evidence of macroseepage likely to support megafaunal chemosynthetic communities may be targeted for later detailed imaging, sampling and characterization work not covered in the present plan, using more expensive deep-sea assets appropriate to that type of work. All potential future analyses are expressly not part of this work plan.

Methodology:

Below is a narrative with details of the goals, methods, limitations and reasonable expectations for this project. In a final section before the budget is a bulleted list of deliverables that the Trustees and BP will receive from this project.

Study Area - Through interpretation of 3D seismic data, BOEMRE reports there ar approximately 200 potential hard-ground sites within about 15 nm of the spill (**Figu** number of these targets correlate with TDI-Brooks' geochemical coring database in proximity to the spill site where natural macro-seepage of oil and gas hydrates have been

identified (**Figure 3**). Other recent water column reports suggest a half dozen potential seep sites based on acoustic profiles. To our knowledge, only two (2) of the potential hard-ground sites have been visited by ROV and confirmed to host macrofauna communities. The MC-294 site, which we discovered in 2009, is about 6 nm WSW away from the Deepwater Horizon wellhead at 1400-m water depth and hosts at least a few chemosynthetic tubeworm aggregations, a mussel bed, and associated seep fauna. The other site, in MC-118, is about 10 nm NW away in 800-m water depth. This second site hosts a single *Madrepora* coral aggregation as well as sparse hard-ground and seep fauna including gorgonians, tubeworms, and mussel beds.

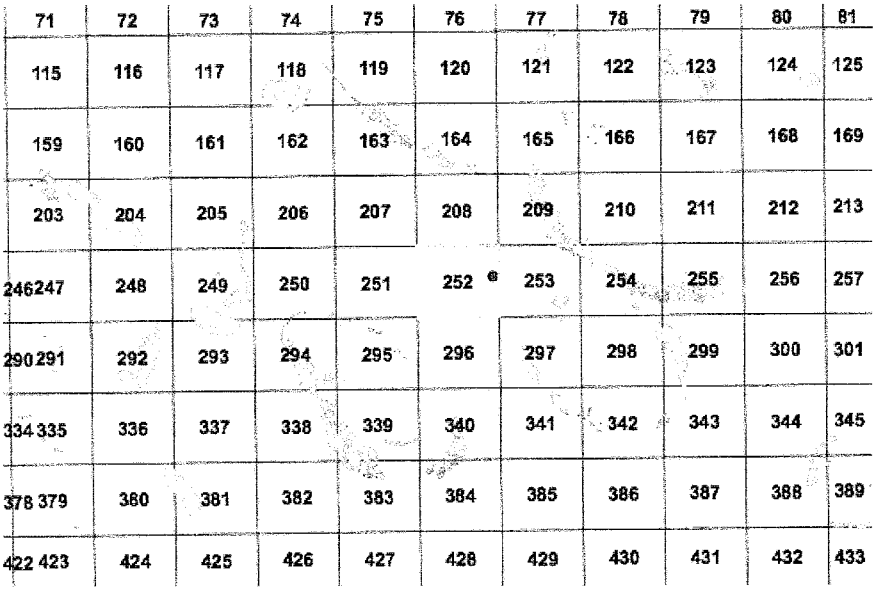

Figure 1. Potential hard-grounds in BOEMRE lease blocks in the vicinity of the Deepwater Horizon spill site identified through interpretation of 3D seismic data. The approximate position of the Deepwater Horizon wellhead is identified with a red circle.

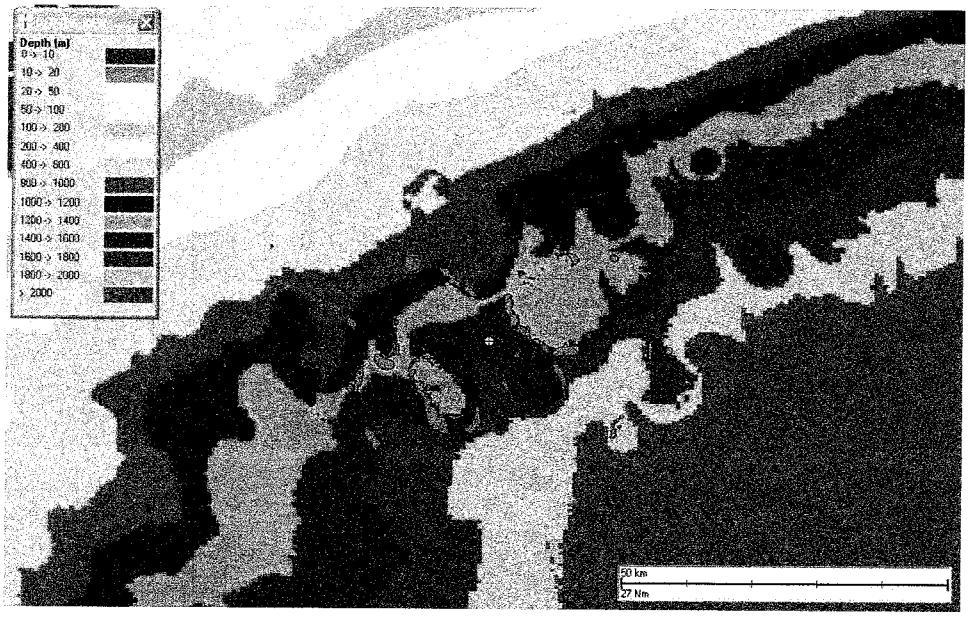

Figure 2. Potential hard-grounds from Figure 1 in relation to bathymetry.

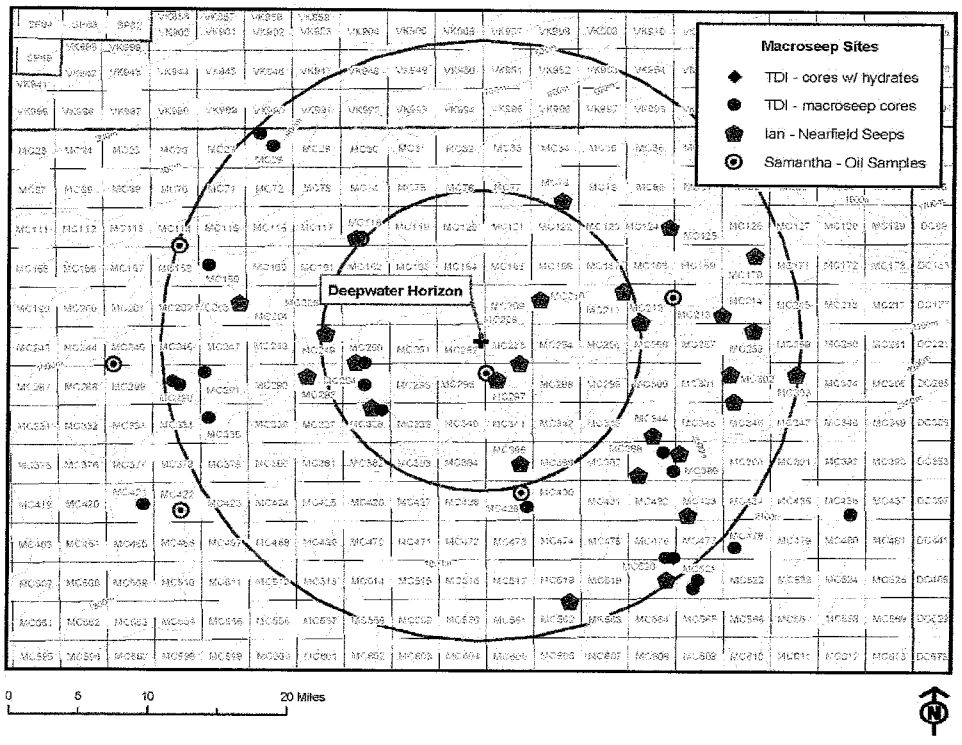

Figure 3. Sites near MC-252 where TDI-Brooks has discovered macro-seepage of gas hydrates in cores acquired from surface geochemical exploration (S where Ian MacDonald has reported nearfield seeps; or where Samanth collected oil samples.

As explained below, members of the Deepwater Benthic Communities TWG have identified other potential hard-ground sites in the area to survey. Our highest priority will be sites within 10 nautical miles of the spill site in all directions. Our site sampling strategy is to target those closest first and then work out from the DWH site with an emphasis on sites projected to be most likely to have been exposed to deepwater oil based on currently available data and NOAA models. **Attachment 1** lists available data on oil concentrations deduced from fluorometry and NOAA modeling results.

Tasks - The research team will follow a protocol developed for previous MMS/NOAA projects (*Chemo-III* and *Lophelia-II;* see Brooks et al. 2008). Dr. Charles Fisher will be Project Manager of the effort with a team that has worked together in the past as part of previous and on-going MMS/NOAA chemosynthetic and hard-ground coral explorations along the northern Gulf margin. This project will require collaboration and cooperation between NOAA's Office of Ocean Exploration and Research (OER), BOEMRE, and other NOAA NRDA teams. All four of the tasks listed below were or will be accomplished with the requested funding:

Task 1 – Site Selection. A meeting of members of the Deepwater Benthic Communities TWG and other relevant experts was convened in New Orleans, Louisiana on September 22 and 23, 2010, to review available data and NOAA modeling projections and develop a site proposal for presentation to the full TWG. The New Orleans meeting identified 25 potential hard-ground areas within 15 nautical miles of the Deepwater Horizon (Macondo) wellhead, and several additional sites further to the southwest of the wellhead (**Attachment 2**). From these sites, 13 sites within 15 nautical miles of the wellhead and four sites further to the southwest were identified as primary targets for field surveys using the drift camera.

Task 2 – Field Survey. The second step is to mobilize an approximately 10 day cruise for 7 days of around the clock operations to visit the identified sites. The cruise will utilize a precisely navigated Drift Camera (**Attachment 3**) to obtain near bottom photos of 17 sites. The project will use TDI-Brooks' research vessel, the R/V GEOEXPLORER or R/V GYRE, currently based in Freeport, Texas (**Attachment 4**).

The area near the spill site may be the most likely deepwater area to have been exposed to deepwater oil, dispersants, or low oxygen levels so survey work will be initiated at those sites. Our highest priority will be sites within 10 nautical miles of the Deepwater Horizon (Macondo) wellhead in all directions. Our site sampling strategy will be to target those closest first and then work out from the DWH site, particularly to targets identified to the southwest heading from the DHW site. The initial site selection and cruise plan may be modified at sea using an adaptive site selection protocol, where discovery of sites meeting certain criteria could determine the order of subsequent site exploration. For example, if one of two potential sites in the same general area and depth is confirmed to host an established megafauna community, exploration of the second site in that area would drop in priority.

Because our goal is to determine the location of hard-bottom communities within at l
discrete sites, each of which may be unique, the image acquisition sampling design w
customized for each site to be surveyed. The survey plan for a site will be based on t
available data (water column, seismic and core data) and also the bathymetry of the sea floor at

that site. The basic approach is to pick "points" on the sea floor within a target site and also choose transect lines between points or along areas of interest. From this, we will plan a 5-10 hour deployment of the drift camera (duration depending on size and complexity of the feature) to maximize the number of images collected in the hard-bottom areas. "Points" will likely have foot prints ranging from thousands to hundreds of thousands of square meters depending heavily on the type of reflectivity and subsurface information derived from the seismic data, but can also sometimes be refined (to smaller areas) from existing geographically accurate data on gas plumes, from existing piston cores, or from known or observed abrupt bathymetric features. For point targets, we would maneuver the ship so that the camera makes several passes over this target, either as a series of parallel lines spaced appropriately to cover a larger target, or using a series of lines that intersect over a central point to provide highest density of coverage over a smaller area of high likelihood. The number of passes will depend on the size of the target. Transects between "points" of interest within a site will be run while the camera is deployed, gathering near-bottom image data while in transit. When appropriate these transects will include other areas of interest and in some cases long transect lines will be the most appropriate way to survey a particular feature (such as a long ridge crest, or up a slope with changing reflectivity). The relative importance assigned to different data sets when designing the sampling strategy for a particular feature or site will vary somewhat depending on whether the feature is interpreted as a site more likely to host corals or chemosynthetic communities. Although the two community types are linked through the carbonates produced by microbes at seeps (and often occur together), chemosynthetic communities are most likely to occur at sites where there is current evidence of natural macroseepage or fluid conduits (and somewhat independent of local bathymetry). However, corals require exposure to appropriate currents and are more often found on local topographic highs and at the heads of local canyon features, but do not require exposure to seep fluids.

Use of the drift camera is a proven time and cost effective method to obtain ground truth information on potential deepwater hard-ground sites hosting megafaunal communities. The drift camera will provide high-resolution images at distances from 2 – 5 meters above the sea floor where features such as individual tubeworms (**Figure 4a**), mussels (**Figure 4b**), coral colonies (**Figure 4c,d**), and remnants of any of these are easily discernable.

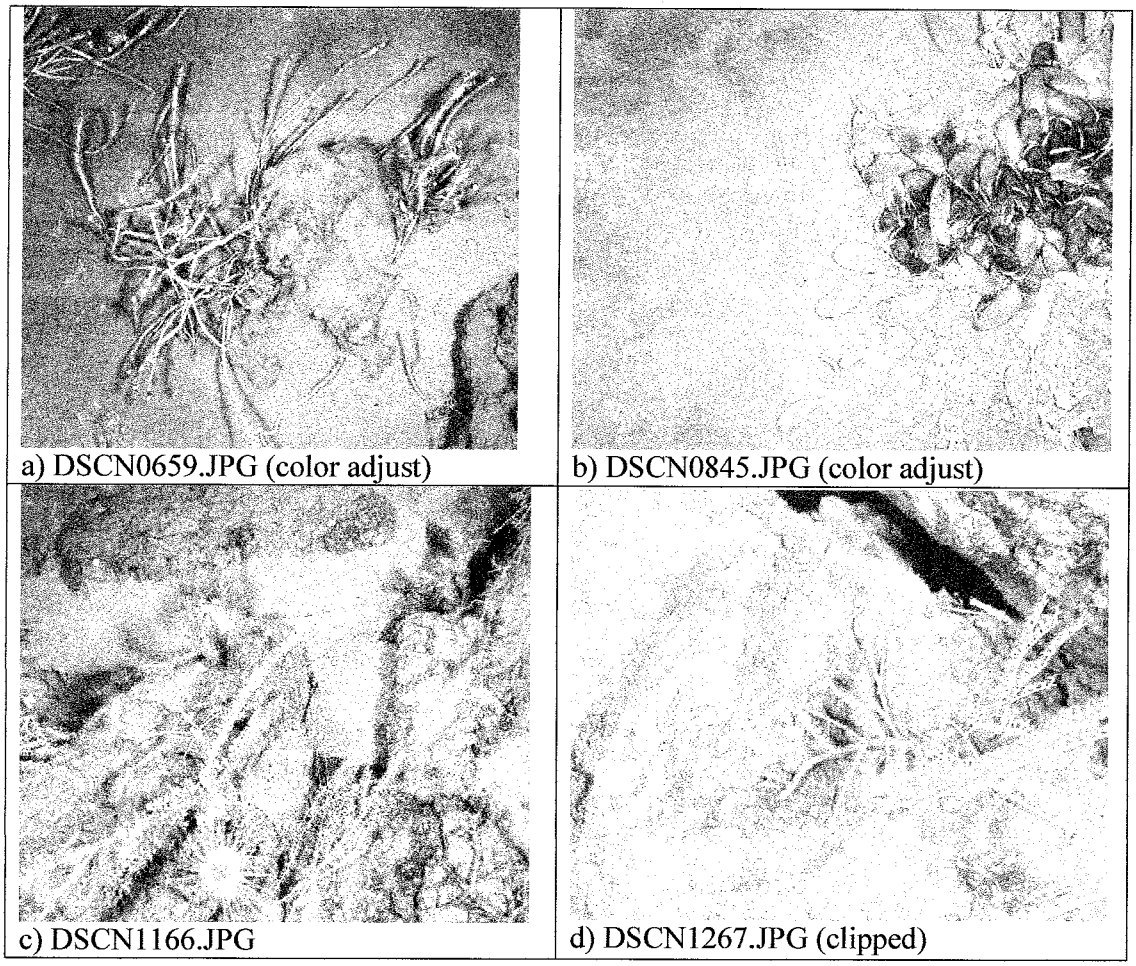

Figure 4. Drift Camera images of macrofaunal community discoveries in the deep-water Gulf from *Chemo-III* and *Lophelia-II* programs.

This field effort will be led by TDI-Brooks, which has experience in precisely navigated benthic operations in deepwater and who own and operate drift cameras appropriate for this p
will be conducted on the TDI-Brooks research vessel, R/V GEOEXPLORER or R/V
outfitted with USBL precision navigation and camera deployment capability. The cr
GEOEXPLORER and GYRE have experience with this type of 24-hour-a-day precis
work off of a wire. Dr. Ian MacDonald (FSU), who designed the drift cameras opera
Brooks, will assure productive use of the cameras. This cruise will also include a sma
biologists to assist in onsite faunal identification.

Task 3 – Initial Provision of Data. Immediately after the cruise, we will supply copies of all images acquired with appropriate metadata and chain of custody to NOAA and BP/Entrix. Within one week of the end of the field effort, we will prepare a quick look report that will include the daily reports, an ARC GIS cruise track map, summary tables of sites visited, and numbers of images collected at each, ARC GIS maps of camera tracks within sites, and first impressions of specific sites, including summaries of all locations with notable megafauna communities or evidence of recently living megafauna.

Task 4 – Final Report. We will prepare a final report integrating several data types, including image data and drift camera tracks along with existing 3D seismic data, water column data, NOAA water column modeling, and piston core data. Even if abundant communities are not documented in the drift camera survey of a particular site, the data will also be examined for sea floor manifestations of active seepage and presence of exposed massive carbonates and, therefore, the likelihood of nearby lush seep and/or coral communities. The final report will provide a summary of the sites visited and our evaluation of the megafauna communities present at the locations of potential hard-ground sites.

Although most pictures collected using a drift camera at these depths will not have the resolution for examination of details such as individual polyp damage (because of the variable distances involved and other uncontrolled variables such as visibility and local shading), the system does have the capability to collect pictures of this resolution as is evident in the examples in Fig. 4. We will collect a subset of pictures that can be examined for features such as discoloration, sloughing tissue, necrosis, excessive mucus production, abnormal polyps, and other visible indicators of damage to a portion of a coral or tubeworm colony. We will identify this subset of photographs in the final report.

Safety Plans:

TDI Brooks' full operations and safety plan is attached (**Attachment 5**). Principal investigators merge this safety plan with any applicable university or participating organization practices. All well established safety protocols will be followed. MSDS hazardous materials sheets will be posted.

BP/Entrix Participation in Field Efforts:

Provision shall be made for a sufficient number of BP/Entrix representatives to participate in field efforts, during proposed working hours. For 24 hour operations, 2-3 representatives may be required. The cruise will not be rescheduled, however, if no Entrix representatives are able to take part.

Transfer of the Shared Electronic Media in the Onboard Equipment to Each of Hardware for Retention and Use.

Upon return to port, the vessel Operations Manager shall produce identical copies of processed electronic media generated during the cruise and deliver one of those copies each to

NOAA (or its QA contractor) and to BP/Entrix. Additionally, all non-analytical data, including field reports and data sheets, will be made available to BP/Entrix within a reasonable time after completion of the cruise.

Summary of Deliverables to the Trustees and BP from the Reconnaissance Survey of Hardground Megafauna Communities in the Vicinity of the Deep Water Horizon Spill Site.

1) Before the field effort commences, a report to the Deepwater Benthic Communities (Deep Coral) TWG and Water Column TWG on the planned cruise track and sampling stations, with the expectation of input that can be incorporated into an adaptive site selection plan.
2) Immediately after the field work, copies of all images acquired, navigation data, and image metadata with appropriate chain of custody.
3) Within one week of the end of the field effort, a quick look expedition report that will include:
    a. The daily reports from the cruise;
    b. An ARC GIS cruise track map;
    c. Summary table of sites visited and numbers of images collected at each;
    d. ARC GIS maps of camera survey tracks accurate to within +/- 5 meters for each site visited;
    e. First impressions of specific sites from a first review of images to include obvious hits with respect to high-density megafauna communities; and
    f. ARC GIS maps with detailed locations (+/- 5 meters) of megafaunal communities identified from a first survey of the image data.
4) Within one month of the end of the field effort, a final report on the project that will include:
    a. Maps showing all data considered in site selection;
    b. A table of the initial selection of highest potential sites (before visitation), with notes on each site (potentially 30 – 40 sites);
    c. A summary of findings from each site, including maps of drift camera tracks with 'bottom in site" images identified and examples of typical and exceptional pictures from each site (about 15 sites);
    d. Interpretation and further recommendations of site prioritization based on findings from this effort and consideration of other factors such as proximity to the spill site, potential for impact from deepwater oil, depth of the site, coverage on different sides of the spill site, and faunal differences among sites; and
    e. Identification of images of sufficient quality for possible visual damage assessment.

Note that we will go to sea with an adaptive sampling plan and could visit in excess of 20 sites. However, the numbers of sites visited and the quality of the track lines and number of collected at each site may be impacted by weather. This effort can be conducted duri average sea state found in the Gulf of Mexico in October, but if the sea state exceeds we deem safe for over-the-side work, we will have to temporarily suspend operations we will have some flexibility in start dates (if severe weather is impending), we will h control of conditions that arise after the field effort has commenced.

Personnel
NOTE: All cruise participants are not listed at this time, only the leaders of the different efforts. We will need additional experienced personnel from each team to work together to accomplish all proposed work at sea with limited bunks. Each cruise will include an Entrix representative.

Dr. Chuck Fisher	Pennsylvania State University - Lead PI - Deep habitat component
Dr. James Brooks	TDI Brooks International, Inc - Project administration
Dr. Harry Roberts	Louisiana State University - Geology
Dr. Bernie Bernard	
Dr. Ian MacDonald	Florida State University
Dr. Gary Wolff	

CVs of project leads are included in **Attachment 6.**

Budget

Task 1 – Program Management and Site Selection

Program Management and Travel	$ 25,000
Dr. Harry Roberts (10-days @ $1,200/day x 20% OH)	$ 14,400
Dr. Chuck Fisher (4-days @ $1,200/day x 20% OH)	$ 5,760
Subtotal	**$ 45,160**

Task 2 – Drift Camera Survey

Mobilization/Demobilization of R/V GEOEXPLORER	$ 20,000
Charter of R/V GEOEXPLORE or GYRE – 10 days @ $20,000/day	$200,000
USBL Navigators (2) – 12 days @ $1,200/day x 2	$ 28,800
Drift Camera and Operator – 12 days @ $1,700/day	$ 20,400
Benthic Biologists (2) – 12 days $1,000/day x 2	$ 24,000
Subtotal	**$293,200**

Task 3 & 4 – Reporting

Dr. Harry Roberts (5-days @ $1,200/day x 20% OH)	$ 7,200
Dr. Chuck Fisher (4-days @ $1,200/day x 20% OH)	$ 5,760
Dr. Ian MacDonald (5-days @ $1,200/day x 20% OH)	$ 7,200
Dr. Gary Wolff (3-days @ $1,200/day x 20% OH)	$ 4,320
Subtotal	**$ 24,480**

TOTAL PROJECT BUDGET **$362,840**

The Parties acknowledge that this budget is an estimate, and that actual costs may prc higher. BP's commitment to fund the costs of this work includes any additional reaso within the scope of this work plan that may arise. The trustees will make a good faith notify BP in advance of any such increased costs.

References

Brooke S. and Schroeder W.W. 2007. State of deep coral ecosystems in the Gulf of Mexico region: Texas to the Florida Straits. In: Lumsden SE, Hourigan TF, Bruckner AW (eds.). The state of deep coral ecosystems of the United States. NOAA Tech Memo NOS-CRCP-3, Silver Spring, MD.

CSA International, Inc. 2007. Characterization of Northern Gulf of Mexico deepwater hard bottom communities with emphasis on *Lophelia* coral. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2007-044. 169 pp. + app. http://www.gomr.mms.gov/PI/PDFImages/ESPIS/4/4264.pdf

Fisher, C.R., Roberts, H.H., Cordes, E.E., Bernard, B., 2007. Cold seeps and associated communities of the Gulf of Mexico. *Oceanography* 20, 118-129.

Brooks, J.M., C. Fisher, H. Roberts, B. Bernard, I. McDonald, R. Carney, S. Joye, E. Cordes, G. Wolff, E. Goehring. 2008. Investigations of chemosynthetic communities on the lower continental slope of the Gulf of Mexico: Interim Report 1. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2008-009. 332 pp.

Attachments:

Attachment 1. DWH Fluorometry and submerged oil-oil modeling (ASA-DWHOS-model_deep-hard bottom-2010Se3.doc)
Attachment 2. Sites identified by the New Orleans Expert Meeting as potential hardground communities, and the priority sites to be surveyed by the drift camera survey.
Attachment 3. TDI Brooks Drift Camera Specifications
Attachment 4. R/V GeoExplorer Ship Specs; R/V Gyre Ship Specs
Attachment 5. TDI Brooks Safety Plan
Attachment 6. PI CVs_