Submerged Oil Characterization Across Multiple Habitats for Assessment of Persistent Exposures in Nearshore Sediments

Deepwater Horizon Oil Spill (DWHOS)

June 23, 2011

Prepared by
the Fish Technical Working Group of the
Mississippi Canyon 252 Trustees

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Attorney Work Product Privileged

Common Interest Privileged

Mississippi Canyon 252 Oil Spill

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

The trustees have developed a preliminary conceptual model of the Deepwater Horizon (DWH) release, potential pathways and routes of exposure, and potential receptors. This preliminary model has informed the trustees' decision to pursue the studies outlined in the work plan. By signing this work plan and agreeing to fund the work outlined, BP is not endorsing the model articulated in the work plan.

This plan will be implemented consistent with existing trustee regulations and policies. All applicable state and federal permits must be obtained prior to conducting work.

APPROVED:

NOAA Trustee Representative: _____ Date: 6/30/11

Louisiana Trustee Representative: FOR MICHAEL SUIDAY _____ Date: 7/13/11

BP Representative: _____ Date: 7/05/11

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Introduction

This **Submerged Oil Characterization Across Multiple Habitats for Assessment of Persistent Exposures in Nearshore Sediments** work plan (the "plan") has been developed as part of the ongoing Mississippi Canyon 252 (MC 252) Natural Resource Damage Assessment (NRDA) initiated by the federal and state natural resource trustees under the Oil Pollution Act of 1990. As part of the NRDA, Trustee agency representatives and experts have formed Technical Working Groups (TWGs) to develop and implement work plans to carry out both baseline (pre-injury) assessment and post- impact assessment of natural resources throughout the northern Gulf of Mexico. The Trustees are currently engaged in a cooperative effort with BP Exploration and Production Inc. (BP), whose representatives are also participating in the Nearshore Fish TWG.

The plan provides for data collection to document post-spill conditions consistent with the methodology and standard operating procedures (SOPs) described in this document. The data will provide information that can inform the trustees in future assessment procedures under the OPA regulations (15 C.F.R. Part 990).

Approach and Rationale

Nearshore shallow water and benthic habitats are known to be extremely valuable in terms of fisheries productivity, and characterizing the extent and nature of oil introduced into these habitats is an important step in determining potential injury resulting from the MC 252 oil spill. Work under this natural resource damage assessment plan will characterize potential exposures of shallow subtidal habitats comprising the nearshore benthic sediments to oil resulting from the MC 252 oil spill. Sampling under this work plan will follow statistical designs, but targeted assessments outside the scope of this work plan have been and may continue to be undertaken in sensitive habitats such as SAV beds or oyster reef. Such assessments have been undertaken by other technical work groups specifically organized to focus on these areas. Additional, targeted assessments of specific resources (such as sand borrow sources) or other areas of interest to the trustees may be undertaken by the Nearshore Fish TWG in a different work plan.

Within the scope of this work plan, sample collections may be made in areas where submerged oil is observed or is anticipated to be found based on visual observations of the adjacent shoreline. For the purposes of this plan, submerged oil is defined as oil or other contaminants associated with the MC 252 oil spill that currently may exist in shallow sub-tidal sediments. This sampling will provide an assessment of the presence or absence of MC 252 oil, and in areas where oiling is detected, sampling will characterize the magnitude and extent of oiling.

Reconnaissance work performed in 2010 under a separate natural resource damage assessment workplan (titled "Submerged Oil Reconnaissance Plan Deepwater Horizon Oil Spill" available at: http://restoration.doi.gov/deepwater_horizon/Deepwater_Horizon_workplans/12.2010_06_06_FISH_Signed_NearshoreFish_Ephemeral1.pdf) has documented visual observations of the presence of submerged oil in nearshore areas that were noted by Shoreline Clean-up and Assessment Technique (SCAT) observations to have been impacted by the MC 252 Oil Spill (from Louisiana to the Florida panhandle). This work plan will move from that reconnaissance effort to an intensive sampling design that will provide an understanding of the distribution, nature, and extent of submerged oil in the various habitats that comprise the nearshore geography potentially

affected by the spill. Sampling effort and techniques will be adjusted based on the habitat type being evaluated and on the results of laboratory analyses confirming the presence of detectable levels of MC 252-related oil or other MC 252-related contaminants.

During 2010 the trustees conducted sampling and made observations of oil in the nearshore using snares and various types of sorbent materials. In order to characterize benthic sediment contamination, this 2011 plan uses core sampling, rapid laboratory-based screening (e.g., gravimetric analysis of total extractable hydrocarbon and TPH screening) and forensic and quantitative analyses to document the potential presence of MC 252-related hydrocarbon and other MC 252-related contaminant concentrations in sediment.

The plan anticipates that subtidal habitats immediately adjacent to oiled shoreline have an increased likelihood of exposure to and accumulation of oil and other contaminants. Oil and other contaminants were transported to shorelines across the water's surface, and can accumulate either on shorelines or in nearshore sub-tidal sediments. These deposits can be moved by currents throughout these close nearshore areas. This is the same conceptual model for the movement of oil and other contaminants in the nearshore environment that is described in the "Assessment Plan for Marsh Edge and Sandy Shoreline", which is being concurrently developed and is expected to be concurrently implemented. Prior sampling efforts for submerged oil (including efforts undertaken by the NRDA trustees and those undertaken outside the NRDA process) have not comprehensively assessed the area immediately adjacent to shorelines due to logistical constraints. The present work plan will address this data gap. By relying on an adaptive sampling approach, the study design will allow investigators to identify areas where oil persists, while reducing unnecessary sampling. This effort will also provide data to support collection of biotic samples under the Assessment Plan for Marsh Edge and Sandy Shoreline

Sediment samples collected from pre-determined sampling locations will be subjected to semi-quantitative screening (dichloromethane extractable material with silica gel treatment [DEM-SGT] gravimetric or GC/FID TPH fingerprinting) and potential subsequent forensic and quantitative chemical analysis for documentation of the exposure of nearshore habitats to MC 252-related oil and other MC 252-related contaminants. This plan will employ an intensive sampling design that will delineate the distribution, nature, and extent of submerged oil in the various habitats that comprise the nearshore geography of LA, MS, AL, & FL known to have been exposed to MC 252-related oil. The plan will also sample at a number of stations believed to be unoiled by MC 252 as reference locations.

The study design, which provides for potential resampling over time in subsequent work plans, may allow for monitoring the rate of any disappearance over time (through burial, dispersal, and dissolution or weathering) of any detected submerged oil.

Objective:

To document and quantify MC 252-related hydrocarbon and other contaminant levels in benthic sediments of shallow subtidal nearshore environments known or suspected to have been impacted by the MC 252 oil spill.

Sampling Site Selection

Sediment chemistry sampling to be performed under this workplan will take place at the same sites selected for sampling under the concurrently developed "Assessment Plan for Marsh Edge and Sandy Shoreline" sampling plan (see Section IIIA of that plan).

As described in the "Assessment Plan for Marsh Edge and Sandy Shoreline", sites have been selected and separated into three strata using a combination of response and NRDA data describing shoreline oiling. These strata are: Heavy (H), Moderate/Light (ML), and no oil observed (N). Sampling for sediment chemistry to be performed under the present work plan will start with the heavily oiled sites. All heavily oiled sites in the initial site selection (both marsh edge and sandy shoreline) will be visited and sampled. In addition, for the marsh edge, all remaining sites will be sampled.; and for sandy shore, a number of moderate/light (ML) and no oil observed (N) sites will be included to obtain a broader geographical distribution of samples. When these samples have been screened by the laboratory, the Trustees, in consultation with BP, will review quantitative and qualitative screening data (DEM-SGT gravimetric or TPH fingerprint) and decide whether continued sampling at any remaining un-sampled moderate/light (ML) or no oil observed (N) sites is appropriate.

Protocol for Submerged Oil (Sediment) Sub-Sampling at a Site

Oil or other contaminants related to the MC 252 oil spill have been recorded as present on shorelines and may have entered and continue to re-enter nearshore, shallow water areas over a large geographic area and at highly variable concentrations. The patchiness of oil and other contaminant distribution resulting from the MC 252 oil spill and the temporal variability associated with oil and other contaminants present at any single location suggest that the best approach to sampling will consist of a large-scale sampling program with probabilistic selection of sites.

The trustees will develop additional targeted work plans or addenda to this work plan (including SOPs) to address areas of particular interest or concern. Such targeted sampling is outside the scope of this work plan, and the need for such work has been and may continue to be determined by requirements to characterize the extent of oiling affecting specific habitat types, areas where important resources exist (such as sand used for beach nourishment or barrier island stabilization), or areas where submerged oiling is known to have occurred or is anticipated based on reconnaissance work or other direct observations.

For the large-scale, probabilistic sampling effort encompassed in this work plan, collection of sediment samples for quantitative chemical analysis will be conducted at the same sampling site locations identified for sampling of biota described in the "Assessment Plan for Marsh Edge and Sandy Shoreline",. Sediment sampling will be preferentially done by coring, in accordance with methods developed by the Nearshore Fish TWG based on methods testing undertaken in the fall of 2010 (see Appendix A and SOPs below). Though the collection of core samples is preferred, field teams will also be equipped with grab samplers such as modified van Veen samplers or Ponar samplers, which may be utilized in the event that site conditions (sediment type, compaction, etc.) do not allow for the effective use of core tubes. As with coring, grab sampling will be done in accordance with methods developed by the Nearshore Fish TWG based on

methods testing undertaken in the fall of 2010 (see Appendix A and SOPs below). Sediment samples will be laboratory-screened with methods determined by the trustees in consultation with the RP, such as DEM-SGT gravimetric analysis or TPH fingerprinting analysis, prior to submitting cooperatively agreed upon samples for forensic source determination and for quantitative analysis. Quantitative analysis will be conducted according to the methods specified in the Analytical Chemistry Quality Assurance Plan (AQAP) developed by the Chemistry Technical Working Group.

Sampling stations will be defined based on site center points as described in the Marsh Edge and Sandy Shore plan. The intent of this workplan is to characterize sediment contamination in each of two sediment depth strata (0-2cm and 2-4 cm) in each of four zones offshore of the site center point. Each zone will be defined as a 200 m wide band of fixed distance from the mean low water line During each site visit one transect perpendicular to the shore will be established at 50 meters on each side of the site center point (defined as the site coordinates). The two replicate transects will be sampled in each zone.

One sediment core for chemical analysis, and a second core for grain size analysis will be collected at four randomly selected distances along each transect. The sampling zones are defined as follows:

Sample Zone A. Between 0 and 10 meters from shore,
Sample Zone B. Between 10 and 20 meters from shore,
Sample Zone C. Between 20 and 50 meters from shore, and
Sample Zone D. Between 50 and 500 meters from shore

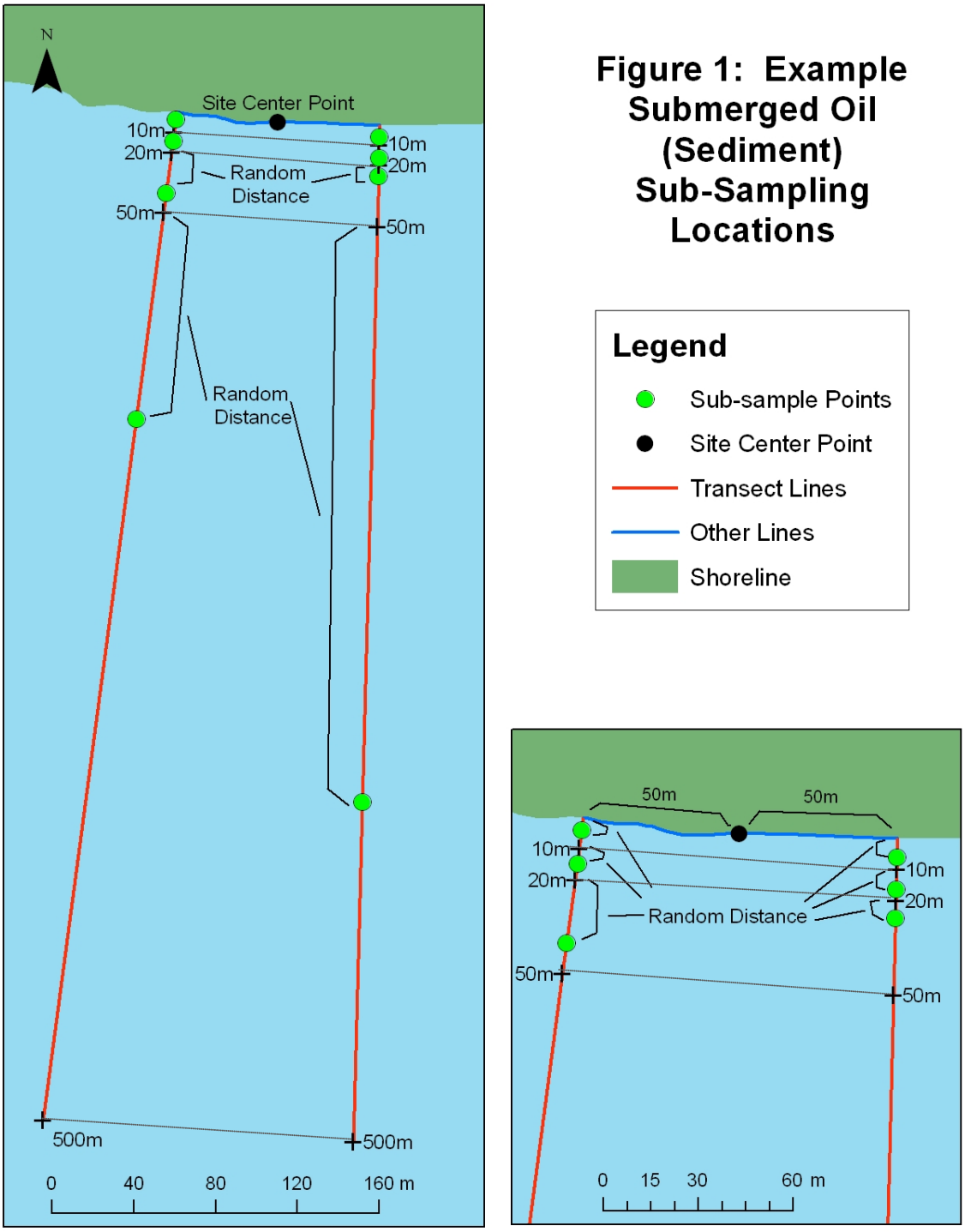


Figure 1. Example illustration for location of transects and randomly located sediment sampling points in each buffer zone.

Sample Collection

The present work plan focuses on sampling of nearshore sediments for analysis to determine potential exposures to MC 252-related oil and other MC 252-related contaminants. This sampling design anticipates up to thirty-two samples (16 for chemistry, 8 for grain size, and 8 for archive) being collected from up to two cores or dredges taken at each of the eight pre-planned points along perpendicular transects from the shoreline. The sample teams will collect sufficient sediment quantity for laboratory analysis from two vertical horizons at each pre-planned sampling point; 0 to 2 cm and 2 to 4 cm below sediment surface. These samples will be collected using push coring techniques with either 10 cm outer diameter (od) or 7.6 cm od core tubes. If site conditions (e.g., flowing sand, unconsolidated silts, dense sediment, or heavy surficial oiling) limit the efficacy of the coring tools and coring methods, stainless steel grab sampler units may be used to collect the shallow horizon samples (SOP Figure A). Deeper sections of cores will be archived.

Replicate Samples

Field duplicate samples will not be required for this program, because the statistical sampling design includes two replicate samples within each sampling zone allowing for a determination of the precision of sampling effort.

Archive Sample

The sample team will also reserve a portion of the chemistry core as an archive sample for future sediment chemistry analysis. The chemistry core will be collected with a 60cm long core tube which will be hand pushed as deep as feasible, and the top 4 cm of sediment will be removed to serve as the 0 to 2 cm sample and a 2 to 4 cm sample, as detailed in the SOP. The remaining sediments will serve as the archive sample, and will be photo-documented, labeled, frozen and archived at a mutually agreed upon location for future cooperatively agreed-upon analysis.

Samples of Opportunity

Field teams may also collect up to five additional cores in or near each sampling site. These samples of opportunity are intended to document unique conditions at a site that are apparent to field teams and are observed within or in transit to a sample site (such as an oil accumulation in a trough, dead vegetation, or an obvious flocculent layer) which would not otherwise be captured by the randomized sub-sample design. The sampling procedure will follow the protocols in this plan to the maximum extent practicable. The field notes will describe the rationale and, to the extent possible, photos will document the observations that suggested the need for the collection of the samples of opportunity.

Selection of Sandy Shoreline Sample Sites

No less than 100 discreet sandy shoreline (beach) sites will be sampled. All heavily oiled shoreline sites will be sampled. For other oiling categories, when more than 10 sites are available, at least 10 sites will be sampled from each of the three oiling categories in each of

three different hydrologic regimes, as shown in Table A, below. These hydrologic regimes comprise the Mississippi River delta, shallow-sloped sandy shorelines (essentially all those west of the Chandeleur Islands), and steep-sloped sandy shorelines (from the Chandeleur Islands east). The trustees, in consultation with BP, will determine whether the proposed sampling is warranted at the remaining 80 un-sampled sandy shoreline sites based on screening results from the initial 100 sampled sandy shoreline sites.

Table A: Minimum number of sandy shoreline sites to be sampled from each oiling category and hydrologic regime prior to adaptive site elimination

	MS Delta	Steep Slope	Shallow Slope	Total
Heavy	4*	30*	26*	60
Medium/Light	2*	10	10	22
No Observed Oil	2*	10	6*	18
Total	8	50	42	**100**

* - reflects the total number of stations available within the habitat/oiling category

Sample Analysis

The laboratory will analyze the sediment samples for SHC/TPH, PAHs, biomarkers, sediment grain size, total organic carbon (TOC) in accordance with the DWH Chemistry AQAP. The samples will be initially screened for petroleum hydrocarbons using DEM-SGT gravimetric or TPH fingerprint screening method based on the need to rapidly evaluate the degree of oiling after the collection of samples from the heavily oiled areas.

Adaptive Sampling

Site locations will be selected once at the beginning of the study, in tandem with the "Assessment Plan for Marsh Edge and Sandy Shorelines" plan, and sampled in the summer (beginning in June 2011). If chemical analysis shows samples to contain MC 252-related oil or other MC 252-related contaminants, the trustees may develop a separate work plan or an addendum to this work plan to undertake subsequent follow-up sampling at the same sites.

The adaptive sampling plan and tiered analytical procedures are key elements of this work plan. Within specific geographical sub-regions in the study area (e.g. Pensacola Bay, Mobile Bay, eastern Mississippi Sound, Barataria Bay, etc.), areas where heavy shoreline oiling was observed may be visited first. As preliminary information on potential sediment contamination becomes available (e.g., TPH analysis or DEM-SGT gravimetric analysis for total extractable hydrocarbons), decisions to stop sampling additional sites within sub-regions may be made by the trustees in consultation with BP. For example, if the majority of the heavily oiled shoreline sites show no evidence of oiling in nearshore sediment samples, sampling of nearshore sediment from sites with moderate or no observed oiling could be suspended. Similarly, if the DEM-SGT gravimetric or TPH screening indicate elevated oil concentrations, then the samples will be analyzed for PAHs, biomarkers, and related methods (see below – SOP for sediment contaminant sampling) .

Preliminary Evaluation of Sampling Protocols

Field trials have helped efficiently implement past sampling programs (Appendix A). Accordingly, senior members of the submerged oil sampling team evaluated the sampling design and collection protocols described in this work plan during a field trial conducted during early May 2011. This preliminary evaluation focused on the efficacy of using cores of different diameters and lengths in different sediment types (high organic sediments, areas with high sediment deposition rates, and hard sands). The findings of the evaluation have been utilized to determine the most effective configuration of sampling equipment for the wide range of sediment types encountered in the Gulf study area. The findings have helped identify procedural changes that will improve other practical aspects of the sample collection effort (site sequencing, adjusting to tidal conditions, appropriate vessels for site access and stable work platforms).

Classroom and Field Training

A classroom and field training event has been conducted prior to field mobilization for this workplan. Attendees at the training event included members of the field sampling teams including state and federal trustee representatives and RP representatives. The training covered the following minimum topics: goals of the work plan; sample location criteria; utilization and documentation of field instruments such as a water quality multi-meter and a hand held GPS unit; photo-documentation techniques; data documentation requirements; sampling handling and preservation techniques and health and safety requirements for field activities. The attendee list and training agenda have been documented and maintained, and the training was video recorded for use by additional field team members who may join the effort later.

Scheduling Field Efforts

A good faith effort will be made to conduct all study elements that fall within the BP safety policy with cooperative, integrated teams of observers and field technicians. Where study elements fall outside of BP safety policy, teams will be integrated to the extent possible. A weekly schedule describing the number of teams and their general area of operation will be prepared by the Trustee's project coordinator and provided to BP or its designated contractor, and for sampling within Louisiana, to a Louisiana representative, two weeks in advance. The Louisiana representative and BP or its designated representative will provide the Trustee's project coordinator and other responsible Trustee agencies a list of the field efforts in which it will participate at least 10 days prior to the beginning of the designated week. If these agreed-upon notification and communication procedures are followed, yet circumstances prevent Louisiana or BP or its designated representative from participating in a field effort, the field effort may be carried out without Louisiana or BP or its designated representative's participation.

Data Handling and Sharing

MC 252 NRDA chain-of-custody procedures will be observed at all times for all NRDA samples. All samples will be transferred with appropriate chain-of-custody forms.

All field and laboratory data will be collected, managed and stored in accordance with US EPA Good Laboratory Practice regulations (GLPs) to the extent practicable. In accordance with GLPs, all field and laboratory work, and the calibration and use of field and laboratory equipment (e.g. scales, hand held GPS devices, etc.) shall be conducted using written Standard Operating Procedures (SOPs). The appropriate training on particular equipment or in the conduct of specific field studies for all personnel involved with the project shall be documented, and those records kept on file by the implementing entity for the duration of this project. All data (including electronically archived data), and original data sheets or electronic files, must be promptly transferred to USFWS, with copies to BP or their representative, and the Louisiana Oil Spill Coordinator's Office (LOSCO). All samples will be sent to NRDA approved laboratories.

Each laboratory shall simultaneously deliver raw data, including all necessary metadata, generated as part of this work plan as a Laboratory Analytical Data Package (LADP) to the trustee Data Management Team (DMT), the Louisiana Oil Spill Coordinator's Office (LOSCO) on behalf of the State of Louisiana, and to BP (or Cardno ENTRIX on behalf of BP). The electronic data deliverable (EDD) spreadsheet with pre-validated analytical results, which is a component of the complete LADP, 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 BP (or Cardno ENTRIX on behalf of BP). Thereafter, the DMT will validate and perform quality assurance/quality control (QA/QC) procedures on the LADP consistent with the authorized Analytical Quality Assurance Plan, after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or Cardno ENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the Analytical Quality Assurance Plan and the issue and results shall be distributed to all parties. 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. In order to ensure reliability of the consensus data and full review by the parties, no party shall publish consensus data until 7 days after such data have been made available to the parties. Also, the LADP shall not be released by the DMT, LOSCO, BP or Cardno ENTRIX prior to validation/QA/QC absent a showing of critical operational need. Should any party show a critical operational need for 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 to BP (or Cardno ENTRIX on behalf of BP). All samples will be sent to labs agreed upon by the trustees and BP.

Observations

Information to be noted and recorded on field data sheets developed specifically for this work plan (see Appendix A), for each sub-sample location, will include at a minimum:

- Time, Date and Name/Affiliation of each observer
- Weather and Sea Conditions, Tidal stage
- Visual observations of PRESENCE or ABSENCE of oil, and a characterization of any oil observed
- Rationale and photos for Samples of Opportunity
- Equipment type and size (e.g. corer diameter, Van Veen or ponar dredge)
- Description of any photos taken.
- GPS waypoints (latitude, longitude) of core sample locations
- Water depth at the time of sampling
- Any other relevant information, particularly in reference to SOPs for specific habitat types

Field data transfer

Prior to concluding each field day, integrated teams will share (1) all data sheets and field logs (2) all official photographs, and (3) the official GPS track log using methods developed under NRDA data management. Louisiana representatives will be invited to participate in any field work conducted within that state.

In the event that the data is collected without a BP representative or the Louisiana representative present, those data (data sheets, track logs, photos, any and all data collected as part of the field effort) will be e-mailed to a designated BP representative, or Louisiana representative as needed, within 3 days of its being collected. In the event that transfer of such data is delayed due to equipment malfunction or other reasons, it will be emailed to the missing representative(s) as soon as practicable.

After completing all field sampling activities for a given day, the field team must take the collected samples, datasheets and electronic information (including photographs and GPS track log) to an appropriate sample processing center.

At this center, the following activities will take place:

- Samples must be appropriately packaged and prepared for shipment to the receiving laboratory(ies).
- Chain-of-custody forms must be completed.
- All data from all field forms should be entered into the appropriate Excel file format (Forms or Flat version) either by the field sampler or a data management team member. Once the file is completed, it should be submitted to the data management team for incorporation into the database.
- All photographs must be archived, in accordance with the instructions in the NOAA Field Photography Guidance (NRDA_Field_Photographpy_Guidance.doc, available on the case NOAANRDA.org site).
- Synchronize the photos with the GPS track in accordance with the instructions in the NOAA ARD-FAST Using GPS-Photo Link instructions (GPSPhotoLink.doc, available on the case NOAANRDA.org site).
- Import the photos into the ORR PhotoLogger database. (This will allow the photos to be uploaded to ERMA.) See the document NOAA PhotoLogger for more information.
- All field **data** sheets will be scanned and originals stored in a secure location.

Durable Equipment

All durable equipment (such as YSI multi probes, cameras, GPS, etc.) purchased by BP for this study will be returned to BP or their designated representatives at the conclusion of their use for this study, unless otherwise agreed.

Health & Safety

Field teams will comply with existing training and safety protocols as applicable to operations. Prior to commencement of field activities, BP and the Trustees will agree upon a person or persons to whom study participants may report any safety concerns. Such person(s) will take action to address and resolve reported concerns.

- The team leader and field crew parties should have completed all applicable health and safety training as directed by NOAA or state agency oil spill policy.
- All field team members must complete the NOAA safety training and documentation requirements as set forth in "Safety Requirements for All Personnel Working on NOAA-led NRDA teams for MS Canyon 252 Incident" (NOAA Safety Documentation Requirements.doc).
- All field team members should read all of the documents in the Safety directory on the case's NOAANRDA.org site. Exception: if field activities do not include use of or helicopter, then familiarity with the safety documents for these vehicles is not required.

- Each field team must submit a plan, not later than the night prior to going into the field. This plan must specify:
    - The team leader;
    - Names of all team members;
    - The sampling location(s)-- please use the NOAA NRDA grid coordinates;
    - What kind of sampling they are doing;
    - Expected arrival time at sampling area (daily);
    - Expected departure from sampling area (daily);
    - Team deployment date;
    - Team return date.

  This information may be reported in one of two ways:
  1. Fill out the Excel spreadsheet "Team Member Information Form – Excel.xls" and send it to [redacted] Please use one tab for each team.
  2. If you cannot submit this spreadsheet electronically, you can call in and report the information using this number: [redacted]

- Field teams must adhere to all procedures set forth in the MC 252 Site Safety Plan ("NRDA MC 252 Site Safety Plan_5.13.10.pdf").

- Any field team member operating an all-terrain vehicle (ATV) for land-based site access will be required to complete a 4-hour ATV driver safety course.

- Any encounters with protected species are to be reported to the appropriate authorities. Field crews are also to follow any guidance or BMPs provided by federal, state, or tribal historic preservation officers to avoid potential impacts to protected species or to historic or cultural resources. Any affected historic or cultural resources are to be reported to the appropriate authorities as described in such guidance or BMPs.

Vessel requirements

Agency-owned and operated vessels, vessels chartered by Trustee agencies or their representatives, or vessels provided through BP's transitional support vessel (TSV) program or chartered directly by BP or its representatives, will be utilized for field work associated with this plan. The vessels will be outfitted with the necessary equipment for deploying core sampling equipment. Vessels will be selected on a case-by-case basis considering site access logistical requirements.

Adaptive Management of Field Efforts

BP's continued participation in, and funding of this cooperative Plan is contingent upon the results of adaptive management meetings which will occur as necessary based on field reports and/or preliminary results. During these meetings adherence to SOPs will be reviewed and discussed.

Estimated Costs

Supplies

- (20) boxes Nitrile gloves, Tyvek coveralls & booties, safety glasses
- 8 Piston Corers and 8 hand-driven push corers
- 10 cm and 7.6 cm polyplastic core tubes
- 8 YSI multi-probes
- Sampling equipment decontamination supplies – lab grade detergent, scrub brushes, buckets
- Personnel and vessel decontamination supplies (detergent, garbage bags, pressure washer, wash water collection containers)
- Lodging, food/water for remote deployment of personnel
- 8 sets of field gear (GPS, camera, radio, satellite tracker, batteries)
- Sample collection jars
- Observation data recording/sample labeling supplies
- 2 enclosed rental trailers and two rental trucks for storing and hauling gear

Personnel

- 369 sample sites / 1.5 sites sampled per team per day / 8 teams working simultaneously = 30.75 days of field effort (369 sample sites is maximum; reduction may occur based on adaptive sampling plan)
- (24) trained personnel (two federal trustee representatives & one state trustee representative per field team X 8 teams) for water & sediment chemistry sampling
- (30.75) 10 hr days for sampling per boat X 8 teams X 2 boats/team (1 work boat & 1 safety boat) = 492 boat days
- 24 personnel * 30.75 days/person = 738 personnel days

Costs are estimated for the anticipated sampling effort associated with this work plan.

Category	Unit Cost	Units		Total Cost
		Type	Number	
Vessel costs – Chemistry sampling	$1,500	Days	492	$738,000
Safety supplies, sample containers, core tubes, consumable materials				$160,000
Core & grab sampling capital equipment and materials				$95,000
Personnel for Analytical Chemistry Sample Collection	$800	Days	738	$590,400
Estimated Total				**$1,583,400**

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

SOPs

All materials associated with the collection or analysis of samples under these protocols or pursuant to any approved work plan, except those consumed as a consequence of the applicable sampling or analytical process, must be retained unless and until approval is given for their disposal in accordance with the retention requirements set forth in paragraph 14 of Pretrial Order # 1 (issued August 10, 2010) and any other applicable Court Orders governing tangible items that are or may be issued in MDL No. 2179 IN RE: Oil Spill by the Oil Rig "DEEPWATER HORIZON" (E.D. LA 2010). Such approval to dispose must be given in writing and by a person authorized to direct such action on behalf of the state or federal agency whose employees or contractors are in possession or control of such materials.

SOP-Sediment contaminant sampling (modified from Oyster TWG SOPs)

1. Sample Volume by Analytical Method

The following table defines the proposed sediment sample analysis, laboratory methodology, minimum sample volumes and sample preservation for each sample location. Due to differing storage temperature requirements, the grain size sample may not be substituted for the chemistry sample.

Table B
Sediment Sample Analysis and Sample Summary

Test	Reference Method	Sample Size (g wet)		Collected (mL)	Sample Storage
		Min	Ideal		
Grain Size	ASTM 422-63	50	100	100	Ambient
TPH/THC	EPA 8015	50	75	100	Frozen
DEM-SGT	NF 01-011				
PAH	EPA 8270				
Biomarkers	EPA 8270				
TOC	EPA 9060	0.5	2		
Total		100.5	177	200	

2. Sample Horizons

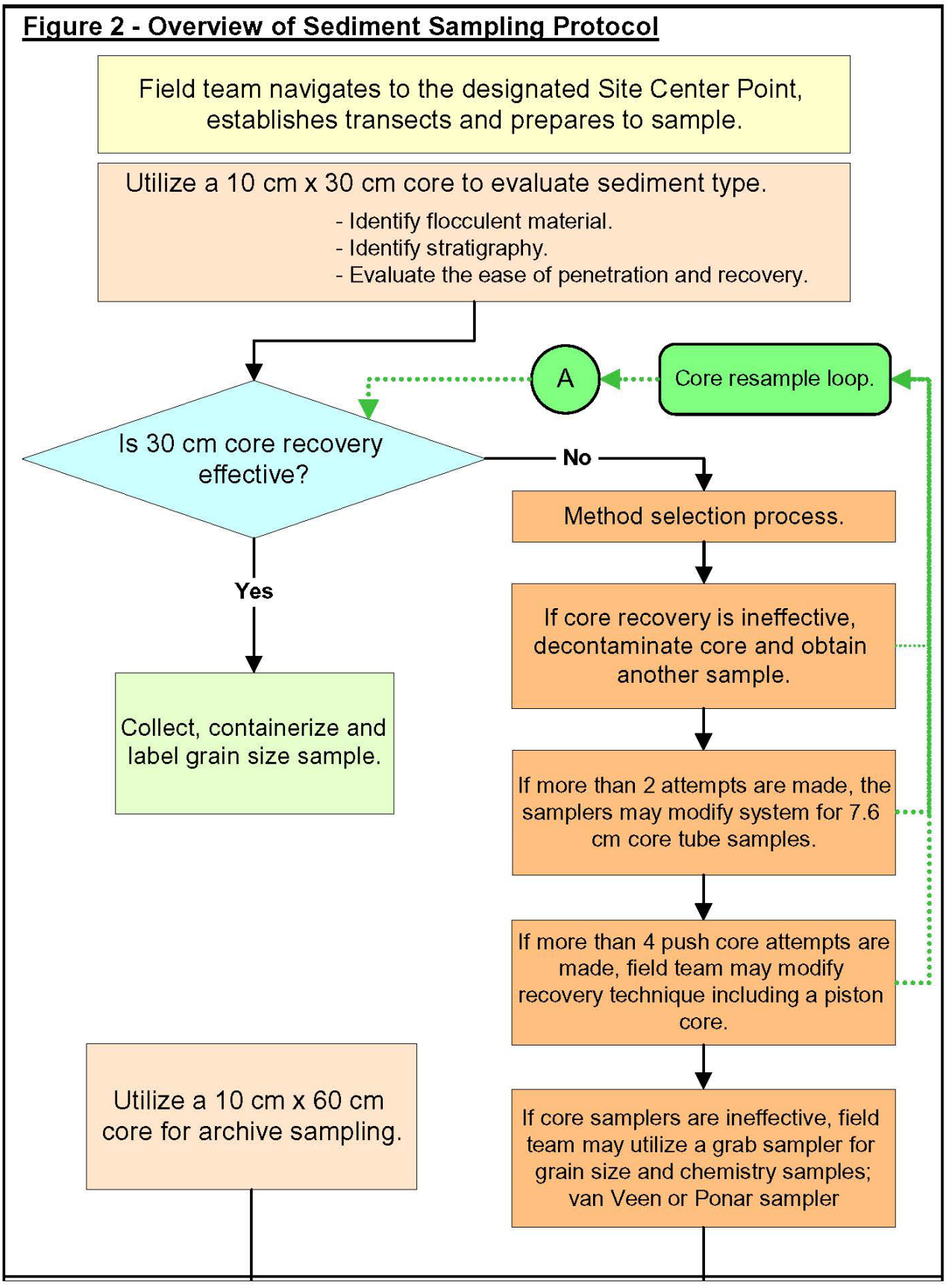
(a) Surface sediment samples will be obtained from the 0 to 2 cm horizon. The surface sediment shall include and target the flocculent material residing at the sediment water interface at each predetermined sample locations. An additional sample will be taken from the 2 to 4 cm layer, and may be analyzed or archived for potential future analysis as determined for each particular sub-sampling location.

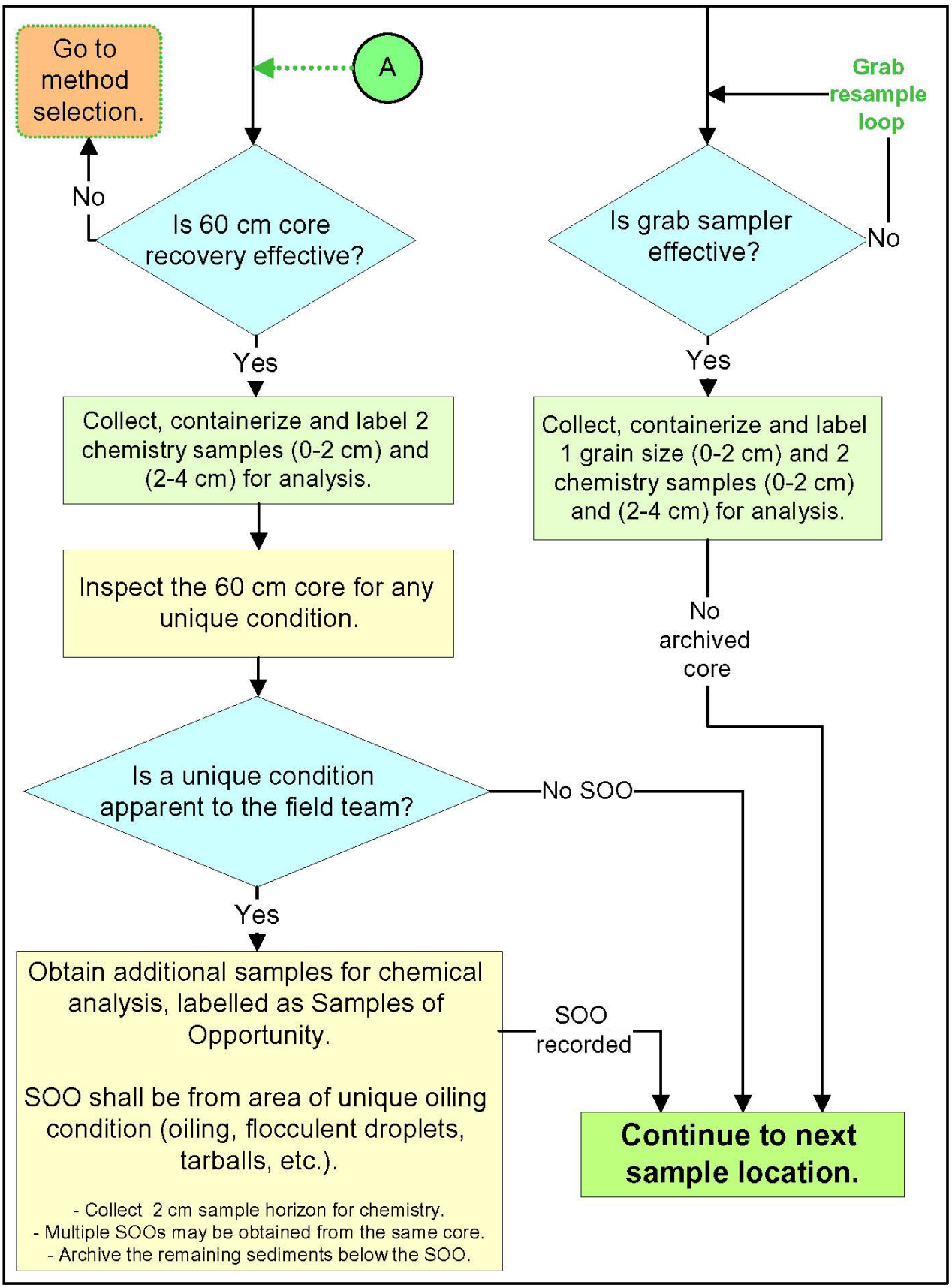
(b) Additional sediment samples may be taken from deeper strata within the same core tube, below the surface sediments. The sample collection team will inspect deeper strata in the core for variations in color, texture, density, water content and other differentiating characteristics when selecting the sample zone. Samples from deeper strata will be collected in a manner and location identical to the surface samples, however these samples will remain in storage for potential future analysis. Deeper strata sample volumes, glassware and preservation methods will be identical to the surface sediment samples.

(c) From a second core, taken as near as practical to the original chemistry core, a grain size sample will be collected from the top 0 to 2 cm of retrieved sediment. The grain size sample should appear similar in composition to the chemistry sample such that it may be assumed to be representative of the original sample; compositing of the two samples will not be required.

(d) The sediment sampling team shall be prepared to obtain additional "samples of opportunity" from any distinct horizon within a sample or from spatially extralimital locations presenting unique oiling conditions (See Samples of Opportunity from Figure 2, below). Examples of a unique horizon could include a distinct oil layer atop the surface sediments or an oiled horizon below the 2 cm layer. An extralimital sample location might be selected based on observations along or near the transect of areas where oil has collected in a trough or depression. The sampling team shall photograph and document the conditions that characterize the horizon or location as unique, such as sheening, oil globules, tarballs, odors, variegated chemical discolorations or other conditions. Samples of opportunity shall follow normal chain-of-custody procedures including a notation and photos of the unique nature of the sample within the sample collection data forms and field books.

Figure 2 - Overview of Sediment Sampling Protocol




Go to method selection.
A
Grab resample loop
No
Is 60 cm core recovery effective?
Is grab sampler effective?
No
Yes
Yes
Collect, containerize and label 2 chemistry samples (0-2 cm) and (2-4 cm) for analysis.
Collect, containerize and label 1 grain size (0-2 cm) and 2 chemistry samples (0-2 cm) and (2-4 cm) for analysis.
Inspect the 60 cm core for any unique condition.
No archived core
Is a unique condition apparent to the field team?
No SOO
Yes
Obtain additional samples for chemical analysis, labelled as Samples of Opportunity.
SOO shall be from area of unique oiling condition (oiling, flocculent droplets, tarballs, etc.).
- Collect 2 cm sample horizon for chemistry.
- Multiple SOOs may be obtained from the same core.
- Archive the remaining sediments below the SOO.
SOO recorded
Continue to next sample location.

3. Collection methodology

(a) Sediment sampling will be conducted with a minimum of 10 cm of standing water and flocculent material above the sediment-water interface

(b) The sediment sampling team shall be equipped with direct push core samplers, piston corers, and grab samplers including a modified van Veen grab sampler and a Ponar grab sampler. These devices have been shown during preliminary evaluation of sampling methods to produce samples of equivalent quality although the volume of sample captured in each attempt will vary (Table B). The sampling team will evaluate the site conditions, with a preference to obtain direct push core samples (see Preliminary Site Assessment from Figure 2, above). If the field team determines the sediment textural characteristics and sediment friction require a driven piston core, the field team may select to use piston coring techniques. If the field team determines that the sediments consist of flowable sand or unconsolidated sands and silts that run out of the core barrel in four consecutive attempts, then the field team may elect to use a more narrow core barrel (7.6 cm od) or a grab sampler such as the modified van Veen sampler or Ponar sampler. If heavily oiled sediments in the 0-2 cm depth interval streak down the inside of the core barrel, then the collection of the 2-4 cm sample should avoid including sediments that touch the inner wall of the core liner.

Table C.
Sampling Device Specifications.

Description	Dimensions (cm)	Surface Area (cm^2)	Maximum 2cm Thick Sediment Volume (cm^3=mL)	Estimated Loss During Handling	Estimated Sediment Volume Per Attempt (mL)	Replicates for 200 mL Target Volume
Push Core (4")	10od (9.5id)	70.8	142	10%	128	2
Push Core (3")	7.6od (7.3id)	41.8	84	10%	75	3
Van Veen	15.2X15.2X15.2	231	462	10%	416	1
Petite Ponar	15.2X15.2X15.2	231	462	10%	416	1

The field teams will document the most appropriate sampling method at each sediment sample location based on sediment type, compaction, etc. The sampling team will attempt to obtain minimally disturbed samples from over the side of the vessel. If the depth, sediment density, or other physical conditions preclude the potential to sample from the vessel, samplers may exit the vessel and proceed on foot to the sampling location, taking care not to disturb the area from which a sample will be taken.

For most substrate types, the push core will be the preferred sampler. However, it may be necessary to use a grab sampler such as the van Veen grab sampler or Ponar sampler when the push core cannot produce an acceptable sample. The grab samplers are "clam-shell" devices with opposing lever arms that close after the device contacts the sediment surface and the operator lifts the lever arms towards the boat. For hand deployment, a small van Veen grab is preferred, approximately 8" x 6" x 6" (20.3 cm x 15.2 cm x 15.2 cm). It is important to note the sampler dimensions to appropriately determine the area sampled. A grab that is 8" X 6" will sample an area of 308 cm^2. One grab should produce an adequate quantity of sample for

laboratory testing. However, the van Veen and Ponar samplers will not be able to collect an archive sample deeper than approximately 15 cm.

(c) An acceptable sediment sample consists of at least 5 cm (>2") with an intact surface layer. Acceptable samples will have a minimum of 2 cm of water overlying the sediment sample, and the sample shall not contact the core head or the piston core. If the sediment contacts the core head or the piston core the sample shall be disposed, the sampler cleaned and another sample will be obtained.

(d) A pre-cleaned clear core tube should be utilized for sampling. The size of the core tube and the material of core tube construction may vary, however a minimum size shall be 7.6 cm o.d. with a preferred core tube of 10 cm o.d. and length of 60 cm. Field testing has indicated the volume of recoverable sediments is variable based on sediment textural characteristics, sediment compaction, sea surface conditions and many other factors. The field teams will strive to recover a 45 cm sediment core at each sample location, or the maximum length practical.

(e) Where hand-driven cores are selected, members of the field sample team must be cautious to minimize disturbance of the overlying water and shall not sample within the immediate vicinity of any footprints or walking area. Each hand driven core tube shall have a top cap with a small hole placed in it or a check valve system to allow air to escape while pushing the core and to minimize the potential for falling materials to enter the tube. Each core tube shall be pushed to the desired sample depth by hand.

When removing hand-driven cores, the field team may hand excavate around the sides of the core tubes to loosen the tubes while minimizing internal disturbance of the tubes. Wearing nitrile or other non-contaminating gloves, the top of the core tube will be capped by slowly placing the cap onto the top of each tube. Once the top cap is in place, the collector will insert a hand into the sediment under the core tube to hold sediments in the core tube during removal from the sediment. Using both hands, the core will be carefully removed from the bottom, taking care not to allow movement of the sediment in the core. Once the core is extracted from the bottom, a cap is placed over the bottom the core. The collector returns the core to the surface where the core will be processed. The core must be kept in the vertical position at all times.

If a driven piston core is used, the field team shall take caution when removing the core from the sediments. The core shall be pulled vertically from the sediment with a steady vertical force. The core heads and push rods shall not be hammered or driven via impact when removing. All actions shall be taken to minimize surface disturbance of the sediments and flocculent material.

(f) An acceptable sediment sample will have overlying water above the sediment sample zone. If the overlying water drains out of the sampler, the water should remain clear and should not significantly erode channels in the recovered sediment. A flocculent layer should appear on the surface when one is known to exist. A sediment sample shall be considered unacceptable if the standing water or sediment surface exhibit obvious features of mixing (e.g., no difference between the surface and subsurface when differences were known to exist). On retrieval of all samples, inspect the sample to make sure that it meets the following criteria:

(1) the sampler is not overfilled;
(2) the sediment surface is not pressed against the sampler top - overlying water is present, indicating minimal leakage and subsequent loss of the flocculent layer;
(3) sediment surface is undisturbed, indicating lack of channeling or sample washout; and
(4) the desired penetration depth is achieved (e.g., 6-8 cm for a 0 to 2 cm and 2 to 4 cm sample set).

(g) The overlying water in the sampler will be siphoned or drained until the sediment is exposed, paying special attention to retain the surface floc. The samples may require time to allow the floc material to settle before dewatering.

(h) Wearing nitrile or other non-contaminating gloves and using any appropriate clean scoop, meticulously collect just the top layer (2 cm), avoiding sediments in contact with the sides or top (see Sample Collection from Figure 2, above). To avoid cross-contamination, a clean scoop will be used for each sample.

(i) Onboard a sampling vessel, collectors will be aware of contamination sources (exhaust fumes, engine cooling systems, oily surfaces), working up-wind of any exhausts, and segregating dirty/clean areas. Lay out clean substrates to work on and replace frequently. If possible, try to sample least-oiled areas first, then the most contaminated areas, however, evaluation of dirty/clean zones may be very difficult prior to sample collection.

(j) Following sampling and isolation of the sediments in the 0 to 2 cm surface and flocculent zone and the 2 to 4 cm zone immediately below the 2 cm surface layer, the remaining sediment core shall be secured, capped and maintained in core tubes during transit to the lab for archiving and potential future laboratory analysis. In addition to top and bottom plastic caps, a pre-cleaned plastic plug shall be placed within each core tube to maintain the vertical integrity of the archived core. A PVC or similar plastic support sleeve shall be field cut to support the head space between the top cap and the sediment interface plug. The field team will use pre-cleaned plastic tubes in order to minimize cross contamination. The field team will remove all of the sediment in each depth interval before collecting the next deeper sampling interval and before capping the sample for archive.

(k) The sample container lids should be labeled immediately during sample collection with the sample location, date and time. An identical record should appear in the field log with any additional information that is required under the QAPP. The samples will be transferred with a complete chain of custody to the sample intake team as soon as possible. Field documentation shall include the quantity and size of the sample containers for each sample location.

(l) All sediment samples will be immediately placed in a cooler and held on ice. Samples shall be shipped or delivered to an interim Sample Intake Center within 48 hours where they may be temporarily stored for up to four days. During this time the samples will be readied for shipment; i.e., hydrocarbon samples are to be frozen, grain size samples will remain refrigerated at 4^{o}C. All samples will then be shipped to a mutually agreed upon laboratory for analysis or archive.

4. Quality Assurance and Quality Control.

(a) The field sampling staff shall read this SOP and be shown how to properly operate all field sampling equipment by an experienced staff member before performing these tasks without supervision. This training will include specific guidelines for how to accurately, precisely, and safely load and trigger each of the grab samplers. Similarly, the training will include the methods to handle the core liners, secure the liners to each of the sampler drive heads, methods to load and handle the piston equipment and all appurtenant tools and materials. Additional field training shall includes decontamination procedures and field documentation.

(b) Whenever possible, the field team should use disposable sampling equipment (e.g. polycarbonate core liners, polybutyrate core liners and gloves) during the collection of each sample. Equipment or rinseate blanks will not be required when using disposable samplers.

(c) Field duplicate samples will not be required for this program, because the statistical sampling design includes replicate samples within each sampling zone allowing for a determination of the precision of sampling effort.

(d) Field sampling equipment coming into contact with environmental samples will be kept as clean as possible to minimize the risk of cross-contamination that could jeopardize data integrity and lead to erroneous scientific conclusions. The sediment sample team shall decontaminate all sampling equipment upon arrival at each sample location.

Field decontamination shall consist of a clean water detergent wash (using Alconox and scrubbing), followed by a thorough rinsing with deionized water, and finally a thorough background water rinse. Decontamination washing shall be conducted with dedicated clean decontamination brushes, decontamination vessels such as covered wash buckets and deionized reference water.

Critical parts that come into direct contact with the sample (e.g., core tubes) will be pre-cleaned using the above procedure. Decontamination of all equipment that contacts sediments will be conducted between individual sample cores or individual sample grabs (e.g. between 1st core sample and 2nd core sample at each location). Decontamination shall include washing as specified above to remove all adhered sediments from the coring device and rinsing to assure all equipment surfaces that contact the sample are visibly clean. Additional decontamination washing shall be conducted at any time oil is indicated within a specific sample, such as observation of a sheen, a tarball, hydrocarbon odors, etc. Under no circumstances will sampling occur through a surface oil slick or sheen. If a surface slick or sheen is present at a station, measures will be taken to avoid deploying any sampling equipment in its path (e.g., relocating the vessel until the slick or sheen has cleared).

Other delicate instruments and probes (such as the YSI multi-meter probes) should be cleaned in a manner appropriate for that equipment and that follows manufacturers' instructions.

Sampling utensils that come into direct contact with the sample should be made of non-contaminating materials (e.g., polycarbonate plastic) and should be thoroughly cleaned between

sampling events (e.g., Alconox scrub followed by DI water and ambient water rinses as described above) or replaced with new pre-cleaned disposable ones. Similarly, sample containers should be cleaned (or purchased as certified pre-clean) before coming into contact with the sample and made of non-contaminating materials appropriate for the type of analysis (e.g., glass jars with Teflon lids). Once cleaned, utensils and other sampling devices should be covered in aluminum foil (shiny side out), or protected by other acceptable means, to prevent contamination between uses.

Any necessary decontamination of the vessel or its components (e.g., anchor, lines) will follow protocols of the vessel owner/operator as well as the spirit of the guidelines given in the NOAA/OMAO (2010) manual for operations near the oil spill.

Procedures to protect personal safety during decontamination operations will follow the guidelines provided in the NOAA Deepwater Horizon NRDA Field Safety Plan, version 1/28/2011 (NOAA 2011).

Field personnel will be responsible for documenting all decontamination activities occurring in the field. Data will be recorded in a field logbook and will include at a minimum the responsible person's name, date and time of activity, description of items decontaminated and the procedure used.

(e) Contaminant-free, nitrile sampling gloves shall be worn at all times whenever handling sediments, sediment sampling equipment, sediment sample containers, decontamination equipment or fluids. The field team shall replace gloves between each sample location and between each major sample task, such as transition from decontamination processes to sediment sampling. The field team shall be trained and knowledgeable regarding potential sources of cross contamination and sample management procedures.

5. Preservation/Holding Times

All sediment samples will be immediately placed in a cooler and held at 4°C. Freeze samples for chemical analysis by the end of each day. Grain size samples should be refrigerated (and not frozen). Samples should be shipped or delivered to a Sample Intake Center within 2 days.

Please see the Analytical Quality Assurance Plan for the MS Canyon 252 (Deepwater Horizon) Natural Resource Damage Assessment (AQAP) for further details on storage and holding times.

6. Labeling, Documentation, and Other Considerations.

(a) On the NOAANRDA.org site, the NRDA Field Sampling Checklist generically summarizes pre- and post field sampling tasks.

(b) Prepare sample labels as presented in NRDA Data Management Protocol for Field Sampling. If using jars, the sample number will be recorded on both the label and lid. IDs on sample labels

must be complete and identical to IDs on the chain of custody. Jar labels will receive a protective layer of clear tape wrapped around the entire circumference of the container to secure the label and protect the writing. For grain size samples plastic sample bags may be used. A sturdy paper label in indelible ink will be placed into the bag and information will be repeated on a label on the outside.

(c) See the event-specific protocol documents for shipping to designated labs (NRDA Sample Shipping Instructions) and for chain of custody and sampling documentation instructions (NRDA Data Management Protocol for Field Sampling). When and where possible, the Sample Intake Centers should be used to ensure compliance and sample integrity. Sediment sampling log sheets typically record sample number; date/time, location, GPS coordinates, water depth and penetration depth. They may also include surface sediment characteristics: texture, color, biota, debris, sheens, odor, etc.

(d) Documentation is critical; all field notebooks should be dated, signed, and preserved. If crossing out or correcting any entries, dates and initials will be indicated when making the changes. Original records will be gathered and archived.

(e) Record the presence of oil, weather conditions, etc., will be recorded in field notes along with GPS coordinates for each sample.

(f) Relevant photographs of the sampling locations and sample collection itself should be taken if possible. Each photograph or series should be able to be later associated with the corresponding sampling location GPS (see NRDA Field Photography Guidance). Do not delete, open or alter any photos.

7. Overview of Lab Analytical Methods

The collected sediment samples should be analyzed in accordance with the MC 252 Chemistry AQAP. Specific suites of analytes to be measured include:

- Gravimetric analysis with silica gel treatment (see NF 01-011; total oil & grease) for semi-quantitative determination of total extractable hydrocarbons may be conducted. These results may be used for screening the potential absence or trace presence of hydrocarbons (that might include MC 252 oil), and thus, obviate the need for further analyses.

- Saturated hydrocarbons (SHC or AHC) - see full list in Table 1.1b of the AQAP, which also specifies the target method detection limits. These compounds comprise a major component of crude oils. In fresh oil, they serve as another line of source confirmation. But being straight chain molecules, they are also a preferred carbon source for oil degrading microbes. As such, they tend to disappear faster than PAHs but do provide information of the weathering state of the oil. Sample prep may require extra steps to remove lipids which may interfere with the analysis.

- Polynuclear aromatic hydrocarbons (PAH), including both standard and alkylated PAHs – see full list in Table 1.1a of the AQAP, which also specifies the target method detection limits.

Biomarkers (S/T). Sterane/triterpane biomarkers are “fossil” compounds unique to the oil formation that are very resistant to weathering, persisting for decades after some events. These compounds provide a secondary and confirming line of evidence in forensic oil identification.

APPENDIX A: FIELD DATA SHEETS