Nearshore Ephemeral Data Collections: Submerged Oil Characterization Across Multiple Habitats Deepwater Horizon Oil Spill (DWHOS)

October 17, 2012

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

Comments and questions should be addressed to:
Ian Zelo (ian.j.zelo@noaa.gov)

Attorney Work Product Privileged

Common Interest Privileged

Mississippi Canyon 252

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All samples will be sent to labs agreed upon by the trustees and BP.

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 ENTRIX 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 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 (AQAP), after which time the validated/QA/QC'd data shall be made available simultaneously to all trustees and BP (or ENTRIX on behalf of BP). Any questions raised on the validated/QA/QC results shall be handled per the procedures in the AQAP, 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 assure reliability of the consensus data and full review by the parties, no party shall publish consensus data until 7 days after such data has been made available to the parties. Also, 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 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 ENTRIX on behalf of BP).

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.

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Approval of this work plan is for the purposes of obtaining ephemeral data to be used in evaluating the likelihood of injury to natural resources due to exposure to oil from the Deepwater Horizon Oil Spill (MC252 Spill). Each party reserves its right to produce its own independent interpretation and analysis of any data collected pursuant to this work plan.

This work plan was developed in 2010 as field conditions relating to oiling were rapidly evolving. The full extent of sampling described in this work plan did not occur because the trustees and BP transitioned to more quantitative methods. The revised methods are described in the work plan entitled "Submerged Oil Characterization Across Multiple Habitats for Assessment of Persistent Exposures in Nearshore Sediments." These methods also extended closer to the shoreline than was envisioned in this original 2010 Plan.

APPROVED:

Department of Commerce Trustee Representative: 10/17/2012
Date

Louisiana Trustee Representative: 11/02/12
Date

BP Representative: 10/19/2012
Date

Introduction

This **Submerged Oil Characterization Across Multiple Habitats** work plan has been developed as part of the ongoing Mississippi Canyon 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 TWG.

This **Submerged Oil Characterization Across Multiple Habitats** work plan provides an adaptive framework for documenting post-oiling conditions consistent with the methodology/standard operating procedures (SOPs) described in this document. The data collection described in this plan targets ephemeral data—data that is anticipated to change or disappear within a relatively short period time (15 C.F.R. §990.43). Additionally, the data will provide information that can inform the trustees in future assessment procedures under the OPA regulations (15 C.F.R. § 990.43).

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 (including salt marsh, submerged aquatic vegetation (SAV), oyster reef, and soft mud or sand bottom) is an important first step in determining potential injury resulting from the MC252 Oil Spill. Work under this natural resource damage assessment plan will characterize potential oiling in shallow (<20m) subtidal habitats in the nearshore water column and benthos. Sampling will follow statistical designs, but targeted assessments will be undertaken in sensitive habitats such as SAV beds or oyster reef, or in areas where submerged oil is observed or is expected to be found based on shoreline assessment observations. This sampling will provide a timely assessment of the presence or absence of oil, and in areas where potential oiling is detected, sampling will characterize the extent of oiling and document exposure of the water column and benthos to hydrocarbons.

Reconnaissance work performed under a separate natural resource damage assessment workplan (titled "Submerged Oil Reconnaissance Plan Deepwater Horizon Oil Spill" available at: https://www.noaanrda.org) has documented the presence of submerged oil in nearshore areas that have been shown by Shoreline Clean-up and Assessment Team (SCAT) observations to have been impacted by the MC252 Oil Spill to date (Louisiana to the Florida panhandle). This work plan will move from that reconnaissance effort to an iterative sampling design that will provide a better understanding of the distribution, nature, and extent of potential submerged oil throughout the various habitats that comprise the nearshore geography affected by the spill. Sampling effort and techniques may be adjusted based on the habitat type being evaluated and on the results of initial sampling efforts.

Submerged oil, which may occur in many forms depending upon the degree of weathering, presence of additives, such as dispersant, and incorporation of sediment, detritus, or plant material, has already been detected in DWH impacted nearshore waters using snares and various types of sorbent materials (the terms "sorbent snare" and "pom-pom" are used interchangeably in this work plan). This plan, which is based on the working hypothesis that snares can be used to locate subsurface oil, will initially detect areas of subsurface oiling that can be further delineated by weighted sorbent snare transect, grid, or spiral pattern searches. In order to test the hypothesis that snares effectively detect various types of oil based on visual observation and rapid field assessment of UV fluorescence, this proposal also includes confirmation of oil presence through quantitative analyses of hydrocarbon concentrations in water and sediment.

Sampling efforts will be based on qualitative observations of visible or UV-fluorescent oil in sediment, on sorbent snares deployed in stationary sentinel locations or dragged in transects across the bottom. The study design will allow investigators to determine whether a correlation can be established between these qualitative observations and more quantitative measures of oiling in the sediment or water column.

Sampling will include rapid assessment of buried oil through visual inspection of sediment grab samples collected at sentinel deployment locations with confirmation of rapid field observations of visible or suspected UV-fluorescent snare oiling through collection of sediment and water samples from a subset of sampling locations for quantitative chemical analysis. This plan will be used to move from reconnaissance of oiled areas to an intensive sampling design that delineates the distribution, nature, and extent of submerged oil throughout the various habitats that comprise the nearshore geography affected by the MC 252 Oil Spill. The study design will evaluate the potential to establish a correlation between the qualitative information gained through observations of oil presence/absence during the rapid assessment and the quantitative information gained through quantitative chemical analysis of sediment and water samples collected from a subset of sampling locations. If submerged oil is located, the rate of disappearance (through burial, dispersal, and dissolution or weathering) of any detected submerged oil could be monitored under a separate work plan if deemed appropriate. These findings about degree and type of oiling may be used in correlating potential impacts documented through other studies (e.g. oyster and SAV assessments, benthic biological assessments, toxicity studies, etc.).

Sampling Plan:

1. Sorbent snare drags (not for use in sensitive habitat areas)

Deployment of sorbent snare drags is mainly intended to provide timely information concerning the likelihood and extent of submerged oil in a given area. The initial reconnaissance phase of this submerged oil characterization effort focused on the use of chain-weighted snare drags using devices known as Vessel Sorbent Oil Recovery System (V-SORS), also referred to as Submerged Oil Detection Apparatus (SODA). V-SORS is a useful means of detecting submerged oil. Due to operational constraints including water depth, deployment of a small-scale version, known "V-SORS Light," was most useful for this reconnaissance and will be used in further investigations. Based on field testing, the default configuration for the V-SORS Light

device will consist of two 8-foot lengths of heavy-link chain, each attached to the end of a single tow line and doubled to 4-foot length for additional weight, and each carrying three sorbent snare pom-poms. The pom-poms are connected to the chain both at the gathered end and near the loose end to prevent them from floating above the chain. V-SORS Light are deployed and retrieved by hand, with two units simultaneously towed from opposite sides of a vessel. Tow speed, tow duration, and distance covered per tow are standardized within sampling strata. Upon retrieval, the chains are hung from a boom across the stern of the vessel or are laid on plastic sheeting on the fantail of the vessel for photo-documentation prior to disposal. Pom-poms will be assessed in the field and/or the laboratory for potential oil presence through documentation of any visible oil or fluorescence detected under UV light in a black box. Samples of suspected oiled snares will be retained for laboratory confirmation and forensic source determination (see item 3 under this section of the plan).

Prior to the deployment of V-SORS Light, randomized transect locations are designated in each sampling stratum. Transect tow lengths are determined by the planning team. V-SORS Light are towed across the shallow water bottom along designated transects using GPS for navigation. At specified intervals, the V-SORS devices are hoisted to the surface for visual inspection as described in the preceding paragraph. The amount of potential oil on the pom-poms retrieved from each transect is described as heavy, medium, light, very light, and no evidence of oil. A pictorial job aid has been created to help ensure consistent visual (i.e., non UV assisted) classification of potential oiling levels on snares across multiple teams (Appendix A). In addition, the composition of V-SORS survey teams will remain as consistent as possible, also to promote uniformity in the results.

V-SORS provide a spatially integrated assessment of submerged oil along transects at a specific point in time. Survey resolution is dependent upon distance between transects and retrieval frequency. Survey transect locations, lengths, etc. are determined as described below (see Site Selection). All transect locations and times will be GPS-referenced and recorded on data sheets (Appendix B), and all drag results will be photo-documented. Photo documentation of V-SORS will be accomplished on-board once the sorbent snares are retrieved, and may also be accomplished during deployment using camera drops or remotely operated vehicles (ROVs). Survey teams will also attempt to document the extent of any submerged oil that is visible from the surface by attempting to circumnavigate any visible submerged oil patches, maintaining a GPS track log and noting the visible submerged oil location and other discernible characteristics (thickness, consistency, etc.) on data sheets.

Sorbent snare drags are deployed only in areas where their use is not expected to cause any significant harm or injury. Excluded areas include sensitive habitats, such as SAV beds. In such areas, sampling and monitoring will be conducted in accordance with resource-specific standard operating procedures (SOPs) and work plans. Chain drags will also comply with Best Management Practices recommended by NMFS Protected Resources Division for the avoidance of entanglement by sea turtles or marine mammals (Appendix C), and by State, Federal, or Tribal Historic Preservation Officers for the avoidance of impacts to historic or cultural resources.

2. *Stationary Sentinel deployments*

Nearshore Ephemeral Data Collections:
Submerged Oil Characterization Across Multiple Habitats

Deployment of stationary snare sentinels is aimed at generating information for a number of specific purposes, including: (a) characterization of potential submerged oil in impacted areas and habitats where deployment of snare drags are precluded; (b) providing complementary information concurrent with snare drag deployments when potential submerged oil exhibits patchy distribution; and (c) allowing for a qualitative assessment of the extent of potential oiling in a single location over a specified period of time.

Sentinels can be configured in a variety of ways, but prior reconnaissance work has shown an effective design to consist of a length of chain with pom-poms attached at regular intervals, laid across the submerged bottom and anchored on either end. Lead line or rollers may be used in place of chain to minimize impacts in sensitive habitat areas such as SAV, oyster reef, or corals. A buoy is attached to one of the anchors to mark the sentinel position, and buoys can be attached to both anchors with pom-poms attached, or lengths of PVC pipe with pom-poms attached may be used to provide assessments of the vertical oiling profile through the water column compared with the swath assessment of the bottom provided by an anchored length of chain. These vertical installations are particularly effective in habitats with soft bottoms or fine sediment types that might limit the effectiveness of chain deployments due to fouling. Consistent sentinel configurations are used within specific habitat types and sampling strata.

Sentinels are deployed on the shallow water bottom at uniquely numbered, objectively selected locations using GPS for navigation (see Section 2 of Site Selection: Statistical Sampling for more detail). At specified points in time, the sentinels are hoisted to the surface to inspect the pom-poms. The amount of potential oil on the pom-poms is visually assessed and a qualitative level of oiling (heavy, medium, light, very light, and no evidence of oil) is assigned to the sentinel or to discrete segments of the sentinel (either in the horizontal plane or the vertical). A pictorial job aid has been created to help ensure consistent visual (i.e., non UV assisted) classification of potential oiling levels on snares across multiple teams (Appendix A). In addition, the composition of sentinel survey teams will remain as consistent as possible, also to promote uniformity in the results.

Sentinels are deployed for 24 hours to characterize the extent of submerged oil in a potentially impacted area where deployment of sorbent snare drags are precluded, or to provide concurrent information with snare drags. If longer deployments are desired to achieve a qualitative assessment of the extent of oiling in a single location over time, they should be checked every 24-hours to ensure compliance with Best Management Practices recommended by NMFS Protected Resources Division for the avoidance of entanglement by sea turtles or marine mammals (Appendix C). The recommended retrieval times and frequencies may be adjusted based on specific field conditions. Deployments will also comply with BMPs recommended by State, Federal, or Tribal Historic Preservation Officers for the avoidance of impacts to historic or cultural resources.

Sentinels provide a time-integrated assessment of potential submerged oil at specific locations over specified periods of time. Survey resolution is dependent upon distance between deployment points and retrieval frequency. Resolution can be improved (at least for a specific point in time) by the use of "diaper drops", which consist of weights wrapped in sorbent material and dropped in a grid or spiral pattern originating from the locations of sentinels that show

potential oiling after retrieval. Combining deployments of sorbent snare drags, sentinels, and diaper drops will be the most effective and thorough means of delineating discreet areas of known oiling. Sentinel deployment locations, lengths, etc. are determined as described below (see Site Selection). All deployment locations, dates of deployment and retrieval, and deployment and retrieval times will be GPS-referenced and recorded on data sheets, and all results will be photo-documented. Survey teams will also attempt to document the extent of any submerged oil that is visible from the surface by attempting to circumnavigate any visible submerged oil patches, maintaining a GPS track log, and noting the visible submerged oil location and other discernable characteristics (thickness, consistency, etc.) on data sheets (Appendix B). Sediment grab samples will be collected at a subset of sentinel deployment locations for the purpose of quickly determining whether visible or suspected UV-fluorescent oil is buried in sediment below the surface of the seafloor and therefore undetectable by sentinels.

3. Oil sampling for analytical chemistry

Field sampling under this work plan will include qualitative observations of potential heavy, moderate, light, very light oiling, or no evidence of oil presence on sorbent snare pom-poms deployed in sentinel arrays or dragged in transects across the bottom, or inferences of visible or UV fluorescent oiling in sediment grab samples. Collection of samples for quantitative chemical analysis will be conducted at a randomly selected subset of the sampling locations that are qualitatively assessed, in order to determine if it is possible to establish a correlation between the resulting qualitative and quantitative data sets.

Additional sampling effort will include collection of co-located water and sediment samples to be analyzed both for forensic source determination and for concentration, according to the SOPs in Appendix E. Additional sampling may be undertaken in sensitive habitats according to the SOPs developed for those resources. For instance, in SAV, oiled vegetation and invertebrates may also be collected for forensic source determination and for concentration. Upon availability of such data, statistical analysis may be performed to assess any potential correlation between the qualitative sorbent snare oiling assessments made by observers and concentrations of MC252 hydrocarbons present.

Site Selection

Currently, it appears that oil from MC252 has entered and may continue to enter nearshore, shallow water areas over a large geographic area and potentially at highly variable concentrations. The potential patchiness and temporal variability of oil distribution resulting from the MC 252 Oil Spill suggest that the best approach to sampling consists of a large-scale sampling program with probabilistic selection of sites and repetitive monitoring of individual sampling locations over time. In addition, targeted deployments are used to characterize the extent of oiling affecting specific sensitive habitat types, or areas where submerged oiling is discovered through reconnaissance work or other direct observations, or is anticipated due to shoreline observations.

Targeted sampling

Targeted sampling may occur in 1) sensitive habitats or sample site locations identified by other TWGs, (e.g. SAV beds or oyster reefs); or 2) in areas where submerged oil is observed or expected to be found based on shoreline assessment observations. The objective of this targeted sampling is to provide a timely assessment of the presence or absence of oil. In areas where oiling is detected, additional sampling may be conducted to characterize the extent of oiling and document exposure of the water column and benthos to hydrocarbons.

1. *Sensitive habitats or sample site locations*

   Detailed mapping of known sensitive habitat areas has been performed in support of work plan development efforts by the SAV TWG and the oyster sub-team of the Fisheries TWG. The objective of these data is to provide the basis for comprehensive baseline and post-oiling sampling of these habitats, including deployment of snare drags and sentinels at specific target areas or locations. SOPs for each of these habitat types will be developed by the respective working group. These sampling plans may consider information concerning nearshore current patterns (e.g., rip currents, long shore currents, eddies), convergences, shallow water bathymetry and other factors driving hydrodynamic patterns, as well as hydrodynamic model predictions.

2. *Known submerged or shoreline oiling*

   Areas where submerged oil is observed or expected to be found based on areas of known shoreline oiling, or known submerged oil based on prior reconnaissance work or as reported by agencies and civilian observers, may be sampled. Sampling of these areas may be prioritized. SOPs for documenting the existence of, and mapping the extent of, submerged oil are described below (Appendix D & Field Procedures).

Statistical sampling

Study Area, Strata and Sample Sizes

The study area for statistical sampling consists of shallow (< 20 meter) intertidal and subtidal habitats in the nearshore water column and benthos between 92.4° W and 86.5° W longitude divided into four strata (Figure 1). The strata are defined as:

I. back-bay – protected open water areas behind barrier island chains,

II. gulf-facing shoreline – subtidal habitat from gulf-facing shorelines to 1 km offshore,

III. nearshore – all areas from 1 km offshore to the 20m isobath, and

IV. Mississippi River Delta.

Sample sizes within each state and stratum are presented in Table 1. and further described below.

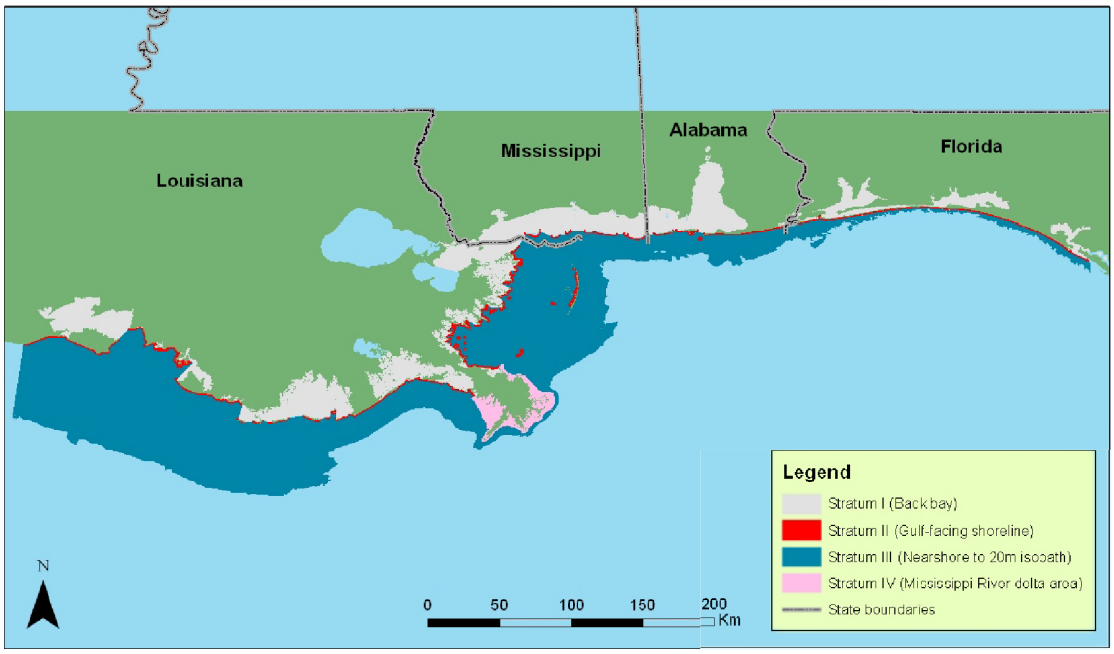


Figure 1. Study area for submerged oil characterization plan divided into four strata.

Table 1. Sample sizes by state and stratum.

State	Stratum	# Sites	# Transects	# Subsample Locations	# Sites for Analytical Chemistry(AC)	# Subsample Locations for AC
LA	**I**	**80**	**320**	**960**	**60**	**360**
	II	**80**	**320**	**960**	**60**	**360**
	III	**80**	**320**	**960**	**60**	**360**
	IV	**30**	**120**	**360**	**24**	**144**
	Subtotal	***270***	***1080***	***3240***	***204***	***1224***
MS	**I**	**20**	**80**	**240**	**16**	**96**
	II	**20**	**80**	**240**	**16**	**96**
	III	**20**	**80**	**240**	**16**	**96**
	Subtotal	***60***	***240***	***720***	***48***	***288***
AL	**I**	**20**	**80**	**240**	**16**	**96**
	II	**20**	**80**	**240**	**16**	**96**
	III	**20**	**80**	**240**	**16**	**96**
	Subtotal	***60***	***240***	***720***	***48***	***288***
FL	**I**	**20**	**80**	**240**	**16**	**96**
	I	**20**	**80**	**240**	**16**	**96**
	III	**20**	**80**	**240**	**16**	**96**
	Subtotal	***60***	***240***	***720***	***48***	***288***
	Total	**450**	**1800**	**5400**	**348**	**2088**

Sample Frames

The stratum II sample frame consists of the infinite number of points (potential site boundary center points) along the gulf facing shorelines, except those within 200 meters of the endpoints of poly-lines used to define the gulf facing shoreline stratum, i.e., stratum II. Site center points within 200 meters of an endpoint would cause the site to extend beyond stratum II because the sampling site is described as an area 200m on either side of the center point. In addition, sites with less than 500 meters of transect length in open water will be dropped and the next site selected on the list. The shoreline layers used to define the stratum II sample frame are presented in Table 2.

Table 2. GIS layers and sources used to define the strata.

Shapefile Name	Source	Description	Modifications	Use
East_Coast_Shoreline_line_census2000	Census 2000 via Industrial Economics, Inc.	shoreline for east coast	NA	defining northern boundaries for strata I in MS, AL and FL
contour_gulf2	Environmental Response Management Application (ERMA) – provided by NPS to ERMA team on 6/7/10	nearshore bathymetric contours in meters	NA	defining southern boundary for stratum III in LA, MS, AL and FL
ShorelineSegments	https://sftp.orr.noaa.gov/deepwater_horizon_ext/DataDiscoveryTeam/SpatialData/SCAT/Mobile/Divisions_Segments/	shoreline segments for the Mobile AOR	NA	defining northern boundary of stratum II for MS, AL and FL
LA_Shoreline_09082010	https://sftp.orr.noaa.gov/deepwater_horizon_ext/DataDiscoveryTeam/SpatialData/SCAT/Houma/Shoreline/	shoreline for LA	simplified by WEST, Inc.[1]	defining northern boundary of strata I, II and III for LA and southern boundary of stratum II

[1] Simplified by removing shorelines that are not consistent with the strata definitions.

Strata I (back-bay), III (nearshore), and IV (Mississippi River Delta) sample frames consist of the infinite number of points (northern boundary center points) within the strata except those within 200 meters of the eastern and western boundaries, and those within 1 km of the southern boundary. Site northern boundary center points within these areas would cause the site to extend beyond the strata. In addition, sites with less than 500 meters of transect length in open water will be dropped and the next site selected on the list. The shoreline and bathymetry layers used to define the strata are presented in Table 2.

Sample Site Selection

Each stratum will be sampled using a generalized random tessellation stratified (GRTS) spatially balanced probabilistic sample of sites (McDonald 2004, Stevens and Olsen 1999, 2004). This sampling procedure is commonly referred to as the EPA EMAP method. The target number of sites is presented in Table 1. In addition, an oversample of 3-10 times the number of sites in Table 1 will be selected to create the GRTS oversample list for use if a site is found to be inaccessible or cannot be sampled safely. In all four strata, if a site is inaccessible, cannot be sampled safely, or there is too little surface water in which to complete four 1 km transects, the next site from the GRTS oversample list will be sampled instead and the initial site labeled as inaccessible. Proposed sample locations are presented in Figures 2 through 5.

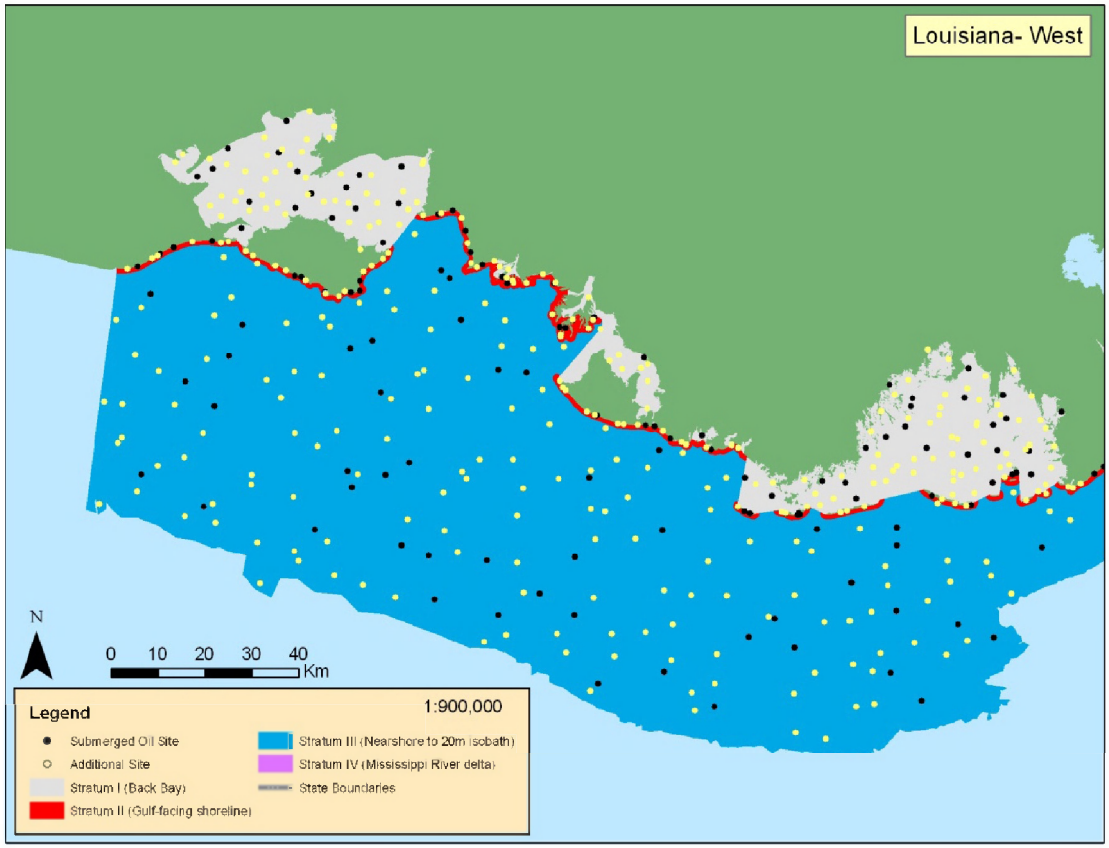


Figure 2A. Proposed sample sites in Louisiana - West.

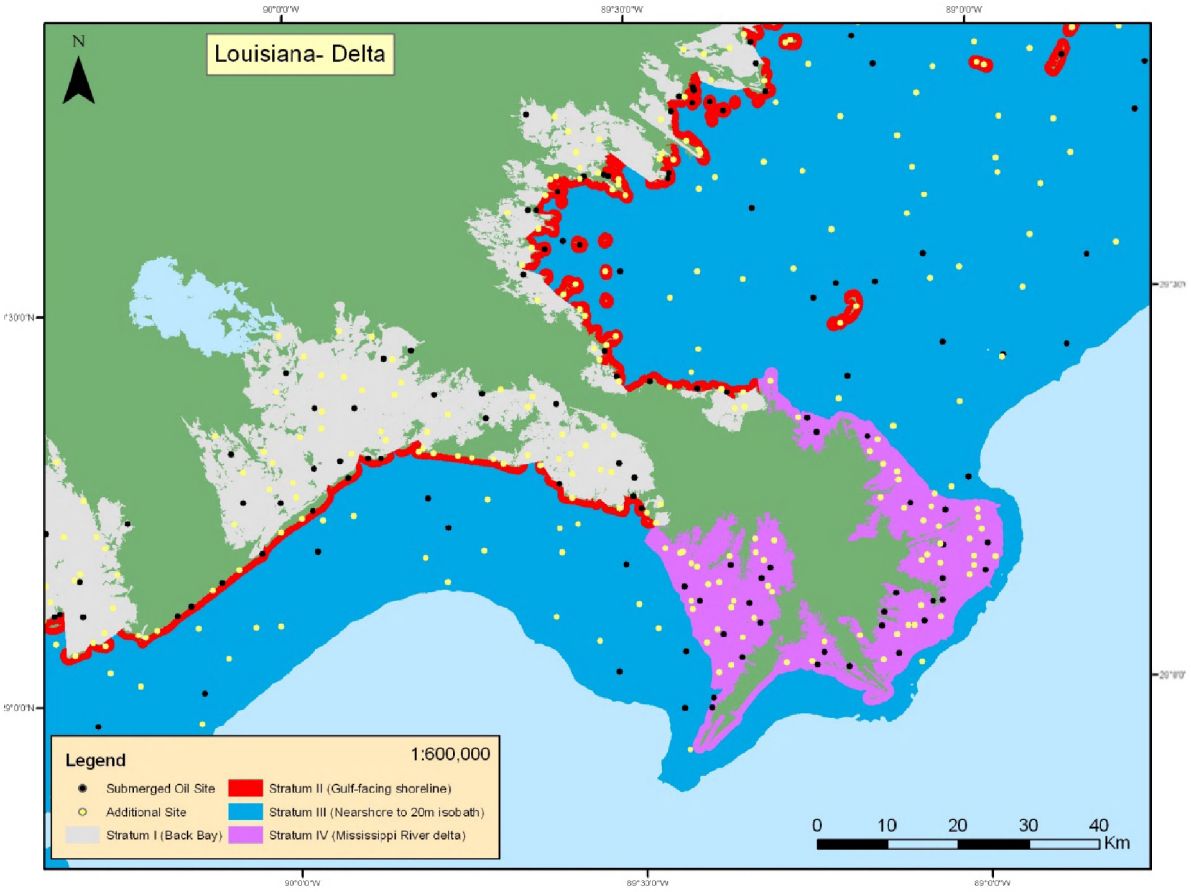


Figure 2B. Proposed sample sites in Louisiana – Mississippi delta.

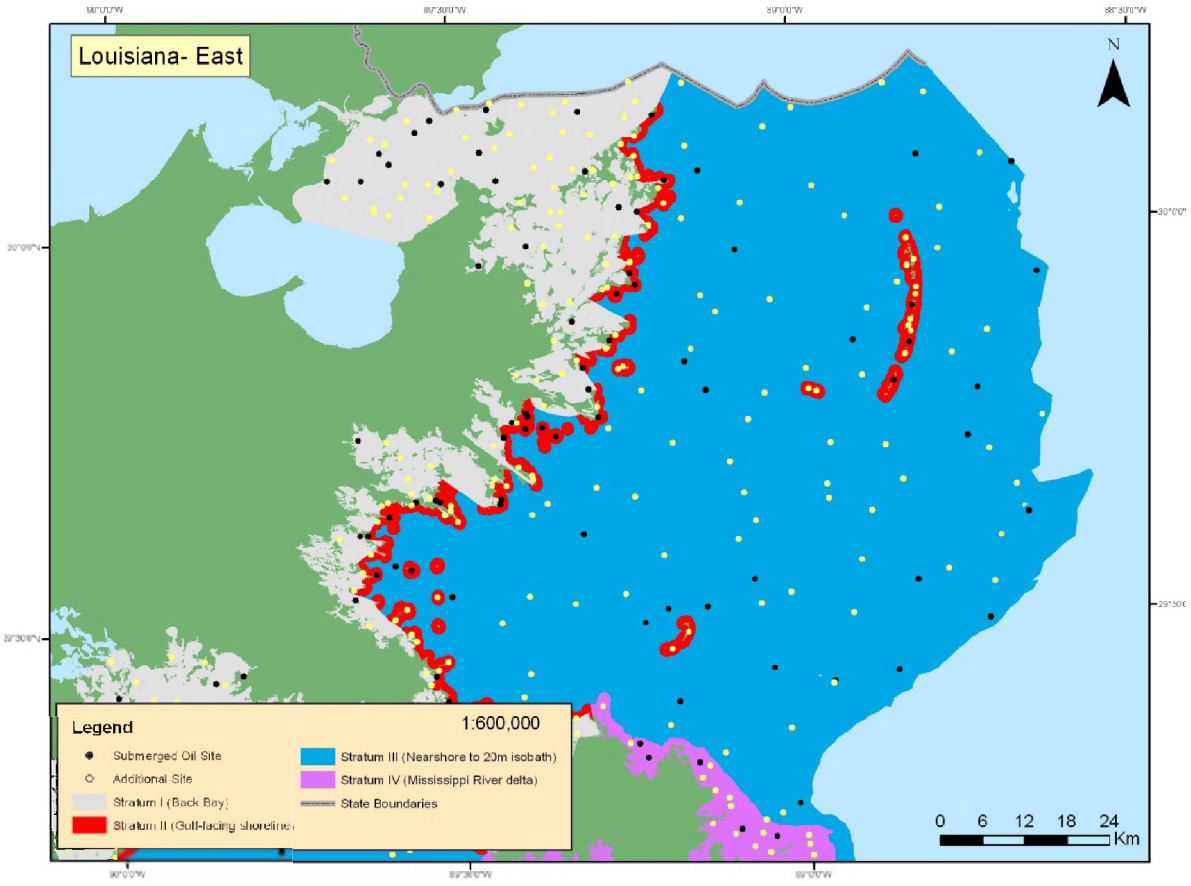


Figure 2B. Proposed sample sites in Louisiana - East.

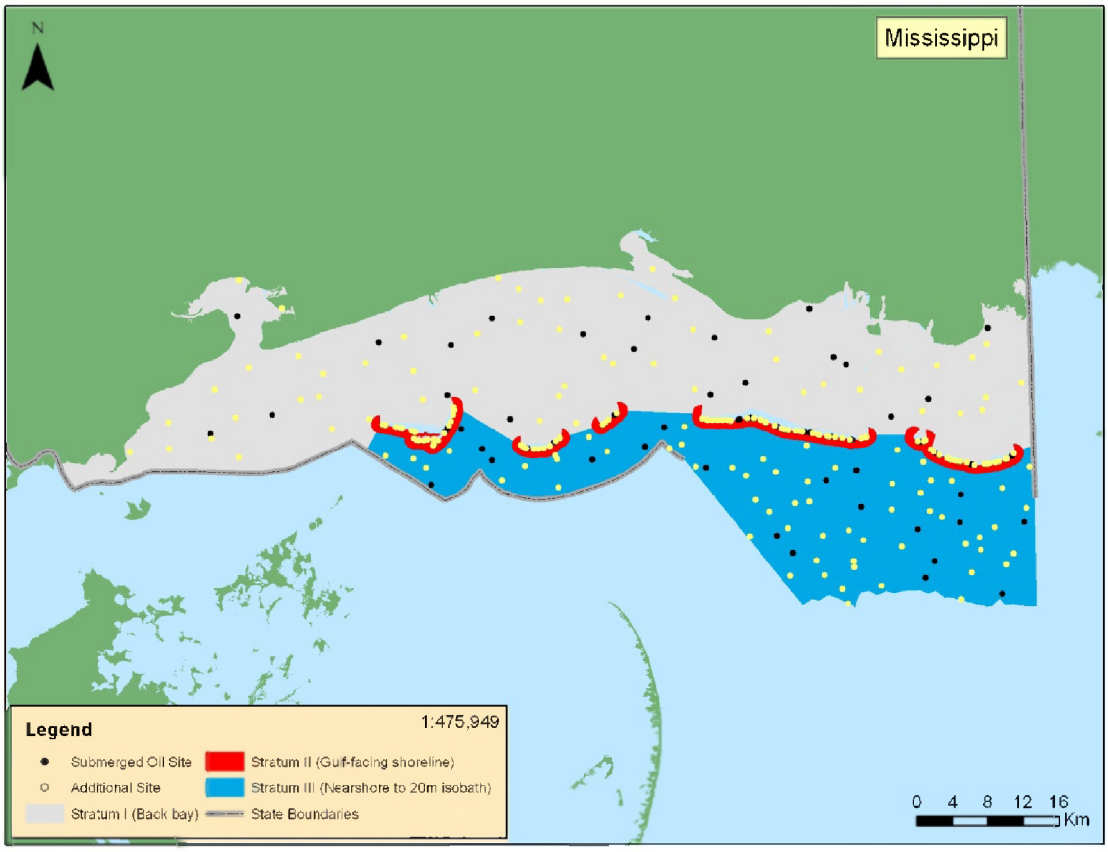


Figure 3. Proposed sample sites in Mississippi.

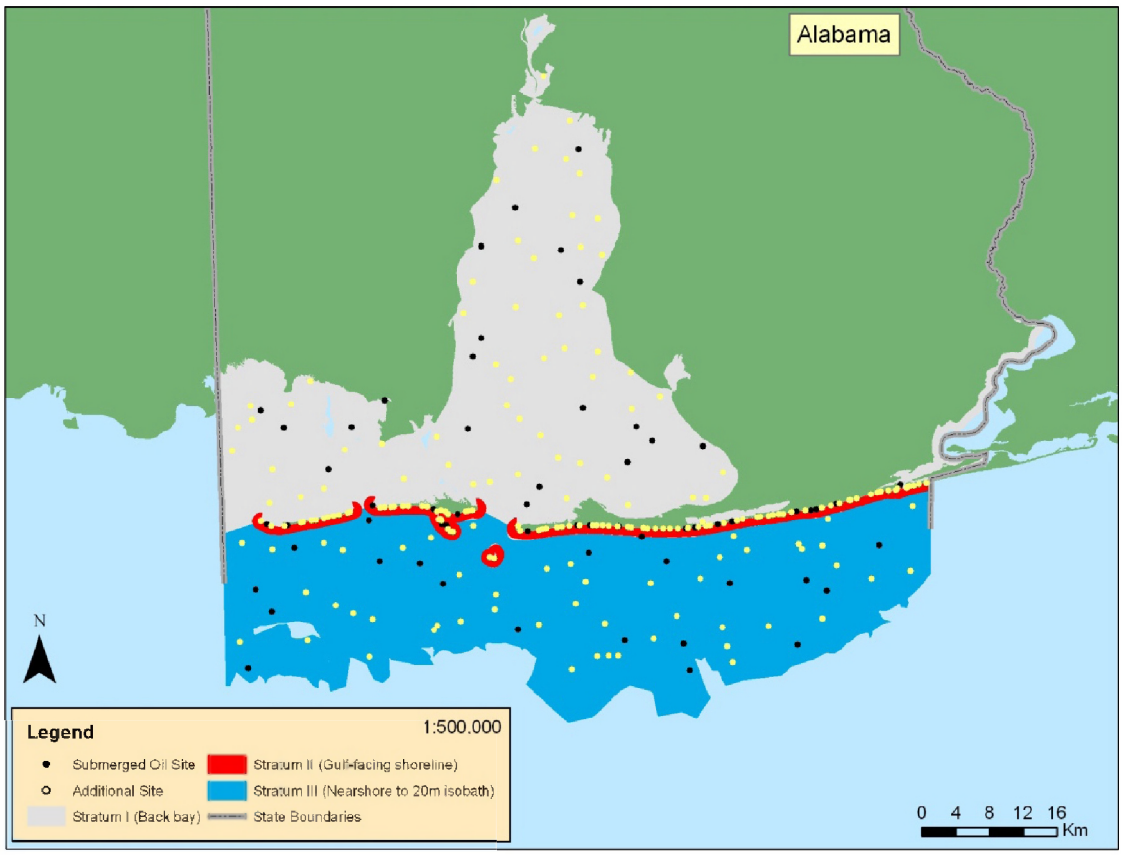


Figure 4. Proposed sample sites in Alabama.

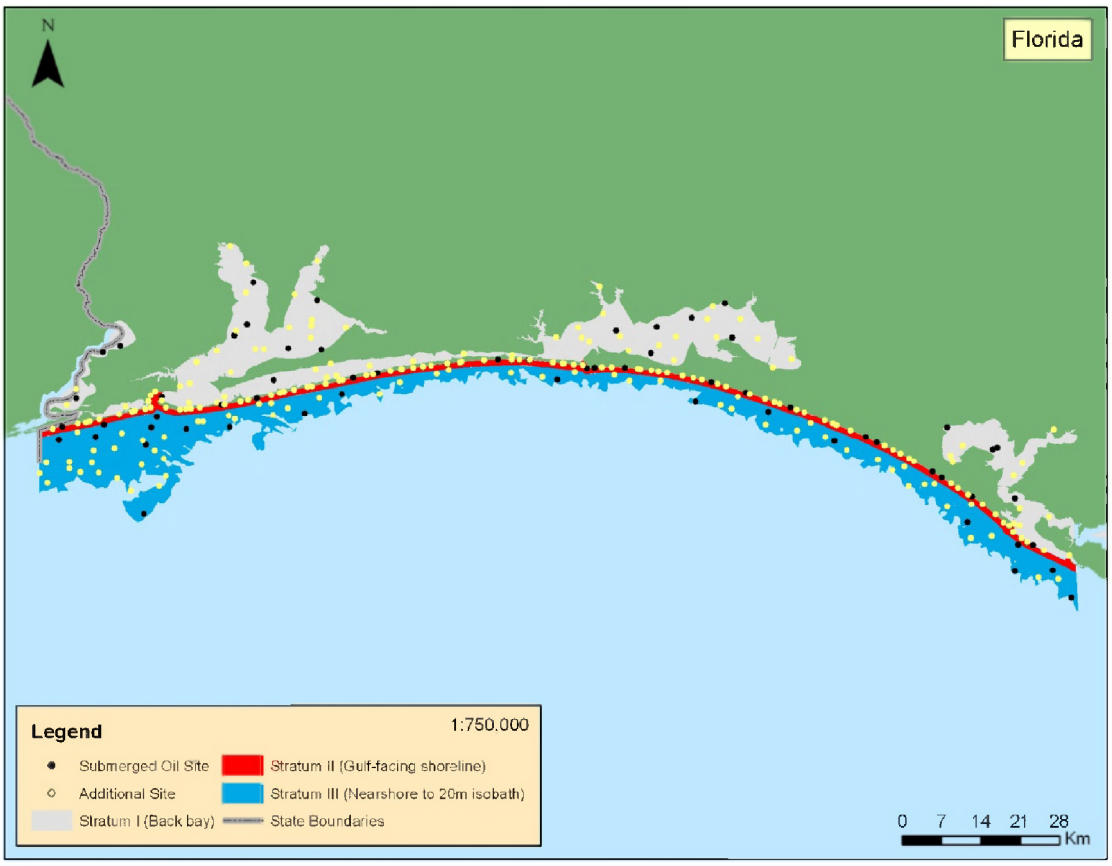


Figure 5. Proposed sample sites in Florida.

Transect Layout

For shoreline sites (sites with transects originating from shore) in Stratum II, four transects, each with a target 1 km length at 50 and 150 meters on each side of the site center point, will be targeted for survey at each site (Figure 6). Transects will be approximately orthogonal to the shore and surveyed from the shore to the open water.

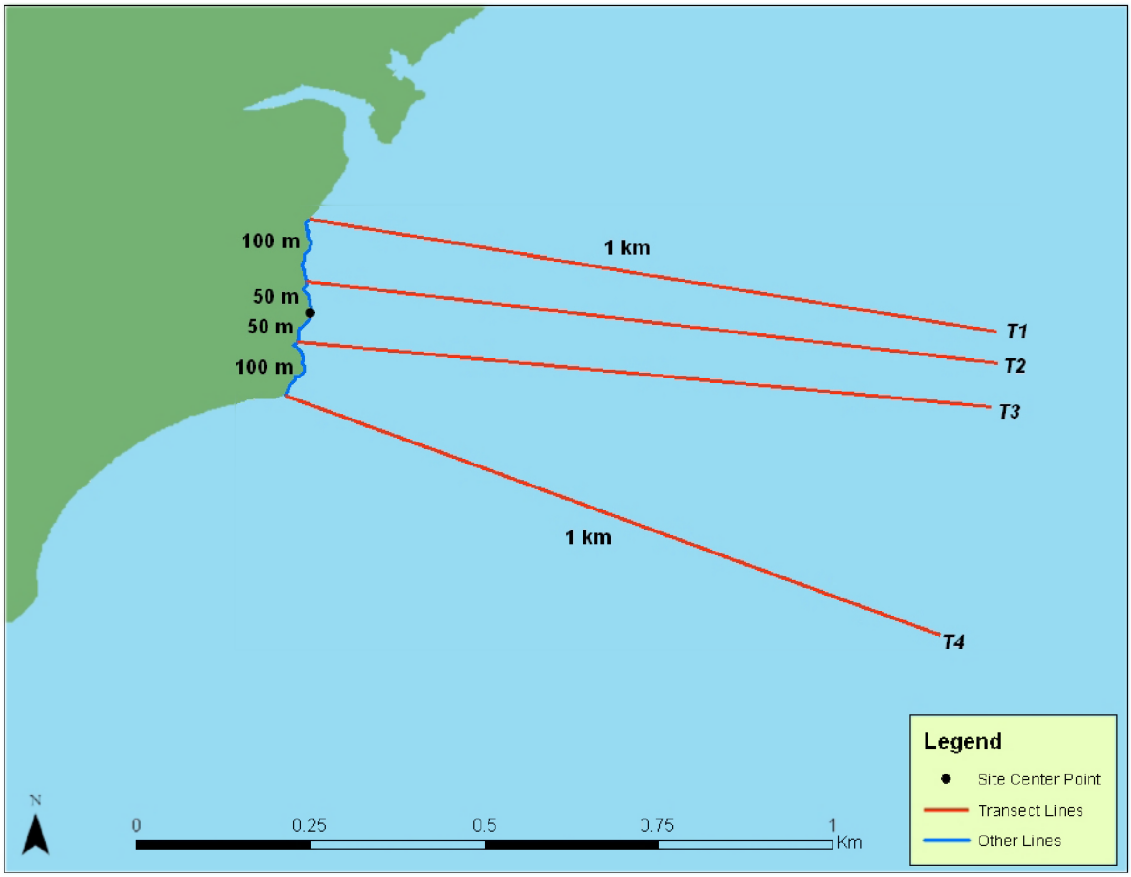


Figure 6. Example transect layout for shoreline sites in Stratum II.

For open water sites in strata I, III and IV, four transects of target length1 km at 50 and 150 meters on each side of the site center point will be targeted for survey at each site (Figure 7). Transects will be aligned approximately north/south and surveyed from the north to the south (approximately from the shore to the open water).

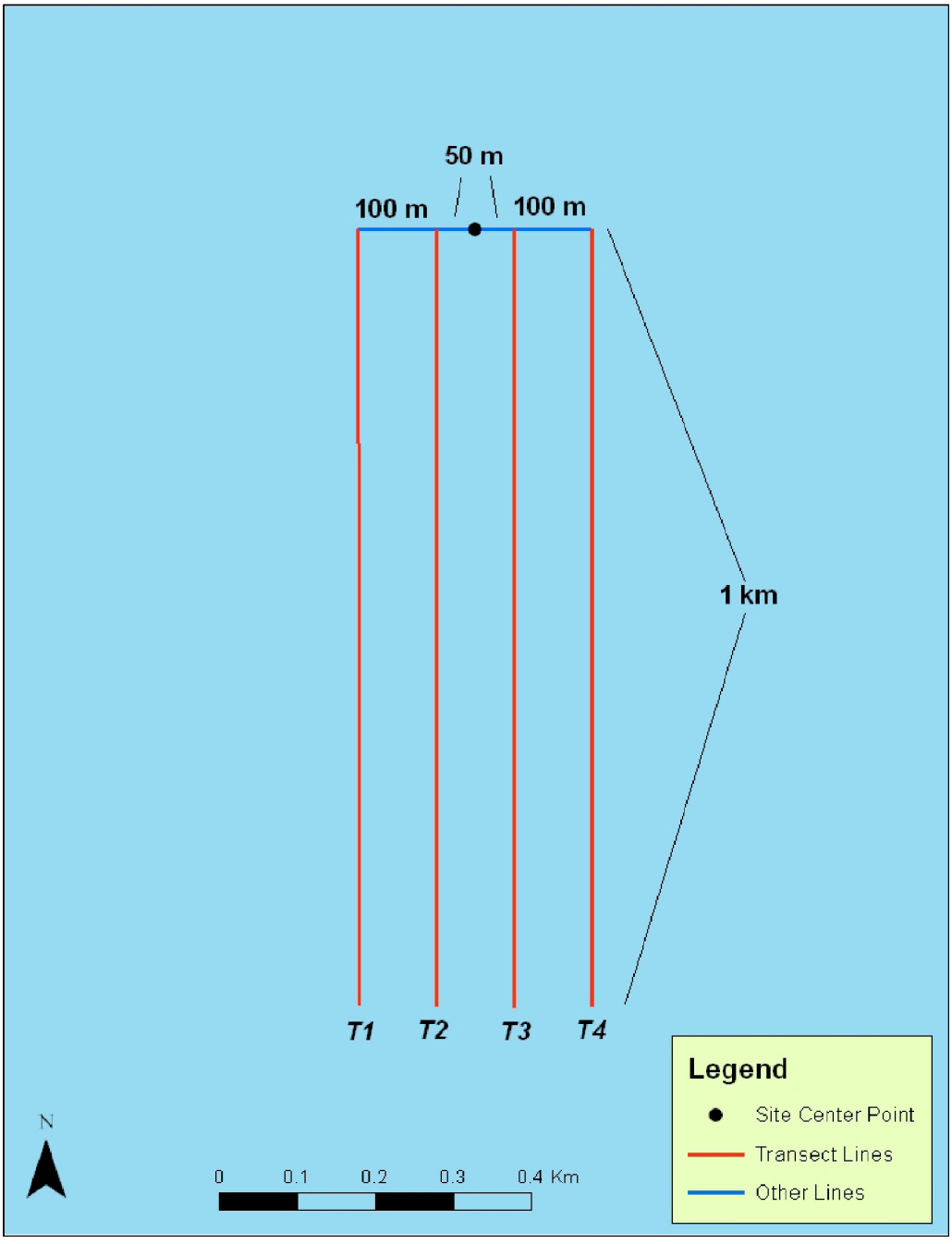


Figure 7. Example transect layout for open water sites in strata I, III, IV.

Each transect represents a strip width of 100 meters. Sites in all strata represent a 400m by 1000m or 400,000 m^2 (0.4 km^2) area. The total number of transects to be sampled under this sample design is 1800, across 450 sample sites (Table 1).

Sub-sample Locations for Sentinel Deployment

In all four strata, target locations for sentinel deployment and associated sampling (coring and analytical chemistry sampling) will be determined randomly along transects. A maximum of three locations are planned along the length of each of the four transects for a total of twelve sentinel sampling stations per site. The first will be determined by random number selection between 1 and 333, representing the number of meters from the starting point of the transect. The location of the second sample point will be the first sampling distance plus 333m and the third sample point will by the first sampling distance plus 666 meters. The total number of sub-sampling points for sentinel deployments and sampling indicated by this sample design is 5400, across 450 sample sites (Table 1).

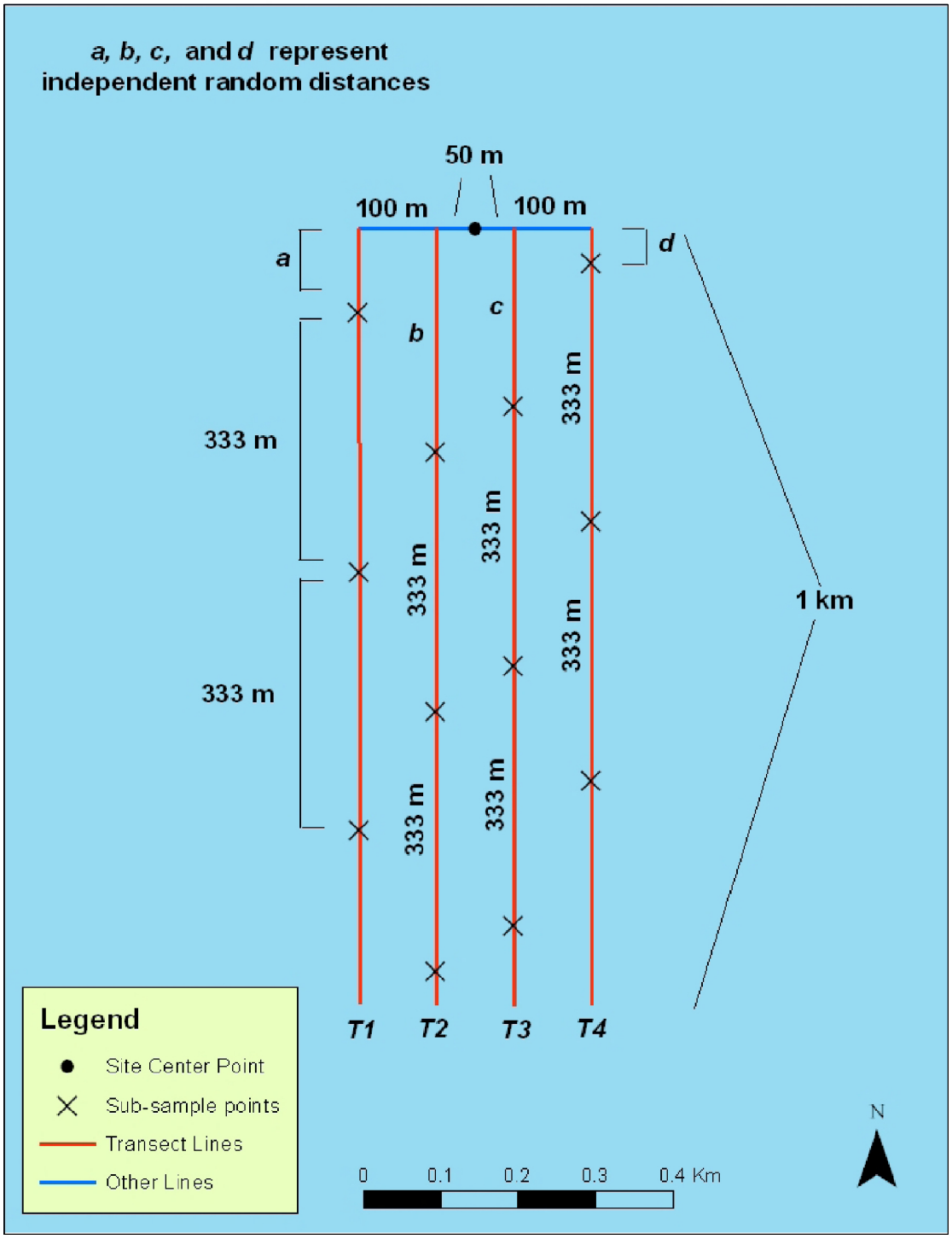


Figure 8. Example sub-sample locations for sentinel deployment.

Sample Subsets for Analytical Chemistry

A random subset of sites within each state and stratum (Table 1) will be selected and targeted for sediment and water sample collection for chemical analysis. The plan includes collection of sediment and water samples to be collected according to the SOPs in Attachment E. Sample collection locations are planned at half of the twelve sub-sample points for sentinel deployments at each site. These six locations will be randomly selected from the sub-sample points. The target total number of sub-sample points at which analytical chemistry samples (both sediment and water) may be collected as described by this sample design is 2088, across 348 sample sites (Table 1).

Sample Phases

The Phase I plan is for field crews to sample stratum II gulf facing shoreline along open water (barrier islands and shoreline not obstructed by barrier islands) in Alabama and Mississippi (Figures 4 and 3). Target sample sizes for Phase I are 10 sites in each state.

The Phase II plan is for field crews to sample the rest of stratum II in Alabama and Mississippi (Figures 4 and 3), all of stratum II in Florida (Figure 5), and strata I (back-bay) and IV (Mississippi River Delta) in Louisiana (Figure 2). Target sample sizes for Phase II are an additional 10 sites per state in Mississippi and Alabama, 20 sites in Florida, and 80 sites in Louisiana.

The Phase III plan is for field crews to sample stratum I (back-bay) in Mississippi, Alabama, and Florida, and stratum II in Louisiana (Figure 2). Target sample sizes for each stratum sampled in Phase III are 80 sites in Louisiana and 20 sites per state in Mississippi, Alabama, and Florida.

The Phase IV plan is for field crews to sample stratum III (nearshore) across all four states (Figures 2 through 5). Target sample size for stratum three is 80 sites in Louisiana and 20 sites per state in MS, AL, & FL.

This sampling strategy may be adapted, if appropriate, to afford greater flexibility in characterizing the nature and extent of submerged oil in the nearshore environment, consistent with the objectives of this plan. The range of adaptive options could include changing the level of effort allotted to the task (e.g., number of teams, number of sample locations, designation of sample strata and etc.).

Additional Transect Survey Procedures

If obstructions are encountered before the full 1 km length of a transect is surveyed then the transect may be adaptively continued by, for example, turning away from the transect at the obstruction for 25 meters then turning and continuing back toward the starting point then turning away from transect again at the starting point and continuing back to open water until 1 km has been sampled (Figure 9). The objective of this approach is to maintain the desired sampling effort for each site with an unbiased survey. Obviously, not all situations will be as simple as illustrated in Figures 6, 7 and 9. The Field Crew Leader, in consultation with the Boat Captain, will be responsible for designing, surveying, and recording an unbiased survey route of 4 1km length transects representing the target 400m by 1000m site when obstructions are encountered. Similar procedures may be followed in targeted sampling areas where obstructions are present.

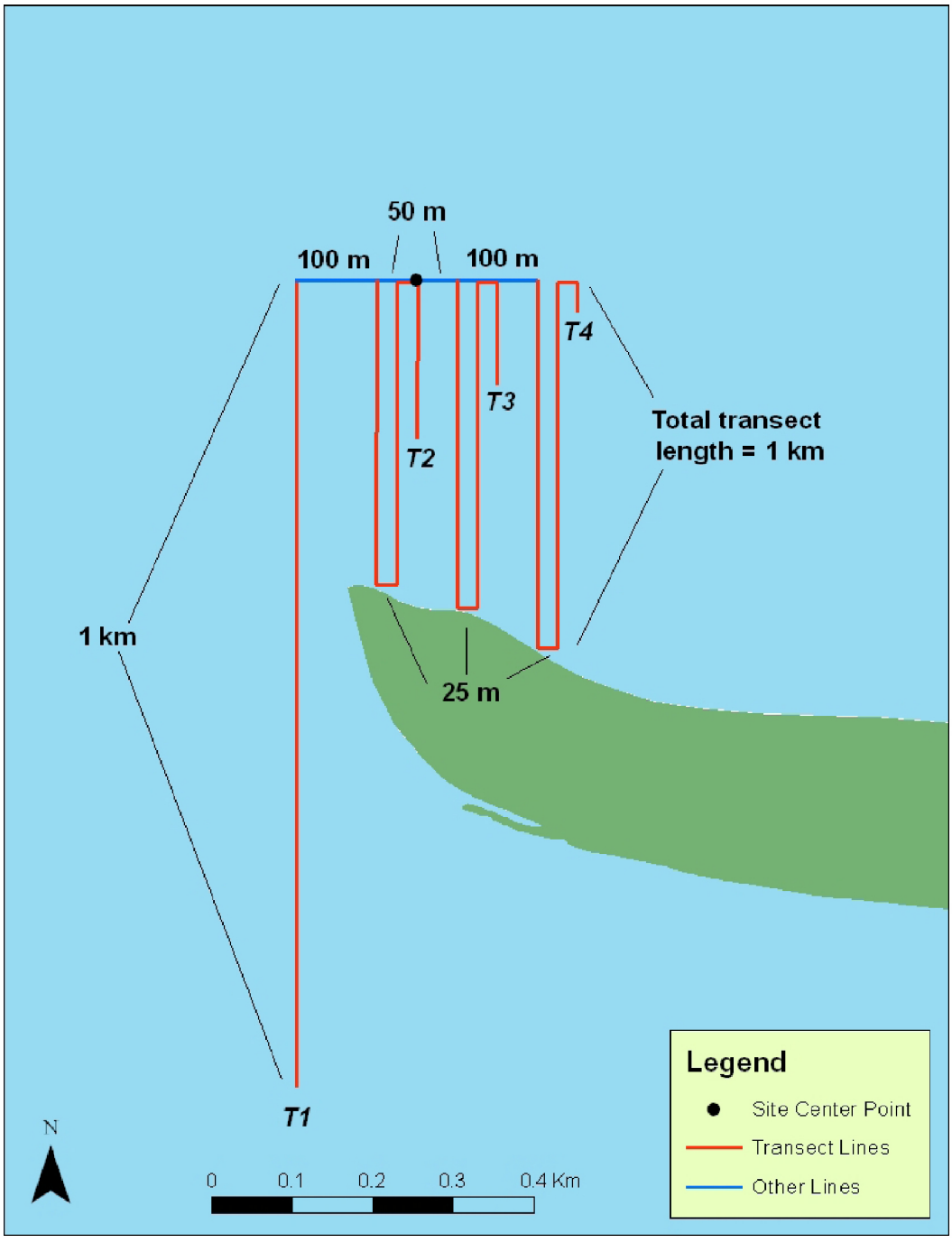


Figure 9. Example obstructed transect procedure.

Field Procedures

During these randomized surveys, the area of interest may be grouped by geographic proximity, divided into subsets and assigned to six field teams. Federal, state, and BP representatives will comprise each team, and will deploy a minimum of 12 sentinels and 4 chain drag transects at each sample location. At each location, field physical/chemical parameters (depth, temperature, salinity, and dissolved oxygen) will be measured at surface and bottom, and recorded on the sample data sheet in Appendix B.

NRDA QA/QC procedures will be followed for chain of custody of specimens collected.

Observations:

Information to be noted and recorded for each sentinel deployment or chain drag transect 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 potential oil, and a characterization of any oil observed.
- Description of any photos taken.
- GPS waypoints (latitude, longitude) of where pom-poms were removed from water for observations, or for track lines from tows
- Any other relevant information, particularly in reference to SOPs for specific habitat types.

After completing all field sampling activities for a given day, the field team will 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 will be appropriately packaged and prepared for shipment to the receiving laboratory(ies).
- **Chain-of-custody** forms will be completed.
- All data from all field forms will 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 will be submitted to the data management team for incorporation into the database.
- Archive all photographs in accordance with the instructions in the **NOAAField Photography Guidance** (NRDA_Field_Photography_Guidance.doc, available on the case FTP 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 FTP 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.

Health and Safety

- **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 ftp site** (http://www.researchplanning.com/downloads/index.php?dir=/Safety). 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 grid coordinates as shown in Maps 1 to 3 below;
  - 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"[1] and send it to dwhnrda@gmail.com. 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: 1 (985) 746-4916.

- **Field teams must adhere to all procedures set forth in the MC252 Site Safety Plan** ("NRDA MC 252 Site Safety Plan_5.13.10.pdf"). [2]

- **If participating in a cruise:** Each cruise may have additional required health and safety procedures that must be observed.

- **Entanglement hazards:** Snare sentinel deployments, and particularly chain weighted snare drags, have the potential to become entangled beneath the sea surface. Field crew

[1] This file is available on the case's ftp site: http://www.researchplanning.com/downloads/index.php?dir=/Safety
[2] This file is available on the case's ftp site: http://www.researchplanning.com/downloads/index.php?dir=/Safety

members should be alert to this possibility and should exercise caution during deployments and retrievals. Snare drag lines should be appropriately secured to cleats, booms, frames, or winches.

- **BMPs:** Field crews are to follow the best management practices recommended by the National Marine Fisheries Service's Protected Resources Division, for the avoidance of entanglement of marine mammals or sea turtles. Any encounters with protected species are to be reported to the appropriate authorities as described in those BMPs (Appendices C & D). Field crews are also to follow any guidance or BMPs provided by federal, state, or tribal historic preservation officers to avoid potential impacts 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 Vessels Of Opportunity (VOO) 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 and retrieving snare sentinels or V-SORS and other sampling equipment (coring equipment, water sampling equipment, PEMD & Dart™ sampler deployment gear). Vessels used in very nearshore, shallow-water deployments should be shallow-draft skiffs or bay boats no larger than 30 feet in length. Vessels used for deployments further from shore and in deeper water may be as large as 150 feet in length. Ideally, handling the sentinels, V-SORS, and other sampling gear will be facilitated by use of a boom or frame. While deployment and retrieval in shallow water (<5m) can normally be accomplished by hand, deeper water (up to 20m) may require use of a motorized winch.

Estimated Costs:

Supplies

- Sentinel & V-SORS hardware (PVC pipe, anchor weights, cinder blocks, buoy line, floats, header bars, chain, rings, etc.)
- (20) boxes Nitrile gloves, Tyvek coveralls & booties, safety glasses
- 30,000 sorbent pom-poms
- 1,000 PEMDs
- 1,000 Darts™ samplers
- 6 Piston Corers
- 2 YSI multi-probes
- UV light/black box
- Plastic sheeting
- Decontamination supplies (detergent, garbage bags, pressure washer, wash water collection containers)
- Lodging, food/water for remote deployment of personnel
- 6 sets of field gear (GPS, camera, radio, satellite tracker, batteries)
- Sample collection jars
- Observation data recording/sample labeling supplies

- 2 enclosed trailers and two trucks for hauling gear

Personnel

- (12) trained personnel (one federal trustee representative & one state trustee representative per field team X 6 teams) for rapid assessment sampling(VSORS/sentinel, coring, PEMD, Darts™)
- (12) trained personnel (one federal trustee representative & one state trustee representative per field team X 6 teams) for water & sediment chemistry sampling
- (70) 10 hr days for sampling per boat X 12 boats = 840 boat days
- 24 personnel * 70 days/person = 1680 personnel days

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

Category	Unit Cost	Units		Total Cost
		Type	Number	
Vessel costs – Sentinel & VSORS Deployments	$1,500	Days	420	$630,000
Vessel costs – Chemistry sampling	$1,500	Days	420	$630,000
Sentinel & VSORS Supplies				$210,000
Safety supplies, sample containers				$16,000
Core sampling supplies				$20,000
PEMDs, Darts™, TarGOST Supplies				$200,000
Personnel for Sentinel & VSORS Deployments	$800	Days	840	$672,000
Personnel for Analytical Chemistry Sample Collection	$800	Days	840	$672,000
PEMD, Darts™, TarGOST Analysis				$300,000
Estimated Total				**$3,350,000**

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

References cited.

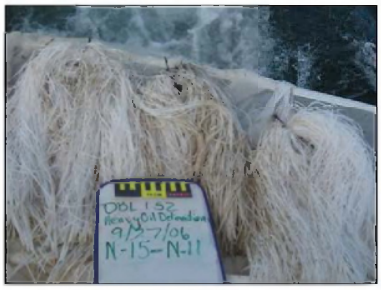
Gilbert, R. O., J. E. Wilson, R. F. O'Brien, D. K. Carlson, B. A. Pulsipher, and D. J. Bates. 2003. Version 2.0 Visual Sample Plan (VSP): UXO Module Code Description and Verification. PNNL-14267, Pacific Northwest National Laboratory, Richland, Washington.

Goovaerts, P. 1997. Geostatistics for Natural Resources Evaluation. Applied Geostatistics Series, Oxford University Press, New York.

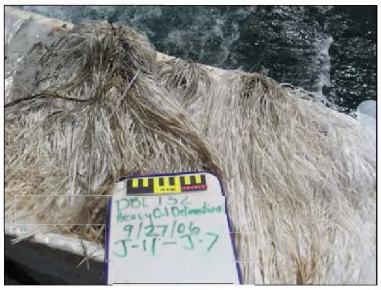
Matzke B.D,, J.E. Wilson and B.A. Pulsipher. 2006. Version 4.4 Visual Sample Plan (VSP): New UXO Module Target Detection Methods. PNNL-15843, Pacific Northwest National Laboratory, Richland, WA.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology **83**:2248–2255.

Appendix A: Pictorial Aid for Consistent Classification of Potential Oiling Levels on Snares Across Multiple Field Teams



Very Light



Light

Moderate

Heavy

Appendix B: Field Data Sheet

NRDA Submerged Oil Characterization Data Sheet: DWH Incident **Team _____**
Fish TWG

Field Trip Date: _____ Time: _____ am/pm Tides: HIGH / LOW
Data Recorder and Affiliation: _____
Sample Location #: _____ Sentinel soak time: _____
Sample Type (circle one): Transect Sentinel Dart Spot
NRDA Grid Cell _____ Deployment / Retrieval
GPS Handler/Photographer and Affiliation: _____
Other Team Members: _____

Sample Location
GPS Unit: _____ (Datum: WGS 84, Decimal Degrees)
Waypoint #: _____ Begin Lat. _____ Long. _____
End Lat. _____ Long. _____

Conspicuous Oiling Information (visual)

Oil observed in nearby water?	Yes	No
Oil observed on shoreline?	Yes	No
Oil observed on seabed?	Yes	No
Oil visible on snares (circle one):	Yes	No
UV fluorescence visible on snares (circle one)	Yes	No UV Box # _____
Extent of oiling observed on snares (circle one):	Extremely Light	Light Moderate Heavy
Depth of Dart sediment penetration _____		
Free oil visible on Dart (circle one):	Yes	No

Distance From Transect Start: _____ Water Depth: _____
Photo Numbers and description:
Notes:

Presence of Fauna (circle one): Yes No
Notes (where found and observations):
Photo Numbers and Description:

Signatures for Field Quality Assurance and Legibility:
Responsible Party Representative: _____
Federal Representative: _____
State Representative:

After the Fact Changes to Data Sheet (sign and date): _____

Version 3 11/4/2010

Appendix C: Protected Resources BMP

All work associated with this procedure should be conducted in accordance with the following Best Management Practices recommended by NOAA:

- All sentinel snares will be securely attached to the bottom substrate with an anchor. Areas of high current or tidal flow should use additional anchors to secure the snare line as needed.
- The length of the lines will be minimized to account for water depth, tidal fluctuations, and wave action to minimize the slack in the rope.
- Snares should be checked every 24 hours to ensure they remain properly anchored and verify that there are no animals are entangled in them.
- Sentinel snares should be retrieved prior to the arrival of tropical storms or hurricanes.
- Any entangled sea turtles, marine mammals, or birds must be immediately reported to the Wildlife Hotline at (866-557-1401).
- All sea turtles and dolphins sighted swimming with or entangled in any type of line or snares must also be immediately reported.
- Use a stiff anchor rope that has a lesser likelihood of looping to reduce the risk of entanglement when interactions with sea turtles and dolphins occur.
- Watch for and avoid collisions with wildlife and report all distressed or dead birds/marine mammals/turtle sightings/whale sharks/rays to the Wildlife Hotline (866-557-1401).
- Retrieve injured/dead/oiled sea turtles using the sea turtle At-Sea Retrieval Protocol (in Annex 4).
- Following coordination with the Wildlife Hotline, please notify NOAA of any “takes”, and notification of those conservation measures that were implemented, and provide an explanation for any measures that could not be implemented. Any lost snares should also be reported to NOAA. "Take" is defined by the Endangered Species Act as "to harass,

harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

Waste Management

All oiled snares (except the most heavily oiled snare, which is retained in a labeled freezer bag) need to be placed in a garbage bag. All other disposable materials (gloves, used rope) should also be placed in a garbage bag. When demobilizing for the day, bagged oiled snares and other waste materials must be properly disposed of.

Appendix D: Procedures for Targeted Sampling of Reported or Expected Submerged Oil

The following steps are planned for documentation of the existence of submerged oil and mapping its extent.

I. Establish boundaries for initial sampling, e.g., GPS locations of landmarks on shoreline or longitude lines for east and west boundaries.
II. Plan for a minimum of 3 days of survey activity to allow for the survey of approximately 12 transects each 1 km in length (4 to 6 transects per day). Each transect may be surveyed using sorbent snare drags and establishment of three stationary snare sentinels while following the standard operating procedures (SOPs) described below (**Field Procedures**).
III. The length of the shoreline adjacent to the area to be assessed could be divided into 12 equal length segments with selection of a random point in the first segment as the starting point for the first transect. The initial transect would be surveyed either north-south, east-west, or perpendicular to the shoreline. The remaining 11 transects will be approximately uniformly spaced within the remaining 11 segments and parallel to the first transect.
IV. If there is not a convenient coastline for establishment of a sampling frame, e.g., an off-shore area of suspected submerged oil, establish an initial east-west reference line with latitude and longitude lines for boundaries. Divide the reference line into 12 equal lengths and conduct 1 km sorbent snare drags between the latitude boundaries following the same SOPs as in Step 2.
V. It is suggested that the transects be conducted in sets of four {1, 4, 7, 10}, {2,5,8,11}, and {3,6,9,12}. This strategy would allow for approximate uniform coverage to be obtained in case equipment or weather problems limit the survey effort.
VI. Additional adaptive sampling of "hot spots" identified in Steps I – V:
    a. Transects that meet the criteria for existence of "significant submerged oil" (see below) may lead to adaptive survey of additional transects to help map and identify the full extent of submerged oil if judged to be necessary by the project manager.
    b. Subsets of the study area may be surveyed by additional transects perpendicular to the original 12. For example, if the original transects are of length 1 km and original transects 3 and 4 meet the criteria for "significant submerged oil, then 10 additional transects may be surveyed perpendicular to the original ones and separated by 100 meters. The length of additional perpendicular transects may extend from the original no. 2 transect to the original no. 5 transect in this example. The pattern and length of any additional perpendicular transects will depend on the shape of the shoreline and results of the original sampling effort in Steps 1-5.
    c. Additional adaptive sampling may be conducted between the original 12 transects if the distance between original transects is judged to be too large to support the Trustee's NRDA case. For example, if original transects 5 and 6 meet the criteria for submerged oil, then 3 additional parallel transects may be surveyed: half-way between 4 and 5, half way between 5 and 6, and half way between 6 and 7. If only transect 3 meets the criteria for submerged oil, then 2 additional transects may be surveyed: half-way between 2 and 3 and half-way between 3 and 4. The

pattern of additional adaptive sampling will depend on the results of the original sampling effort in Steps 1-5.

d. Adaptive sampling following the example guidelines in Steps b. and c. may continue until the project manager judges that resulting qualitative, quantitative, and chemistry data are adequate to support the Trustees' NRDA case.

(See attached)