US ARMY CORPS
OF ENGINEERS
New England District

Contract No. DACW33-03-D-004
Delivery Order No. 44
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Sampling and Analysis Plan

BOSTON HARBOR
INNER HARBOR
MAINTENANCE DREDGING
PLUME MONITORING

Boston Harbor, MA

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Sampling and Analysis Plan

for

BOSTON HARBOR INNER HARBOR
MAINTENANCE DREDGING PLUME MONITORING

Contract Number: DACW33-03-D-004
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U.S. Army Corps of Engineers
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New England District

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ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
APP	Accident Prevention Plan
BHIH	Boston Harbor Inner Harbor
BHNIP	Boston Harbor Navigation Improvement Project
CAD	Confined Aquatic Disposal
CTD	Conductivity Temperature Depth
CY	Cubic Yards
MBDS	Massachusetts Bay Disposal Site
NFT	Near Field Turbidity
NTU	Nephelometric Turbidity Units
NTP	Notice to Proceed
NED	New England District
OBS	Optical Back-Scatter
SAP	Sampling and Analysis Plan
TSS	Total Suspended Solids
USACE	U.S. Army Corp of Engineers

1. PROJECT DESCRIPTION AND TECHNICAL APPROACH

1.1 Scope and Objectives

The primary objective of this monitoring effort is to conduct boat-based field monitoring to gauge the extent of potential water quality impacts resulting from dredging and disposal operations. This information will be used to make operational adjustments as may be necessary to limit the dispersal of suspended sediments and their associated contaminants as well as limit the extent of biological impacts. In particular, U.S. Army Corps of Engineers (USACE) is concerned with potential impacts on winter flounder spawning habitat and limitations to seasonal fish passage.

Water quality monitoring will be conducted in Boston Harbor's Inner Harbor during maintenance dredging of portions of the Federal navigation channel and disposal of resulting dredge material into a designated Confined Aquatic Disposal (CAD) cell. The monitoring will assess potential water quality impacts from dredging to determine if any resuspended material may be impacting winter flounder spawning habitats in the Harbor. It is anticipated that the dredging operation could take up to six months and that the separate sampling events: southern area dredging monitoring, CAD cell cap dredging monitoring, and disposal monitoring will be performed at intervals throughout that period. The details of each monitoring task are presented in Section 1.3.

Use of Acoustic Doppler Current Profiler (ADCP) technology in combination with turbidity sensors integrated with a Conductivity, Temperature, Depth (CTD) recorder/Rosette Water Sampler Profiler is proposed as the most efficient way to identify and track a suspended sediment plume and to sample in real-time within and outside of the plume. The in situ ADCP backscatter data and in situ turbidity sensor nephelometry data will be compared to laboratory derived total suspended solids (TSS) data from whole water samples to post-calibrate the instrument measurements and to provide an independent measure of particulate concentration.

1.2 Project Background

Boston Harbor is the largest port in New England and serves as a major hub for national and international shipping and commerce. The Conley terminal, the port's largest public cargo terminal located at the confluence of the Reserved Channel and Main Ship Channel, is used by importers and exporters from all over New England for transporting a wide range of goods. In 1998, USACE began expansion and deepening of the shipping channels of the Inner Harbor to provide safer, more effective navigation through the Main Ship Channel and into the major dockage areas. In addition, CAD cells were created to provide confined disposal of fine-grained dredge material unsuitable for ocean placement.

Beginning in the spring of 2008, USACE is scheduled to conduct maintenance dredging of a portion of the Federal navigation channels in Boston Harbor, Massachusetts. The maintenance dredging has been broken into base work and optional contract work. The base work involves dredging the Main Ship Channel from a location approximately half-way between Spectacle Island and Castle Island upstream to approximately the North Jetty, the upper Reserved Channel, and the approach channel to the Navy Dry Dock, all to their authorized depths. The base plan dredging also involves the creation of a CAD cell in the Mystic River and the removal of the silty layer over another potential CAD cell in the Main Ship Channel. The optional work which may be performed involves dredging the Main Ship Channel from the North Jetty upstream to the Inner Confluence, a portion of the Mystic River not previously deepened during the Boston Harbor Navigation Improvement Project (BHNIP), dredging in Chelsea River from just south of the Chelsea Street Bridge in the vicinity of the Keyspan Gas siphon up through the Chelsea Street Bridge. If the optional dredging is performed it will also require the creation of a CAD cell in the Main Ship Channel (Figure 1).

Approximately 1.3 million cubic yards (cy) of the 1.7 million cy to be dredged from the Federal channels is unsuitable for ocean placement and will be disposed into CAD cells located beneath the Federal channels. The CAD cell for the base contract work will be sited in the Mystic River. If the optional work is conducted, that material will be placed into a single CAD cell located in the Main Ship Channel below the Inner Confluence (Figure 1). The remaining 400,000 cy of dredged material, plus the material excavated in constructing the CAD cells will be disposed at the Massachusetts Bay Disposal Site (MBDS).

Potential impacts from sediment resuspension and transport of material away from the dredging areas and subsequent deposition on areas identified as potential winter flounder spawning habitat (sensitive life stages) has been identified by the resource agencies as an area of particular concern. In order to identify any potential project related impacts relative to these resources, this monitoring effort will use proven methods from similar dredge monitoring projects to track dredging plume migration in real-time. Monitoring is proposed for those times when dredging activities have the greatest potential to impact sensitive resource areas.

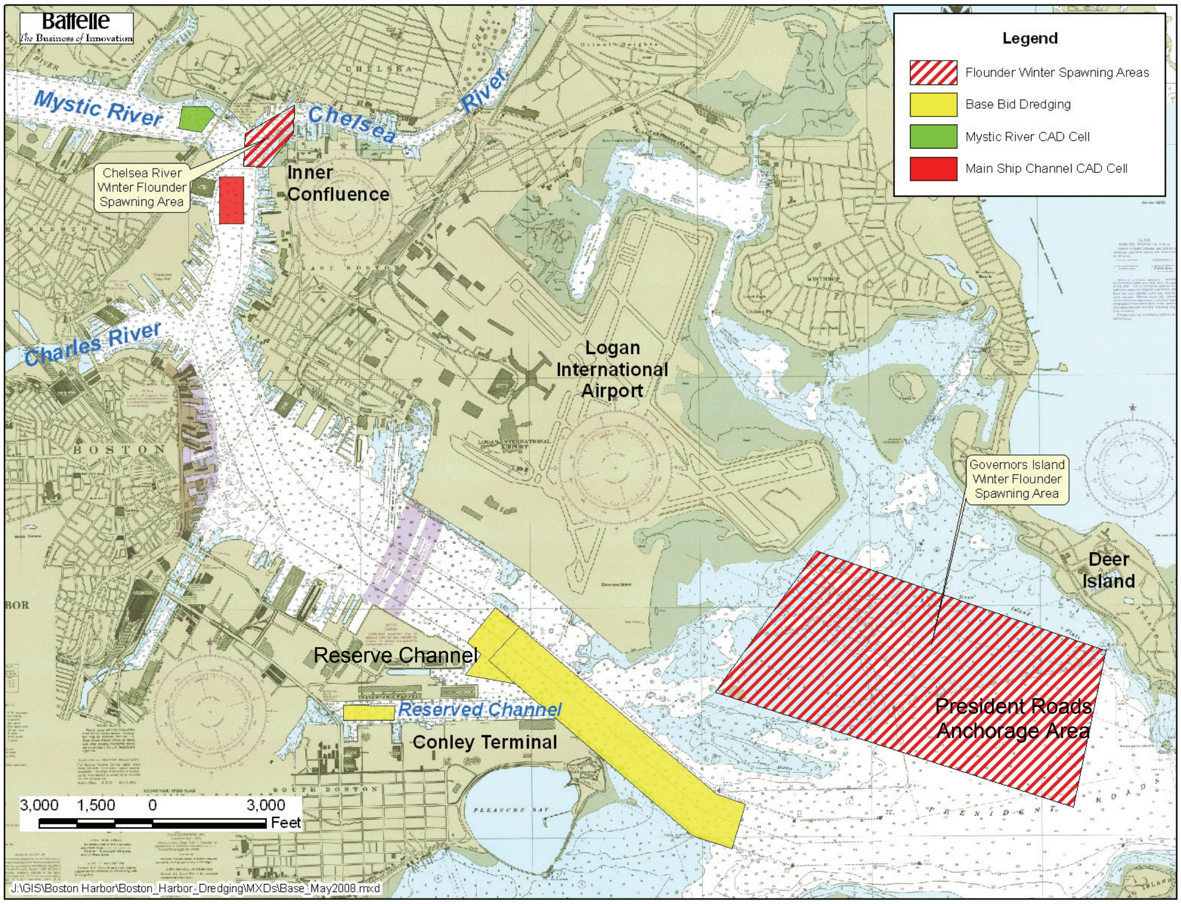


Figure 1. Map of Boston Harbor Inner Harbor Maintenance Dredging and Winter Flounder Spawning Areas.

1.3 Sampling

The dredge plume will be monitored while work is being performed within an area south of the Reserved Channel, closest to the President Roads Anchorage Area (Figure 2). This area was chosen because of it's proximity to Governor Island Flats (a potential winter flounder spawning habitat) and would therefore have the greatest potential for impact (Figure 2). Additionally, this area was previously modeled for the Boston Harbor maintenance dredging project using SSFATE. Monitoring in this area would also provide the added benefit of confirming the results of the model.

The second area selected for monitoring is located at the upper end of the project in the Inner Confluence where the proposed Main Ship Channel CAD cell will be located (Figure 3). Monitoring will occur when the silty maintenance material is being removed from the top of the CAD cell. This area was selected due to its proximity to potential winter flounder spawning habitat (Figure 3), the fact that this area has not previously been modeled by SSFATE and there was only limited dredged plume monitoring conducted during the previous BHNIP in this area.

The approach will incorporate broad scale monitoring of sediment plumes using a ship-mounted ADCP combined with discrete location water column profiling for *in situ* turbidity and whole water sample collection using a CTD/Turbidity sensor mounted on a Rosette. Continuous ADCP measurements of acoustic backscatter from suspended particles in the water column from the moving vessel will map the extent and intensity of any plumes. CTD/Turbidity water column profiles will be then be performed at discrete locations throughout the plumes and at reference locations. Water samples collected during water column profiling will be analyzed in the laboratory for TSS to post-calibrate the instrument measurements and provide an independent measure of particulate concentration.

Monitoring operations will be conducted during daylight hours only.

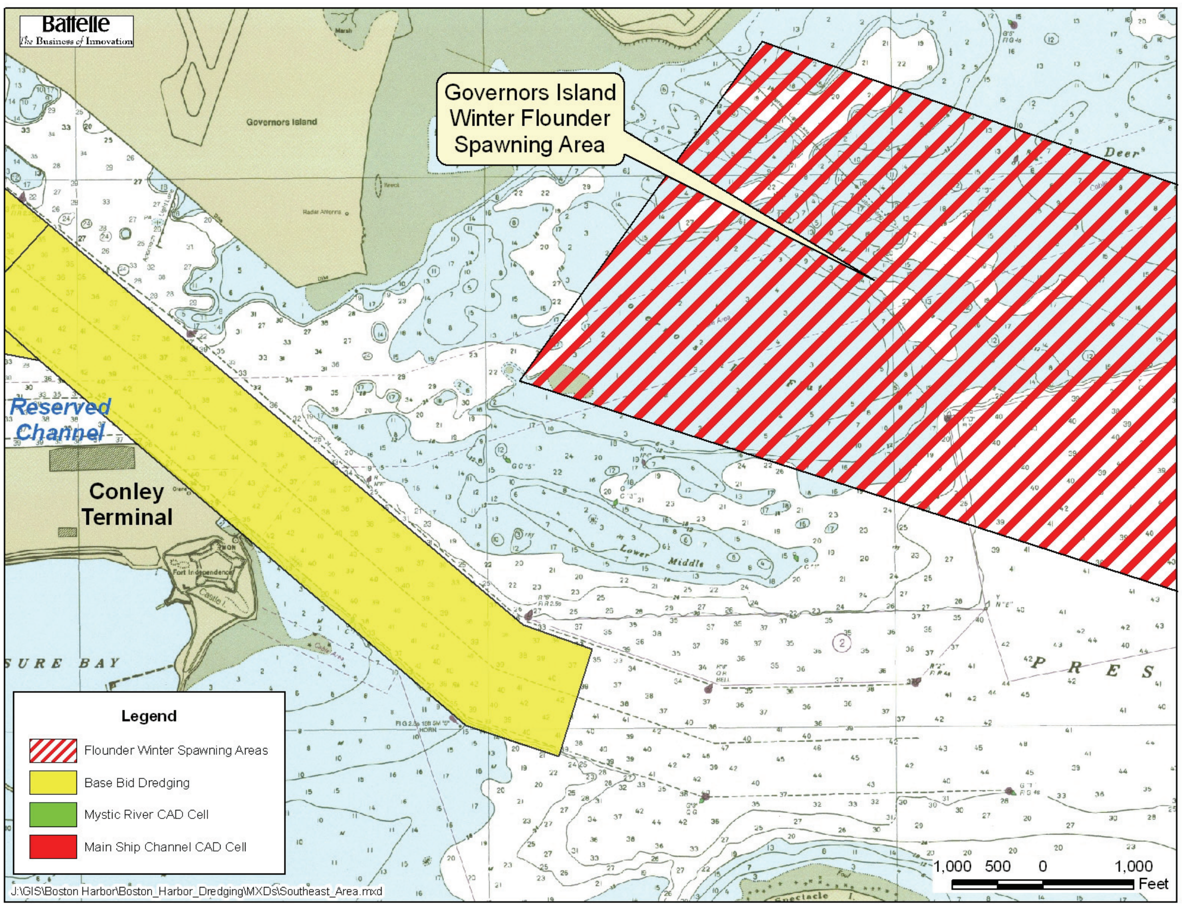


Figure 2. Map of Boston Harbor Inner Harbor Maintenance Dredging Lower Harbor Area and Winter Flounder Spawning Area.

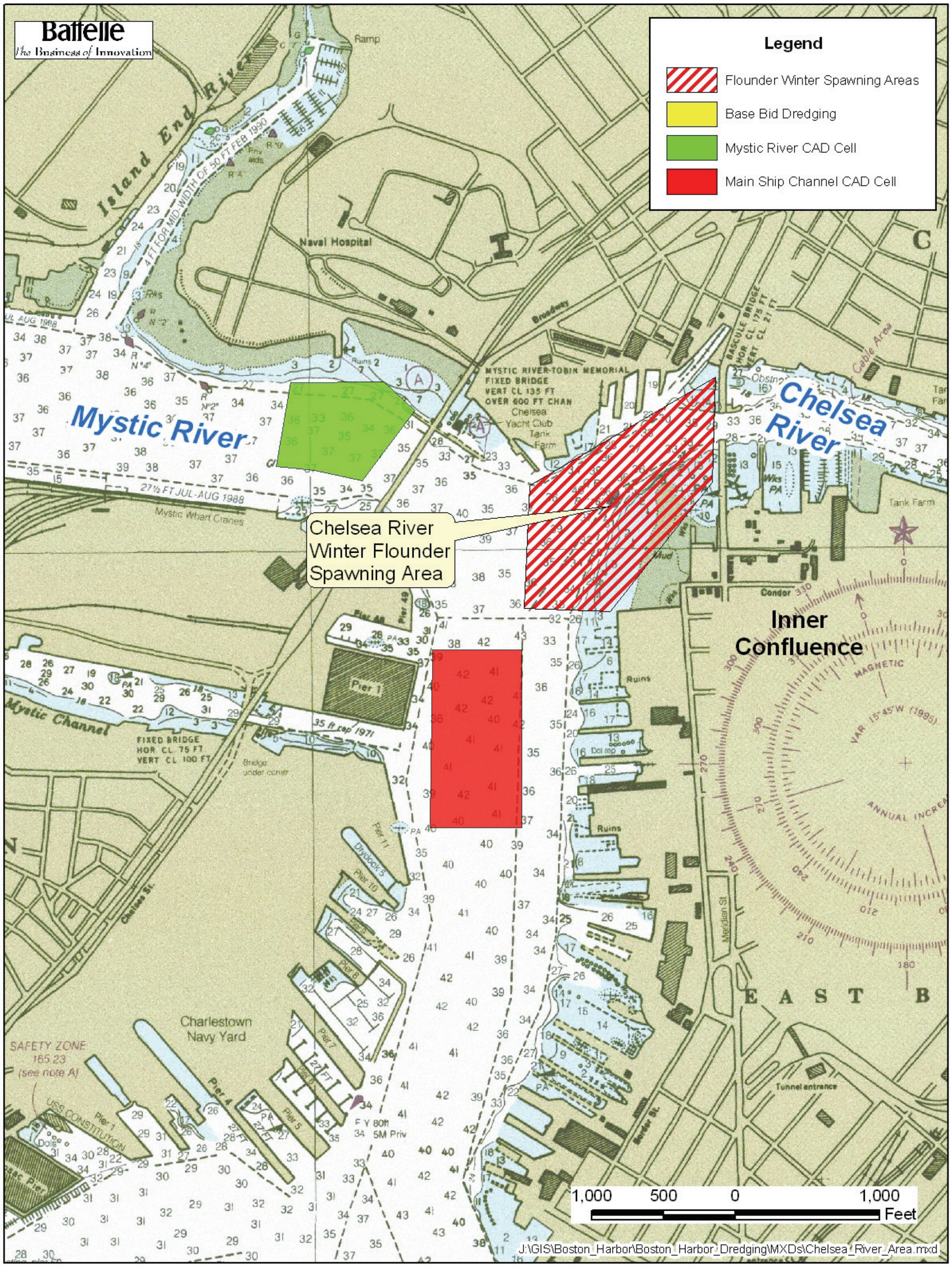


Figure 3. Map of Boston Harbor Inner Harbor Maintenance Dredging Inner Confluence Area and Winter Flounder Spawning Area.

1.3.1 Plume Tracking with ADCP

The plume tracking will be conducted using RD Instruments 1200kHz Workhorse Mariner ADCP mounted on the Battelle R/V Aquamonitor (or equal counterpart) and a CTD/Turbidity profiler deployed over the side of the same vessel. The ADCP will be used to measure acoustic backscatter intensity in decibels (db) every 1-2 seconds at 0.5 -1 m intervals in the vertical throughout the water column while the vessel is underway. The acoustic backscatter intensity varies with the suspended sediment concentration in the water column. As the vessel runs transects across the ship channel and adjacent flats or longitudinally along the ship channel or flats, the ADCP will map out vertical slices of suspended sediment concentration along those transects. These cross sections will provide a general understanding of plume location, movement, and dispersion in the channel. The ADCP concurrently measures velocity of the tidal currents (speed and direction) which will be used to aid plume tracking. The ADCP measurements are recorded and displayed in real-time. Real-time demarcation of the plume with ADCP will provide the information needed to select CTD/Turbidity water column vertical profile locations. All data from the ADCP will be recorded to PC for further post-survey analysis. Details of the sampling location and frequency for each task assignment are provided in Sections 1.3.3 to 1.3.5.

Dredged material plumes resulting from continuous dredging operations are roughly steady state in nature compared to those resulting from disposal operations which are much more transitory and more difficult to track. To aid plume tracking during disposal operations, drogues may be optionally deployed to help track the leading edge of the plume after release.

1.3.2 Vertical CTD/Dissolved Oxygen/Turbidity Profiling and TSS Sampling

During each monitoring event, vertical profiles will be performed at discrete locations determined from the real-time ADCP plume tracking data. Vertical profiles are performed using an underwater unit consisting of a CTD/Turbidity sensor (optical backscatter sensor [OBS]) and a water-sampling system equipped with up to twelve 9–L Rosette sampling bottles. The CTD will also be configured with a Dissolved Oxygen (DO) sensor. Sample and data collection methods are detailed in Battelle SOP 5-275-02: At-Sea Collection of Hydrographic Data Using CTD and Rosette System. CTD/Turbidity profiles will provide more accurate nephelometry measurements than can be made with the ADCP. They will also provide a general synopsis of water column stratification and allow the field team to make predictions as to the dispersion patterns of the dredge plume. There will be three OBS's affixed to the CTD Rosette, each configured for a different range of potential turbidity measurements (0– 5, 0–125, and 0–500 NTU).

In addition to in situ hydrographic measurements, whole water samples will be collected at a range of depths for laboratory TSS analysis. Bulk water samples will be collected by triggering the Rosette bottles at designated depths. Once the Rosette is on deck, TSS samples will be transferred to 1-L dark bottles and stored on ice (~4°C) and in the dark until they can be delivered to Alpha Analytical for processing and analysis. A 7-day holding time from collection to analysis is expected. The specific requirements for TSS collection under each task are presented in Sections 1.3.3 to 1.3.5 below. TSS field duplicate samples will be collected at a frequency of 5% to assess water column homogeneity and sampling reproducibility.

During water column profiling, the CTD/Rosette Water Sampler will be lowered through the water column to measure turbidity, salinity, temperature, DO and to collect water samples. All parameters will be logged using NavSam©, Battelle's shipboard navigation and data collection software. As the instrument travels through the water column, the field staff will monitor the real-time display of turbidity, salinity, temperature, and DO. During the upcast, water will be collected at the prescribed depth by closing Rosette sampling bottles. When the Rosette deck unit indicates that a bottle has been closed, an event is recorded electronically in the NavSam© data file to record vessel position, depth, and concurrent in situ water column parameters including turbidity. The NavSam© software will also generate unique bar-coded sample-bottle labels to be affixed to sample bottles and survey logs.

1.3.3 Dredging Operation Monitoring: Lower Harbor Area & CAD Cap (Task 3)

Dredging monitoring will take place when dredging activities are being conducted in the Lower Harbor within an area south of the Reserved Channel, near the President Roads Anchorage Area (Figure 2) and when surface sediments of the CAD cell in the upper reaches of the Main Ship Channel are dredged (Figure 3). Plume sampling will be conducted when the dredge has been active during typical dredge activity for a minimum of 4 hours and an established plume has been created. The dredge plume will be monitored at each dredge location for intensity and trajectory over two complete tidal cycles. Since no monitoring operations will be conducted after dark, the two tidal cycle sampling actions will be carried out on separate days. Each tidal cycle monitoring will include the four sampling events covering the four extremes of tidal currents: high slack (HS), maximum ebb (ME), low slack (LS), and maximum flood (MF) for a total of eight monitoring events in the Lower Harbor and eight monitoring events at the Main Ship Channel CAD cell.

Each tidal phase monitoring event will be conducted as follows (summarized in Table 1). Prior to beginning of sampling for the day, the field team will confirm the status of dredging operations and projected dredge activities for that day via communication with the Corps Construction Supervisor Timothy Rezendes. The field team will then use the ADCP to confirm the current direction and speed near the dredging operation. Initially, cross-channel transects will be conducted with the ADCP at pre-designated locations 300 feet up current of the dredge and 100, 300, 500 and 1000 feet down current of the dredge (or until the plume is no longer visible). The ADCP will also capture the lateral spread of the plume at these locations. Based on initial results, the vessel will run a longitudinal transect up current toward the dredge to locate the area of highest plume concentration. Once the centroid has been identified, the vessel will hold station at that location and conduct a CTD/Turbidity vertical profile and collect whole water samples for TSS analysis at three depths. The depths are

1) within approximately three feet of the bottom,
2) approximately one foot below the surface, and
3) at the depth of maximum turbidity, or if the turbidity maximum is near-bottom or near-surface then at mid-depth.

In the same way, two lateral and one down plume stations will also be sampled. These locations will be located within the plume but near the lateral and down-current plume boundaries as determined in the field from the ADCP plume tracking data. Reference stations will be profiled and sampled (3 depths: approximately three feet from the bottom, mid-depth and approximately one foot from the surface) at least 1000 ft up current with respect to bottom current and/or at least 1500 ft down current of the dredge activity, the results from which will be averaged for comparison to the monitoring samples.

Any monitoring which indicates that the dredge plume has migrated to areas outside the navigation channel in water depths of less than 25 feet MLLW at turbidity levels of 25 NTU's above background or greater will initiate the Exceedance Protocol (Section 1.3.5) and will be reported immediately to the Corps Project Manager, Mike Keegan (978-318-8087) and/or Ms. Catherine Rogers (978-318-8231), as a warning of potential dredging related water quality impacts on resource areas of concern.

Table 1. Dredging Plume Monitoring Sampling During Each Tide Phase Event (High Slack, Max Ebb, Low Slack, Max Flood).

Transect/Station	Parameters	Depth	Number of Water Samples	Comments
Plume Mapping (ADCP)				
Cross-channel transect 300 ft up current[a]	Turbidity[b]	full depth	na	ADCP transects will map extent and movement of the plume and locate plume max (centroid).
Cross-channel transect 100 ft down current	Turbidity[b]	full depth	na	
Cross-channel transect 300 ft down current	Turbidity[b]	full depth	na	
Cross-channel transect 500 ft down current	Turbidity[b]	full depth	na	
Cross-channel transect 1000 ft down current	Turbidity[b]	full depth	na	
Longitudinal transects as needed	Turbidity[b]	full depth	na	
Additional transects as time allows	Turbidity[b]	full depth	na	
CTD/Turbidity Vertical Profiles / TSS Sampling				
Plume Centroid Station	C, T, DO, Turbidity[c], TSS	3 depths[d]	3	Add 5% dup sample for QC. Exceedance protocol: 25 NTU above background outside of channel (<25ft).
Lateral extent Stations (2)	C, T, DO, Turbidity[c], TSS	3 depths[d]	6	
Plume down current Station	C, T, DO, Turbidity[c], TSS	3 depths[d]	3	
Reference Stations (3) ≥1000 ft up current and/or ≥1500 ft down current	C, T, DO, Turbidity[c], TSS	3 depths[d]	3	
Ship Stations (up to 3)	C, T, DO, Turbidity[c], TSS	3 depths[d]	9	Optional

[a] During high and low slack the current direction referred to here is the current direction as it was before slack since that current will have put the plume on the leeward side of the dredge where it will remain during slack until the tide turns significantly.
[b] Acoustic backscatter.
[c] Optical backscatter (NTU).
[d] Near-bottom, near-surface, and at the depth of maximum turbidity, or if the turbidity maximum is near-bottom or near-surface then at mid-depth.

Passing Ship Samples (Task 3C, Option)

Additional TSS samples, up to three, will be collected as an option if it is noted that a ship has passed through the collection area during monitoring. These samples will be located outside any dredged material plume present at the time, as determined in the field from additional ADCP transects. The ship wake samples will be collected to provide a measure of the impact of large vessel disturbance on the harbor baseline turbidity in the project area. The samples will capture three water column depths (bottom, mid-depth, and surface). The type/name of ship, date, weather, time of day, tidal condition, and location of the samples in relation to the dredging operation will be noted. The contractor will promptly notify Mr. Keegan and Ms. Rogers if this option has been undertaken.

1.3.4 Disposal Operation Monitoring: Mystic River CAD Cell (Task 4)

Mystic River CAD Cell (Task 4A&B)

Disposal monitoring will take place during five disposal events for the CAD cell located in the Mystic River (Figure 3). One monitoring event will occur during the first week of disposal into the cell, two monitoring events when the cell has been filled to at least 50% of design capacity, and two monitoring events when the CAD cell is filled to within 90% of design capacity. Ms. Rogers will monitor the progress of dredging operations and will notify the Battelle project manager when to initiate monitoring. Disposal into CAD cells will occur only during the three slack tide hours, defined for this activity as the time from one hour before to two hours after the predicted Boston time.

Each CAD cell disposal event monitoring will be conducted as follows (summarized in Table 2). Prior to beginning of sampling, the field team will use the ADCP to confirm the current direction and speed at the CAD cell including any water column shear. Reference stations will be profiled and sampled (mid-depth and near-bottom) 1000 ft up current and 1500 ft down current of the CAD cell. The data from two reference samples at each location will be averaged for comparison to the monitoring samples.

If multiple disposal events occur during any one slack tide event, the timing of the plume sample shall be measured from the last disposal event in order to capture any cumulative effects resulting from disposal activities. At the time of disposal, a drogues or drogues may be deployed to aid in tracking the leading edge of the plume. While the densest portion of the plume crosses 500 feet down current of the CAD cell boundary, based on ADCP measurements, CTD/Turbidity vertical profiles and whole water samples for TSS analysis will be collected at three stations along the 500 ft line. At each station samples will be collected at two depths:

1) within approximately three feet of the bottom,
2) at the depth of maximum turbidity, or if the turbidity maximum is near-bottom then at mid-depth.

Water current direction and the time the plume crosses 500 feet after the disposal event will be recorded. Cross-channel transects will be conducted with the ADCP at locations 300 feet up current of the CAD cell boundary and 500 and 1000 feet down current of the CAD cell boundary. Additional cross-channel and longitudinal transects may be performed as time allows to better determine the plume extent and trajectory/dissipation. Those transects located up current of the 500 foot line may be performed before the leading edge of the plume crosses the 500 foot line if time allows, based on ADCP measurements and drogue observations, but once the plume nears the 500 foot transect the vessel will monitor that location to sample when the densest portion of the plume arrives.

Any monitoring which indicates that the dredge plume is greater than 50 NTU's above background at 500 feet down current of the CAD cell boundary or has migrated to areas outside the navigation channel in water depths of less than 25 feet MLLW at turbidity levels of 25 NTU's above background or greater will initiate the Exceedance Protocol (Section 1.3.5) and will be reported immediately to the Corps Project Manager Mr. Michael Keegan (978-318-8087) and/or Ms. Catherine Rogers (978-318-8231), as a warning of potential dredging related water quality impacts.

On completion of the plume tracking and sampling for the monitoring event the drifting drogues will be recovered.

Table 2. Disposal Plume Monitoring Sampling During Each Disposal Event (5 Events for the Mystic River CAD cell).

Transect/Station	Parameters	Depth	Number of Water Samples	Comments
Plume Mapping (ADCP)				
Transverse transect 300 ft up current	Turbidity[a]	full depth	na	ADCP transects will map extent of plume, track plume advance to 500 ft line, and locate plume max density.
Transverse transect 500 ft down current	Turbidity[a]	full depth	na	
Transverse transect 1000 ft down current	Turbidity[a]	full depth	na	
Additional transects as time allows	Turbidity[a]	full depth	na	
Vertical Profiles / TSS Sampling				
500 ft down current (3)	C, T, DO, Turbidity[b], TSS	2 depths [c]	6	Add 5% dup sample for QC. Exceedance protocol: 50 NTU above background 500 ft down current or >25 NTU in <25ft depth.
Reference Stations (2) 1000 ft up current and 1500 ft down current	C, T, DO, Turbidity[b], TSS	2 depths [c]	4	
Ship Stations (up to 3)	C, T, DO, Turbidity[b], TSS	2 depths [c]	6	Optional

[a] From acoustic backscatter (db).
[b] From optical backscatter (NTU).
[c] Near-bottom and at the depth of maximum turbidity, or if the turbidity maximum is near-bottom then at mid-depth.

Passing Ship Samples (Task 4C, Option)

Additional TSS reference samples, up to three, will be collected as an option if it is noted that a ship has passed through the collection area during monitoring. Location of these samples will be determined in the field based on additional ADCP transects. The reference samples will capture the two depths of the water column (bottom and mid-depth). The reference samples will be collected to capture the impact of ship disturbance on turbidity in the water column in the project area. The type/name of ship, date, weather, time of day, tidal condition, and location of the reference samples in relation to the dredging operation will be noted. The contractor will promptly notify Mr. Keegan and Ms. Rogers if this option has been undertaken.

Main Ship Channel CAD Cell (Task 4D, Option)

A second CAD cell located in the Main Ship Channel may also be used for disposal operations. Except for the following exception, the same monitoring protocol will be used as described for the Mystic River CAD Cell. Instead of five monitoring events as described above, the Main Ship Channel CAD cell will be monitored on three occasions. One monitoring event will occur during the first week of disposal into the cell, another monitoring event will occur when the cell has been filled to at least 50% of design capacity, and the last monitoring events will occur when the CAD cell is filled to within 90% of design capacity.

1.3.5 Water Quality Exceedance Protocol (Task 5, *Option*)

Dredging Operation Monitoring Exceedance Protocol

The Exceedance Protocol is initiated whenever monitoring indicates that the dredge plume has migrated to areas outside the navigation channel (25 NTU's above background in less than 25 feet depth). USACE Project Manager, Mr. Michael Keegan (978-318-8087) and/or Ms. Catherine Rogers (978-318-8231) will be notified and additional plume monitoring and sampling will be performed as determined in consultation with the USACE. This would include monitoring plume activity up to the remainder of the day or until the condition has abated. Protocols will follow the same procedures as described in Section 1.3.3 above as well as additional sampling of the plume within the 25 ft MLLW contour (Table 3). In this area, CTD/Turbidity profiles and water sampling will be performed on an hourly basis until the plume has dissipated or until field operations must be terminated due to safety conditions/requirements due to loss of daylight or time spent in the field. Samples will be taken from the center of the area of the plume exhibiting the greatest intensity, down current of the plume, and two samples will be taken outside of the lateral extent of the plume for use as reference samples. The samples will be taken at three depths:

1) within approximately three feet of the bottom,
2) approximately one foot below the surface, and
3) at the depth of maximum turbidity, or if the turbidity maximum is near-bottom or near-surface then at mid-depth.

ADCP transects will be performed to monitor plume extent, movement, and dissipation. If exceedances continue through the sampling period then the field team will return to next day or as soon as possible to monitor any plumes or residual conditions and take additional water samples through one tidal cycle. Battelle will communicate from the field the results of the monitoring to Mr. Keegan and/or Ms. Rogers for use in determining what operational changes may be warranted, if any, to abate the condition.

Table 3. Dredging Operation Monitoring Exceedance Protocol Sampling Outside the Navigation Channel (Every Hour Until Plume Dissipates).

Transect/Station	Parameters	Depth	Number of Water Samples	Comments
Plume Mapping (ADCP)				
Continuous Transverse and Longitudinal transects as necessary	Turbidity[a]	Full depth	na	ADCP transects will map extent of the plume and locate plume max (centroid).
Hourly Vertical Profiles / TSS Sampling				
Plume Centroid Station	C, T, DO, Turbidity[b], TSS	3 depths[c]	3	Hourly.
Lateral Extent Stations (2)	C, T, DO, Turbidity[b], TSS	3 depths[c]	6	
Plume down current Station	C, T, DO, Turbidity[b], TSS	3 depths[c]	3	

[a] Acoustic backscatter.
[b] Optical backscatter (NTU).
[c] Near-bottom, near-surface, and at the depth of maximum turbidity, or if the turbidity maximum is near-bottom or near-surface then at mid-depth.

Disposal Operation Monitoring Exceedance Protocol

The Exceedance Protocol is initiated whenever monitoring indicates that the disposal plume is greater than 50 NTU's above background at 500 ft down current of the CAD cell boundary or the plume has migrated to areas outside the navigation channel (25 NTU's above background in less than 25 feet depth). USACE Project Manager, Mr. Michael Keegan (978-318-8087) and/or Ms. Catherine Rogers (978-318-8231) will be notified and additional plume monitoring and sampling will be performed as determined in consultation with the USACE. This would include continuing to monitor the plume in the channel to monitor the extent of its migration and/or monitoring the plume within the 25 ft MLLW contour. Protocols will follow the same procedures as described in Section 1.3.4 above for in-channel monitoring as directed by the USACE. To monitor and sample the plume within the 25 ft MLLW contour, CTD/Turbidity profiles and water sampling will be performed on an hourly basis until the plume has dissipated or until field operations must be terminated due to safety conditions/requirements due to loss of daylight or time spent in the field. Two stations will be sampled from the center of the area of the plume exhibiting the greatest intensity and two stations will be sampled outside of the lateral extent of the plume for use as reference samples (Table 4). The samples will be taken at two depths the results of which will be vertically averaged:

1) within approximately three feet of the bottom,
2) at the depth of maximum turbidity, or if the turbidity maximum is near-bottom then at mid-depth.

ADCP transects will be performed to monitor plume extent, movement, and dissipation. Battelle will communicate from the field the results of the monitoring to Mr. Keegan and/or Ms. Rogers for use in determining what operational changes may be warranted, if any, to abate the condition.

Table 4. Disposal Operation Monitoring Exceedance Protocol Sampling Outside the Navigation Channel (Every Hour Until Plume Dissipates).

Transect/Station	Parameters	Depth	Number of Water Samples	Comments
Plume Mapping (ADCP)				
Continuous Transverse and Longitudinal transects as necessary	Turbidity[a]	full depth	na	ADCP transects will map extent of the plume and locate plume max (centroid).
Hourly Vertical Profiles / TSS Sampling				
Plume Centroid Stations (2)	C, T, DO, Turbidity[b], TSS	2 depths[c]	4	Hourly.
Lateral Extent Stations (2)	C, T, DO, Turbidity[b], TSS	2 depths[c]	4	

[a] Acoustic backscatter.
[b] Optical backscatter (NTU).
[c] Near-bottom and at the depth of maximum turbidity, or if the turbidity maximum is near-bottom then at mid-depth.

1.3.6 Work Boat and Navigation

Battelle will be responsible for providing the workboat with a licensed captain for water quality monitoring in Boston Harbor. They will adhere to the applicable health and safety measures found in the Corps of Engineers (COE) EM 385-1-1, Safety and Health Requirements Manual (USACE 1996) and the project Accident Prevention Plan (APP).

Plume monitoring operations will be conducted from the 45 ft survey vessel R/V Aquamonitor (or equal counterpart), equipped with a stern-mounted A-frame for deployment of water quality instrumentation. Battelle will provide a qualified differential Global Positioning System operator to position the workboat. Sampling stations will be determined by dGPS with accuracy of ±2 meter. Water depths will be determined using the bottom tracking of the ADCP with an accuracy of 2%. Calibration checks of the GPS will be conducted daily and documented. Survey locations will vary depending on the location of the dredging platform, tidal stage, and location of plume. The actual sampling location coordinates will be recorded by Battelle in the field using NavSam©.

1.3.7 Sample Handling and Custody

Whole water samples will be collected from Rosette sampling bottles into 1L containers. Sample containers and preservation conditions are defined in Table 5. Containers will be affixed with labels generated by NavSam© shipboard navigation and data collection software. For details see Section 5.1. Samples will be placed in coolers on ice immediately upon collection. Coolers will include a temperature blank (sample bottle filled with tap water when the cooler is first prepped).

Procedure for decontaminating sampling equipment for TSS sampling requires only that sample bottles be rinsed three times with Rosette sampling bottle water before filling the 1-L sample bottles.

All samples will be delivered to Alpha Analytical for TSS analysis. Samples will be transported to Battelle Duxbury laboratory at the end of each day in the field. Custody forms for each cooler will be placed in a plastic bag and taped to the inner lid of the cooler. Coolers will be taped shut. Coolers will be delivered to the Battelle laboratory sample custodian, Jeanine Seyfert. The sample custodian will ship samples to Alpha Analytical at the end of each sampling event but if a sampling event is protracted by weather or other delays, samples will not be stored at Battelle for more than 2 days. Sample shipment to Alpha Analytical will follow Battelle SOP 5-210 Packaging and Shipping of Samples.

Table 5. Sample Volumes, Containers, and Processing for Field Samples.

Parameters	Sample Volume	Sample Container	Preservation	Storage Condition	Holding Time[a]
TSS	1L	HDPE Bottle	Ice	4 ± 2 ° C	7 Days

[a] Holding time from collection to initial Lab preparation.

1.4 TSS Analysis

The 279 water samples (plus optional samples) from Boston Harbor plume tracking will be analyzed by Alpha Analytical Laboratory for the total suspended solids. TSS will be measured using EPA method 160.2. A well-mixed sample will be filtered through a standard GF/F glass fiber filter and the residual retained on the filter will be dried and weighed. For each batch of 20 or fewer samples, a laboratory method blank, duplicate, and SRM will be processed and analyzed with the field samples. Acceptance criteria are defined in Table 8. Results will be reported on a dry-weight basis, and will be used to verify the field measurements of turbidity.

1.5 Project Reporting (Task 6)

1.5.1 Monitoring Data

A written data summary will be developed within two days of completing each monitoring event. The data summary will include:

- summary tables and figures of ADCP transects, CTD/Turbidity profiles, and TSS sampling
- example raw ADCP data figures (not geospatially referenced),
- example raw OBS vertical profiles (in NTUs).

TSS data will subsequently be provided within one week after the laboratory results are available.

1.5.2 Field Report

A field report (3 hardcopies plus electronic) will be prepared for each dredging and disposal event measured within a two week period.

1.5.3 Final Report

A draft report (3 copies) will be provided to the USACE for review within three weeks of all dredging monitoring activities have been completed and another draft report (3 copies) within three weeks once all disposal monitoring activities have been completed. The final report (10 copies) will be prepared within two weeks of USACE comments of both draft reports and include the results from both the dredging and disposal monitoring. In addition to “hard copies” of both the draft and final reports, the contractor will also provide the reports electronically in Microsoft Office format (Word, Excel).

The draft and final reports will include at a minimum:

- a cover page,
- a table of contents,
- a description of the monitoring and methods used and purpose, including dates, tidal conditions, weather, other notable ship/harbor activities,
- figures showing the location of the dredge and disposal operations, location of the monitoring with respect to the navigation channel and winter flounder spawning habitat, and plan and cross-section views of the plume at the specified depths,
- results of the turbidity and TSS monitoring, including summary tables,
- discussion of results relative to any exceedence criteria,
- and a conclusion.

2. PROJECT ORGANIZATION, RESPONSIBILITIES, AND COMMUNICATION

2.1 Project Organization and Responsibilities

Ms. Tracy Stenner is Battelle's Program Manager for the current USACE NAE contract. Mr. Paul Dragos will be the project manager on this delivery order. Mr. Dragos will be the primary contact with the NAE Project Manager and will ensure that the objectives of the task order are met within budget and on schedule, and will be responsible for overall quality and conduct of the work. Mr. Matt Fitzpatrick will be the chief scientist in charge of all field operations. Ms. Rosanna Buhl will serve as Battelle's Quality Assurance (QA) Officer, and will be responsible for identifying areas for corrective action, coordinating the QA activities such as systems and data audits, and preparing reports to management for this delivery order. Table 6 lists the names, addresses, and telephone numbers of key personnel.

Table 6. Project Personnel Responsibilities, Addresses, and Telephone Numbers.

Responsibility	Project Personnel			Address
	Contact	QA Officer	Sample Custodian	
USACE				
Corps Project Manager	Mike Keegan	NA	NA	U.S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742-2751 978-318-8087 (M. Keegan) 978-318-8231 (C. Rogers) 978-318-8229 (T. Rezendes)
Corps Environmental Monitoring Manager	Catherine Rogers	NA	NA	
Corps Construction Supervisor Timothy Rezendes	Timothy Rezendes	NA	NA	
Battelle				
Battelle Duxbury Program Manager	Tracy Stenner	Rosanna Buhl	NA	Battelle Duxbury Operations 397 Washington Street Duxbury, MA 02332 (781) 952-5309 (R. Buhl) (781) 952-5357 (P Dragos) (781) 952-5351 (M. Fitzpatrick) (614) 424-4302 (B. Himmelsbach) (781) 952-5270 (J. Seyfert) (781) 952-5389 (T. Stenner) (508) 524-1168 Field Cell Phone (Fitzpatrick) or (617) 968-1812 Aquamonitor cell phone
Battelle Duxbury Project Manager	Paul Dragos	Rosanna Buhl	NA	
Task 1 – Sampling and Analysis Plan	Paul Dragos	Rosanna Buhl	NA	
Task 2 – Accident Prevention Plan	Paul Dragos	Bernie Himmelsbach	NA	
Tasks 3&4 – Monitoring and TSS Sampling	Matt Fitzpatrick	Rosanna Buhl	Jeannine Seyfert	
Tasks 5 – Optional Sampling	Matt Fitzpatrick	Rosanna Buhl	Jeannine Seyfert	
Task 6 –Reporting	Paul Dragos	Rosanna Buhl	NA	
Alpha Analytical				
Task 3&4 plus optional tasks – TSS Analysis	Nickolas Corso	Jim Todaro	Kim Baley	8 Walkup Drive Westborough, MA 01581 (508) 898-9220

TSS analyses will be performed by Alpha Analytical Laboratory in Mansfield, MA and Mr. Nickolas Corso will be the primary contact.

2.2 Communication

2.2.1 Internal Communication

The Battelle project manager will hold a kickoff meeting for the project team prior to initiation of field and analytical work. The SAP will be distributed prior to this meeting for review by the project team and will be reviewed at the kickoff meeting. The Battelle Team members will be responsible for communicating to the project manager any and all problems (or potential problems) encountered during each phase of a project, and for keeping him/her appraised of the hours being expended (versus budgeted hours) and the progress of the results relative to the due dates.

All field operations will be coordinated by the chief scientist, Matt Fitzpatrick, who will be in daily contact with the Battelle project manager. He will have the authority to make all field decisions, except as pertains to ship operations and safety where the vessel captain has sole authority, and will ensure all activities are completed as required. In the event that an Exceedance Protocol is initiated, the chief scientist will immediately communicate directly with the Corps Project Manager and keep the Battelle project manager apprised of the situation.

2.2.2 Communication with NAE

Mr. Dragos will be responsible for communicating with the NAE project manager on all issues relating to schedule, budget, and data being generated. Mr. Dragos will communicate by phone or email on a daily basis during field and laboratory activities. He will also prepare a formal monthly progress report, which will detail, by task, any problems encountered and corrective actions taken, along with a schedule of deliverables noting proposed and actual delivery dates.

2.2.3 Communication in the Field

Activities in the field will be coordinated with onsite Corps staff and the dredge operators through the Corps Construction Supervisor Timothy Rezendes. Mr. Rezendes or his designate will be the point-of-contact in the field who will keep the Battelle field team informed as to dredging operations including the duration of dredging operations, expected dredging activities for the survey day, and ETA of disposal barges at the CAD cells.

3. SCHEDULE OF MILESTONES AND DELIVERABLES

Table 7 summarizes the schedule of field and laboratory activities as well as planned finish dates. Most tasks depend on the schedule of harbor dredging activities and so remain to be determined. However, the following items are important to be aware of during this project:

- The first disposal monitoring event at the Mystic River CAD cell (1 day) will be performed consecutively with the first dredging monitoring survey (2 days). One mobilization is planned for both sampling events;
- At least 1 week notice from the Corps prior to sampling in the field will be required for all dredging and disposal monitoring activities;

- Two tidal cycle surveys during dredging monitoring for the Lower Harbor area will be performed (weather permitting) on 2 consecutive days requiring one mobilization;
- Two disposal monitoring events each for 50% or 90% monitoring at the Mystic River CAD Cell will be performed (weather permitting) on 2 consecutive days requiring one mobilization each;
- If a standby day occurs, due to weather, dredge breakdown, or other contingencies, the project manager and/or field chief scientist will immediately contact the Corps to consider options.

Table 7. Estimated Project Schedule.

Description	Planned Start	Planned Finish
Notice to proceed	3/21/2008	NA
Task 1-Sampling and Analysis Plan	4/1/2008	5/30/2008
Task 2-Accident Prevention Plan	4/1/2008	4/28/2008
Task 3A&B-Dredging Operations	TBD	TBD
Task 4A&B-Disposal Operations	TBD	TBD
Task 6-Reporting the Data		
Monitoring Data	end each monitoring event	+ 2 days
Field Report	end each monitoring event	+ 2 weeks
Final Dredging Report	end of all dredging monitoring	+ 3 weeks
Final Disposal Report	end of all disposal monitoring	+ 3 weeks
Final Report	receipt of Corps comments	+ 2 weeks

4. QUALITY ASSURANCE AND QUALITY CONTROL

All field activities used during in situ turbidity and hydrographic measurements and in the collection and analysis of water column samples for physical testing will follow approved Battelle SOPs, will reference approved agency methods, or are detailed in this SAP.

4.1 Data Quality Objectives

Data will be examined in terms of precision, accuracy, completeness, comparability, and representativeness to ensure that all data generated during the conduct of survey, analyses, and reporting are of the highest quality.

- Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms.
- Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations.

- Completeness is the amount of data collected as compared to the amount needed to ensure that the uncertainty or error is within acceptable limits.
- Comparability is a measure of the confidence with which one data set can be compared to another.
- Representativeness is the degree to which data accurately and precisely represent a characteristic of a population.

The application of these data quality measures is described below.

4.1.1 Precision and Accuracy

Manufacturer precision and accuracy objectives for navigation, turbidity, and hydrographic sampling are presented in Table 8. In addition, the laboratory QC acceptance criteria are defined. If QC samples do not meet the acceptance criteria, the data will be submitted to Mr. Paul Dragos for review and assessment of the potential impact of the results. Affected samples may be reanalyzed at his discretion. Data accepted outside these criteria will be flagged with the appropriate data qualifier, and the rationale for accepting the analysis will be thoroughly documented. Sections 1.3.3 to 1.3.5 provide details on sampling procedures established to ensure data quality. Section 4.3 contains instrument calibration methods and specifications.

Table 8. Accuracy and Precision of Instrument Sensors

Sensor	Model/Method	Units	Range	Accuracy	Precision
Navigational and Hydrographic Data					
Pressure	SeaBird SBE-29	decibars	0 to 1000	0.1%	0.1
Temperature	SeaBird SBE-3	ºC	-5 to +35	0.001	0.01
Conductivity	SeaBird SBE-4	mS/cm	0 to 70	0.03	0.01
Dissolved oxygen	SeaBird SBE-43	mg L^{-1}	0 to 20	0.10	0.05
OBS	SeaPoint Turbidity Meter	NTU	0 to 25	5%	2%
			0 to 125	5%	2%
			0 to 500	5%	2%
ADCP	RDI Workhorse 1200khz	Current velocity (cm/s)	0 to 500	±0.3% of ship speed ±0.3cm/s	0.1cm/s
		Backscatter (decibels)	0 to 80	1%	±1.5dB
		Depth, measurement and bottom (m)	0 to 20	2%	0.5m (bin size)
Nephelometer (bench)	2100P IS Portable Turbidimeter	NTU	0 to 1000	.01	
Fathometer	Furuno 943	ft	0 to 200	6.6	0.3
Navigation	North Star 952XDW (WAAS Capable)	degree	World	2 m	2 m
Analytical Data					
Total Suspended Solids	EPA 160.2	mg/L	NA	85 – 115 %	< 5%
	Method Blank (1 per batch of 20)	mg/L	RL	1 mg/L	NA
	Laboratory Duplicates (1 per batch of 20)	Relative Percent Difference	NA	NA	< 5%
	Standard reference material - 2 concentration levels (1 per batch of 20)	Percent Difference	NA	85 – 115%	NA

4.1.2 Completeness

Because in situ turbidity and hydrographic data are acquired electronically and monitored in real time, no loss of data is expected. With the sampling rates of the CTD (4 Hz), ADCP (1 Hz) and navigation systems (1 Hz), sufficient data will be acquired to locate and track any dredged material plumes. Plume tracking activities will not continue if CTD measurements, ADCP measurements or navigation coordinates cannot be obtained. If instrument malfunctions occur and operations are modified or suspended during any survey day, a decision on modification of activities for that survey will be made with consultation and agreement of USACE, whenever possible.

The completeness goal for TSS samples is 100%. If any samples are lost after collection due to breakage or equipment malfunction the station will be resampled if possible. If that is not possible, the loss will be documented and corrective actions taken as necessary.

4.1.3 Comparability

The electronic instruments that will be used during the surveys are similar to the instruments that are routinely used in marine monitoring programs throughout the U.S. To improve the representativeness of the electronic OBS and ADCP plume data, the electronic data will be quantitatively compared and post-calibrated using the laboratory derived TSS data.

4.1.4 Representativeness

The representativeness of the sampling program design is establish in the SOW which details the plume sampling procedures. Representativeness will also be ensured by proper handling, storage, and analysis of calibration samples so that the materials analyzed reflect the collected material. Deviations from the data collection procedures described in this SAP will be documented in the survey logbook and described in the survey report.

4.2 Sample Custody

Electronic Data

Field documentation forms are provided as Attachments and include a Field Log Form (Attachment 1) used to track electronically captured data. Field custody of electronic data including all navigation, CTD, Dissolved Oxygen, ADCP acoustic backscatter, and optical backscatter turbidity data will be the responsibility of the survey chief scientist. The field custody of the electronic data consists of creating compact disc backups of all electronic data generated each day. The label on the backup media will include a survey ID (described in Section 5.1), date, name of person creating the backup files, and a disk number. The data will be transferred to Battelle's physical oceanographic analysis system (described in Section 5.3) upon completion of the survey. The Field Manager or his designee maintains the disks until the annual archive cycle.

Water Samples

Section 1.3.7 describes sample handling, packaging, and shipping procedures. Custody of samples will follow Battelle SOP 6-010 Sample Receipt, Custody, and Handling. Custody forms will accompany all samples from the field to the laboratory (Attachment 3). Documentation of sample integrity and temperature will be completed upon receipt at the laboratory.

Trained laboratory sample custodians are designated at Battelle and Alpha Analytical laboratories.

- Upon receipt, samples are inspected to verify that (1) integrity is intact (containers are sealed and intact), (2) the sample label and custody forms agree, (3) all shipped samples have been received, and (4) holding temperatures were maintained.
- Sample receipt and the receipt conditions are documented, as are any discrepancies, which are also communicated to the project manager immediately.
- Samples are stored in a limited access area.
- Sample receipt and holding times are communicated to the laboratory manager who adds the samples to the laboratory schedule. Samples will be analyzed upon receipt.
- The sample custodian retains custody of the samples until they are transferred from the holding location to the laboratory for analysis. The relinquishing of samples by the custodian and the receipt of sample by the analyst are documented.
- Internal laboratory documentation tracks sample custody location and storage conditions throughout processing and analysis.

4.3 Calibration and Maintenance Procedures

4.3.1 Navigation System

To verify calibration of the DGPS system, a surveyed location of known coordinates is chosen. At this location, actual coordinates are recorded into the DGPS system to ensure that DGPS read-out is accurate to within 2 m of known location. The calibration of the DGPS system is verified each morning during the survey and documented in the survey logbook. The operation, maintenance, and calibration of the DGPS system is described in SOP 3-118.

4.3.2 Fathometer

To verify calibration of the fathometer, a weighted measuring tape will be deployed over the side of the survey vessel while the vessel is docked. The difference between the fathometer reading and the reading from the weighted measure will be documented on the Field Log Form (Attachment 1). Additionally, the difference between the fathometer and the weighted tape can be used as an offset in the NavSam© software. The operation of the fathometer will be verified at the beginning and end of the survey and documented in the survey logbook. The operation, maintenance, and calibration of the fathometer is described in SOP 3-129.

4.3.3 Acoustic Doppler Current Profiler

The ADCP transducers and electronics are designed to maintain their calibration for current velocity. Standard methods for ADCPs require no recalibration once the ADCP has been calibrated by the manufacturer unless the instrument is damaged. Turbidity as measured by the acoustic backscatter of the ADCP will be calibrated against whole water samples analyzed for TSS.

To ensure that the ADCP is maintained in good working order, a series of bench checks are performed before each field deployment. With the instrument transducer face immersed in water, an instrument software self test is run that tests the signal path of all major signal processing subsystems. The instrument compass, pitch, and roll sensors readings are a checked as the instrument is rotated and tilted. The transducer heads are tested to verify the transducer beam is operational. Pre-survey testing records will be maintained in the instrument files. The operation of the ADCP will be verified at the beginning of the monitoring event and documented in the survey logbook.

4.3.4 CTD/Turbidity

Maintenance methods for the SBE-25 CTD are detailed in Battelle SOP 5-275-02: At-Sea Collection of Hydrographic Data Using CTD and Rosette System. Calibration and maintenance methods for the modular sensors interfaced to the SBE-25 (i.e., Temperature, Pressure, Conductivity, DO and OBS) are described below.

Pressure (Depth) Sensor

At the beginning of each day of each survey, the offset of the SeaBird SBE-29 CTD depth sensor is set to read zero meters when the sensor is on deck to correct for atmospheric pressure variations and any instrument calibration change. The offset is entered into the equipment setup file. After the correction is made, the readings are checked again and should be with ± 0.1 m; this testing is documented in the survey logbook. Although the readings are not recorded, the day-to-day drift is ± 0.2 m for the normal range of atmospheric pressure.

Temperature and Conductivity

The gain and offset of the SeaBird SBE-4 temperature and SeaBird SBE-4 conductivity sensors are calibrated annually at the factory. The factory calibration settings are not changed by Battelle. A review of the calibration coefficients for the CTDs shows that they are quite stable from year to year. Based on the annual calibrations of the Seabird CTD, calibration drifts are approximately 0.018º C for temperature, 0.042 mS/m for conductivity, 0.055 PSU for salinity, and 0.046 for sigma-t per year.

In Situ Dissolved Oxygen

The gain and offset of the dissolved oxygen sensors will be calibrated annually at SeaBird. In addition, since the DO sensors are used frequently in Battelle field programs, the calibration settings may be changed using results of Winkler titrations. The operation, maintenance, and calibration of the SBE-43 dissolved oxygen sensor are detail in Battelle SOP 3-180-1: Seabird Electronics Model 43 Dissolved Oxygen Sensor.

Optical backscatter sensor

The SeaPoint Turbidity sensors will be bench calibrated at the factory prior to their use in the field. Calibration will follow the procedures outlined by the manufacturer using a traceable turbidity standard. To maintain the instrument, after each deployment the optical surface on the tip of the probe will be inspected for fouling and cleaned. The operation, maintenance, and calibration of the turbidity sensor is described in SOP 3-162: Use of the Seapoint Turbidity Meter.

4.3.5 Laboratory Instruments

Alpha Analytical will calibrate and maintain the equipment used for TSS analysis (analytical balance and drying oven) according to the manufacture's instructions and the laboratory's quality assurance manual.

4.4 Quality Assurance Performance Audits, System Audits, and Frequency

Quality assurance audits refer to the formal assessment of conformance to the QA Program and its effectiveness. During an audit, the agreement with QA policy documents (e.g., SOPs) is evaluated, deficiencies are identified, and corrective action is taken. Ideally, audits also serve to increase awareness and understanding of QA policies and procedures.

A technical systems audit (TSA) will be performed during review of the project SAP (this document) to verify that field and activities, facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and report procedures are in place and adequate to support the project.

Data audits or reviews will be conducted for analytical data within the organization responsible for collecting the data. These audits will reconstruct representative data from each sample based on sample processing records and the final reported data. Samples will be tracked from receipt and processing through analysis and reporting to ensure that the reported data are accurate, complete, and traceable. Each laboratory deliverable must include a QA/QC narrative that summarizes sample processing and any deviations, including QC failures. Data reports submitted by Battelle or contracted laboratories will be reviewed by the Battelle project manager and QA Officer prior to delivery to USACE-NAE.

4.5 Corrective Actions

This SAP defines requirements for field survey activities. Any modifications or changes to the planned activities are deviations and must be approved by the Project Manager. Changes anticipated prior to field work must be reported to the Project Manager ahead of time. The Project Manager will assess the potential impact and contact the client if prior approval is needed. If circumstances in the field require deviations from the SAP the Project Manager must be contacted as soon as it is safe to do so. All deviations must be documented as such in the field Logbook and approved by Project Manager at the end of the survey. The Log should indicate the date that the Project Manager was contacted from the field and any resulting verbal approval. The documentation should include a description of the deviation and the reason, an assessment of impact that the deviation has on the study design and data quality, and any corrective action implemented. A discussion of deviations will be included in the final report.

5. DATA MANAGEMENT

The goal of Battelle's data management procedures for the Boston Harbor Inner Harbor Maintenance Dredging Project is to ensure all electronic data, physical samples, and their associated results are linked uniquely in a traceable fashion. Battelle staff responsible for sample collection will implement systematic, documented, quality control procedures to ensure that project data are traceable and validated, starting with field collection and analysis through report production.

5.1 Data Recording

Field documentation forms for water samples include a Sample Data Collection Form (Attachment 2) and a Chain of Custody Form (Attachment 3). A field logbook will also be used to document field-sampling activities (Section 5.1). Custody of samples will follow Battelle SOP 6-010 Sample Receipt, Custody, and Handling. Documentation of sample integrity and temperature will be completed upon receipt at the laboratory.

Each sample collected in the field (i.e., discrete water samples for TSS analysis) will be automatically assigned a unique Sample ID by the shipboard sample collection software NavSam©. The Sample ID is a unique eight character string which is a concatenation of a five character Survey ID (called Event ID in the NavSam© application) and a three-character hexadecimal number (Sample Marker). The Sample ID will identify the water collected in the Rosette sampling bottles from a certain depth during a particular station on the specified survey. The five character Survey ID will be unique to each monitoring event (Table 9). The Sample_Marker is a non-repeating (within a survey) number generated by the NavSam© software during the closing of a Rosette sampling bottles at one depth. NavSam© will record electronically the related sampling data (date, time, location, depth, collector, etc.) at the same time it closes a sampling bottle. Water samples will be labeled with waterproof, adhesive-back labels which are generated by NavSam©. Data from electronic sensors including ADCP and CTD sensors are recorded digitally along with all collection data including date, time, location, and depth.

At Alpha Analytical Laboratory, samples will be logged into sample tracking systems that will assign a unique laboratory ID that will be used to track sample processing and testing.

Documentation procedures will follow SOP 6-017. All notes will be written in black ink. Corrections to hand-entered data will be initialed, dated, and justified. Corrections to electronically captured data (e.g., electronic "spikes") will be documented on a hard-copy plot of the data. Completed data forms or other types of hand-entered data will be signed and dated by the individual entering the data.

Table 9. Survey IDs for the Project Monitoring Events.

Monitoring Event	Survey ID[a]
Dredge Monitoring Lower Harbor Area	BH081
Disposal Monitoring Mystic CAD cell - Initial	BH082
Disposal Monitoring Mystic CAD cell – 50% Full	BH083
Disposal Monitoring Mystic CAD cell – 90% Full	BH084
Dredge Monitoring Main Ship Channel CAD Cap	BH085
Disposal Monitoring 2nd CAD Cell (Option)	BH086

[a] If the order of surveys changes, the Survey Ids will be assigned chronologically.

5.2 Data Validation

Data validation is the responsibility of those immediately responsible for overseeing and/or performing analyses, data entry, data reduction, and data reporting. A series of reviews by technical personnel will be implemented to ensure that the data generated for this delivery order meet the data quality objectives. Routine QC checks are performed on the data to verify the accuracy before the validation process. The QC checks will include the following activities:

- Data and related project records will be reviewed by field and laboratory personnel at the end of each working day to ensure that analytical activities are completely and adequately documented.
- All hand-entered or transcribed data will be 100% validated.
- Any calculations performed manually will be checked for accuracy. Calculations performed by software will be checked at a frequency sufficient to verify their accuracy.

The review of quality control data is a critical step in the data validation process because quality control data that are within the SAP acceptance criteria indicate that the sample processing and analysis systems are in control. The Task Leaders will be responsible for reviewing analytical results and supporting documentation. The results of QC sample analyses will be compared to pre-established criteria as a measure of data acceptability. All quality control data that do not meet the measurement quality objectives will be flagged and brought to the attention of the task leader and the project manager, who will determine the appropriate corrective action (e.g., reanalysis or data reported with qualifiers).

5.3 Data Reduction

5.3.1 Electronic Field Data

ADCP and CTD/Turbidity data generated during the survey will consist of rapidly sampled, high-resolution measurements of acoustic backscatter, optical backscatter, temperature, salinity, depth, and dissolved oxygen. All data will be electronically logged with the time and position data from the shipboard navigation system. Following the survey, processing of the electronic shipboard data will be conducted using Battelle's Matlab-based physical oceanographic analysis software. ADCP transect and CTD vertical profile data will be processed into calibrated units, edited for outliers, reduced as appropriate with temporal or spatial averaging, geo-referenced, and checked for quality.

5.3.2 Laboratory Data

Results from the TSS analysis of discrete water samples will be furnished by Alpha Analytical and delivered in Excel spreadsheet format. Data packages for analytical methods will include any of the following elements that are applicable to the analysis:

- Data package narrative or cover letter with dated signature of the laboratory manager
- Final data summary tables
- Entire package of sample custody documentation, including sample receipt form
- Sample processing records (e.g., bench sheets)
- Analytical records: TSS data

The Battelle PM will receive and review the data packages submitted by Alpha Analytical Laboratory. Data packages will be evaluated for completeness, acceptability, and compliance with the requirements of this SAP.

6. BUDGET

Budgets for the field portion of the project will be assigned separately by the field manager. Work Package numbers are presented in Table 10.

Table 10. Work Package Numbers.

Task	Work Package Number (G606444)
Dredge Monitoring	-T3
Dredge Monitoring Ship (Option)	-T3C
Disposal Monitoring	-T4
Disposal Monitoring Ship (Option)	-T4C
Disposal Monitoring 2nd CAD Cell (Option)	-T4D
Dredge Standby (Option)	-T7A
Disposal Standby (Option)	-T7B
Extra Samples (Option)	-T8

7. HEALTH AND SAFETY

The site-specific APP prepared under Task 2 will address risks associated with shipboard sampling activities on and around a dredging operation. This includes information on potential site/project-specific hazards such as man overboard situations, slipping and tripping hazards, heavy duty machinery, and chemical hazards associated with contact with dredged materials. The APP will address additional health and safety issues, providing a thorough safety resource for the field team. All field personnel involved with sampling are required to be familiar with and comply with the APP (distributed separately). The contents of the APP reflect anticipation of the types of activities to be preformed, knowledge of the physical characteristics of the site, and consideration of the preliminary chemical data from previous investigations at the site. The APP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

The Battelle Field Safety and Equipment Checklist outline site-specific safety precautions (see Attachment 4).

8. REFERENCES

Battelle, 2008 (in progress). Accident Prevention Plan. For Sampling Activities for the U.S. Army Corps of Engineers Environmental Monitoring Boston Harbor Inner Harbor (BHIH) Maintenance Dredging Boston, MA. Prepared under Contract DACW33-03-D-0004 Task Order No 0044 for the U.S. Army Corps of Engineers New England District, Concord, MA.

USACE (U.S. Army Corps of Engineers). 1996. COE EM-385-1-1. U.S. Army Corps of Engineers Safety and Health Requirements Manual.

ATTACHMENT 1

DREDGE PLUME WATER QUALITY MONIORING FIELD LOG

BATTELLE **Survey ID**: BHmmm

Duxbury Project Number: G606407 **Project Title**: Boston Harbor Dredge Plume Monitoring

DATE (mm/dd/yy): ____________ **INITIALS**: __________ **WEATHER**: ______________________

MONITORING PERIOD (hh:mm) From: ________ **To**: ________ **TIDE STAGE** HS ME LS MF

DREDGING ACTIVITY:

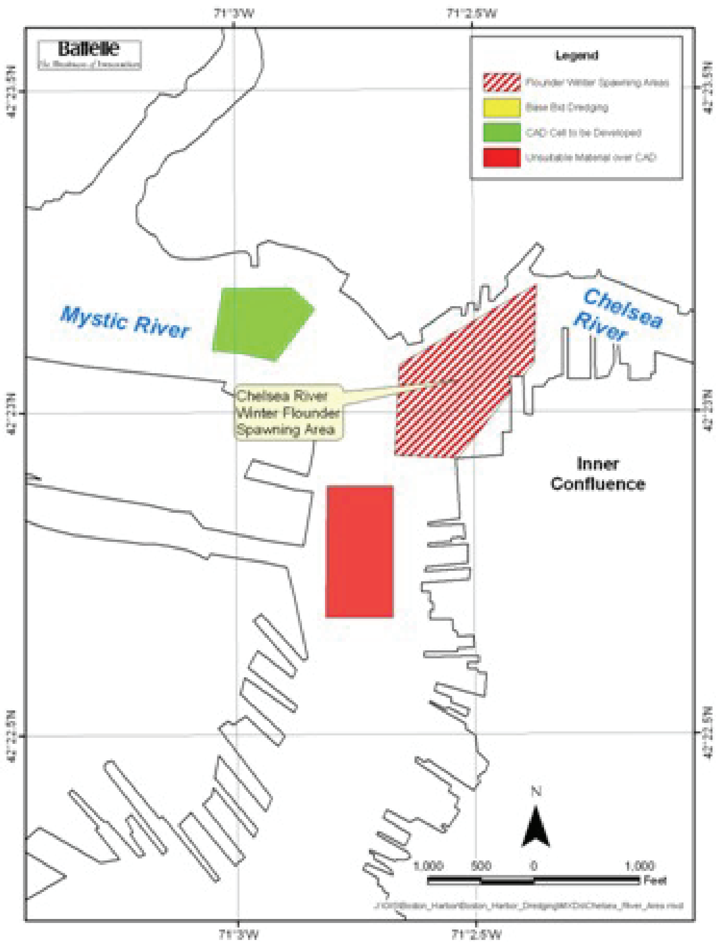
Dredging Disposal

ADCP TRANSECTS:

Map Ref	File Name/Notes
1	

CTD PROFILES:

Map Ref	Station ID/Notes
A	



FISH PASSAGE:

NOTES:

PREDICTED TIDES (stage @hh:mm) HS @ ME @ LS @ MF @

ATTACHMENT 2

STATION LOG for NAVSAM SAMPLE DATA COLLECTION

BATTELLE
Duxbury Project Number: G606407

Survey ID: BHnnnn
Project Title: Boston Harbor Dredge Plume Monitoring

STATION ID ____________
BOTTOM DEPTH (M) ____________
DATE ____________
TIME ON STATION ____________
INITIALS ____________

WEATHER OBSERVATIONS
GENERAL ____________
SEAS ____________
WIND ____________
TIDE STAGE HS ME LS MF

LEVEL ID: 0 STATION ARRIVAL
DEPTH (M)
MARKER NO
(AFFIX LABEL)

LEVEL ID: 5 NEAR-SURFACE
DEPTH (M)
MARKER NO
(AFFIX LABEL)

LEVEL ID: 5 MID-DEPTH
DEPTH (M)
MARKER NO
(AFFIX LABEL)

LEVEL ID: 5 NEAR-BOTTOM
DEPTH (M)
MARKER NO
(AFFIX LABEL)

COMMENTS
Highest Turbidity: Surface Mid Bottom

ATTACHMENT 3

Chain of Custody Form

Battelle
. . . Putting Technology To Work

Chain of Custody

Proj. No	Proj. Name

SAMPLERS: Signature

ANALYSIS REQUESTED → "NUMBER OF CONTAINERS"

DATE	TIME	BATTELLE ID	CLIENT ID	SAMPLE DESCRIPTION	PEST	PCB	TPH FINGERPRINT	PAH	VOA	TBT	METALS	OTHER	ACIDIFIED	PRESERVED	Total Number of Containers

Relinquished by:	Date/Time	Received by:	Date/Time

Relinquished by:	Date/Time	Received by:	Date/Time

Comments:

ORIGINAL

ATTACHMENT 4
Field Safety and Equipment Checklist

FIELD SAFETY AND EQUIPMENT CHECKLIST

FIELD SAFETY CHECKLIST

Date of Survey________________

Project No. __________________

Type of work:

Sample collecting	
Landbased	[ ]
Waterbased	[x]
Mooring operations	[ ]
Dive operations	[ ]
Towed sampling	[ ]
Navigation	[x]
Other:_____________	[ ]

Type of sample collected:

Water	[ ]
Sediment	[x]
Sludge	[ ]
Raw sewerage	[ ]
Dredge materials	[ ]
Living organisms	[ ]
Marine debris	[ ]
Electronic data	[ ]
Other:_____________	

	Y	N
*Do samples impose a health risk?	[x]	[ ]
If yes, what kind of hazard:		
Chemical	[x]	[ ]
Biological	[ ]	[ ]
Radioactive	[ ]	[ ]
Other _____________		
Specify Hazard:_______________		
* (or fixatives / additives used w/ samples)		
Is there a spill response plan?	[ ]	[x]
Is one necessary?	[ ]	[x]
Are immunizations necessary?	[ ]	[x]
Will electrical equipment be used by staff?	[ ]	[x]
Will electrical equipment be used on deck?	[ ]	[ ]
Will ground fault interrupt (GFI) be used?	[ ]	[ ]
Will elecrtrical equipment be checked-out before survey?	[ ]	[ ]

List type of sampling equipment to be used:
____

	Y	N
Do all members of the survey party have appropriate field experience?	[x]	[ ]
Is training necessary before the survey?	[x]	[ ]
Will there be lifting of heavy objects?	[x]	[ ]
Are all members of survey party familiar with safe lifting practices?	[x]	[ ]

Reviewed and approved

Task Leader_____________________ Date__________

Chief Scientist___________________ Date__________

Dept Manager___________________ Date__________

FIELD SAFETY EQUIPMENT CHECKLIST

Check equipment needed for survey

	Tech Staff	Lab Staff
Hard Hats**	x	
Work Vests**	x	
Life Raft		
EPIRB		
First Aid Kit	x	
Cold Weather Suits		
Safety Glasses	x	
Nitrile Gloves	x	
Tyvek Suits	x	
Radiation Detector		
Respirators		
Air Hood		
Face Shields		
Lab Coats		
Eye Wash	x	
Flash Lights		
Spill Response Kit		

** Required for surveys using vessels

Survey Party, Battelle Staff

_______________ _______________

_______________ _______________

_______________ _______________

_______________ _______________

_______________ _______________

_______________ _______________

_______________ _______________