*L*ower *D*uwamish *W*aterway *G*roup

Port of Seattle / City of Seattle / King County / The Boeing Company

QUALITY ASSURANCE PROJECT PLAN: BATHYMETRIC SURVEY OF THE LOWER DUWAMISH WATERWAY

FINAL

For submittal to

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

August 12, 2003

Prepared by: Windward environmental LLC

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TITLE AND APPROVAL PAGE
LDW BATHYMETRIC SURVEY
QUALITY ASSURANCE PROJECT PLAN

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Distribution List

This list identifies all individuals to receive a copy of the approved QA Project Plan, either in hard copy or electronic format, as well as any subsequent revisions.

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Nicholas Lesnikowski, DEA Field Operations Manager

Jon Dasler, DEA Project Manager

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Acronyms

USACE	US Army Corps of Engineers
CTD	conductivity, temperature, and depth
DEA	David Evans and Associates, Inc.
DGPS	differential global positioning system
DTM	digital terrain model
EPA	US Environmental Protection Agency
GIS	geographic information system
GPS	global positioning system
HIPS	hydrographic information processing system
HSP	Health and Safety Plan
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MLLW	mean lower low water
NAD	North American datum
NAVD	North American vertical datum
NOAA	National Oceanic and Atmospheric Administration
POS/MV	position and orientation system for marine vessels
RAID	redundant array of independent disks
RI	remedial investigation
RTK	real-time kinematic
TIFF	tagged image file format
Windward	Windward Environmental LLC
XTF	extended triton format

1.0 Introduction

This quality assurance project plan (QAPP) describes the methods and quality control for conducting a high-resolution multibeam bathymetric survey for the Lower Duwamish Waterway (LDW) study area. US Environmental Protection Agency (EPA) guidance for QAPPs was followed in the preparation of this project plan (EPA 2002). This plan is organized into the following sections:

- Section 2 – Project Management
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessment and Oversight
- Section 5 – Data Validation and Usability
- Section 6 – References

2.0 Project Management

2.1 PROJECT ORGANIZATION

The bathymetric survey will be conducted by David Evans and Associates, Inc. (DEA). Windward Environmental LLC (Windward) will be responsible for overall project coordination and for performing the administrative tasks needed to ensure timely and successful completion of the project. Windward will also be responsible for communicating with the Lower Duwamish Waterway Group (LDWG), EPA, and the Washington Department of Ecology (Ecology) on schedule, deliverables, any significant deviations from the QAPP, and administrative details. DEA will be responsible for conducting the survey and reporting deviations from the QAPP to the Windward project manager. Berit Bergquist will serve as the Windward project manager for the bathymetry survey, and can be reached as follows:

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2.2 PROJECT DESCRIPTION

The objective of the survey is to produce an accurate, up-to-date bathymetric dataset containing bank-to-bank data (where possible) for the LDW study area, as part of the Phase 2 Remedial Investigation (RI) for the LDW. Results of the survey may be used to support the following RI activities: 1) placement of additional sediment sampling locations, 2) evaluation of fish and wildlife habitat, 3) analysis of bottom substrate composition, 4) evaluation of potential sediment transport conditions, and 5) preparation for remedial options.

The primary survey area covers approximately 5 mi of the waterway from the southern tip of Harbor Island to just south of Turning Basin 3, as shown in Figure 1. An additional survey area extends from river mile (RM) 5, as shown in Figure 1, to just upstream of RM 6. The latter area will be surveyed as conditions allow.

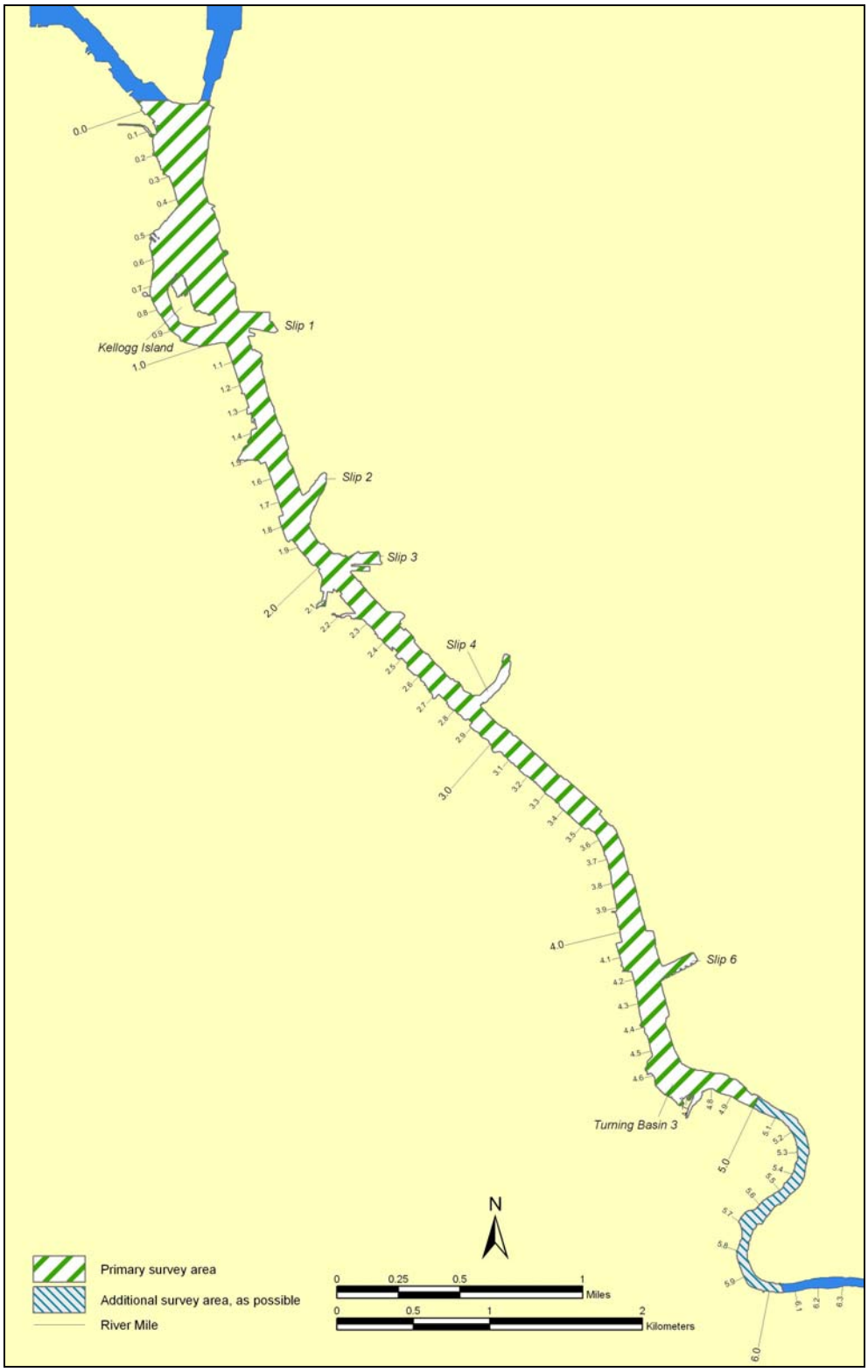

Figure 1. Coverage for bathymetric survey of the Lower Duwamish Waterway

2.3 PROBLEM DEFINITION/BACKGROUND

Bathymetry surveys of the LDW have been conducted in the past by the US Army Corps of Engineers (USACE) to determine the need for dredging for navigational purposes within the federally maintained navigation channel. Surveys were conducted approximately every other year from 1963 to 1983 between RM 2.6 and 4.0 (Windward 2003).[1] More recent bathymetric surveys have been conducted by the USACE in 1998, 2000, and 2001 in this same region (Windward 2003). In the spring of 2003, the USACE completed a survey of the entire navigation channel (up to RM 4.7). These USACE surveys were conducted using single beam methodology. Other remediation project proponents (e.g., King County and the Boeing Company) have sponsored site-specific bathymetric surveys in the vicinity of their projects. None of the existing surveys have covered the entire LDW bank-to-bank. Complete bathymetric coverage of the LDW was identified in the Phase 1 RI (Windward 2003a) and in a technical memorandum on data needs (Windward 2003b) as a data gap to be filled in the Phase 2 RI, as described in Section 2.2.

2.4 QUALITY OBJECTIVES AND CRITERIA

The data quality and targeted methods selected for this survey will be obtained using state-of-the-art equipment and technology, and will meet the data needs presented in Section 2.2. After data processing, the completeness of final data (i.e., areal coverage) will be evaluated in consultation with EPA and Ecology to determine if there are data gaps requiring alternative surveying methods. The overall data quality objective for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Parameters used to assess data quality include precision, accuracy, representativeness, comparability, completeness, and sensitivity. These data quality parameters are discussed as follows.

Precision: The measure of agreement among repeated measurements will be evaluated during data processing using the Caris® subset editor by comparing overlapping swaths. During subset editing, each individual swath can be color-coded to allow for comparison of horizontal and vertical features from swath to swath.

Accuracy: The target horizontal accuracy is 3 ft at a 95% confidence level and target vertical accuracy is +/- 0.5 ft at a 95% confidence level.[2] These accuracy levels meet the minimum performance standards for soft bottom material navigation and dredging support surveys in the USACE hydrographic surveying engineering manual (USACE 2002). Accuracy will be demonstrated in the cross-line analysis, which provides a confidence level for each sonar beam.

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[1] Dates and locations of bathymetry surveys were obtained from the USACE and compiled in Table 4-19 of the Phase 1 RI. River mile locations are as shown in Figure 1 of this QAPP.

[2] Although data are collected and processed using metric units with the hydrographic information processing system (see Section 3.4), final maps will be produced in units of feet for consistency with previous surveys in the LDW.

Representativeness: The overall degree to which the data appropriately reflect the LDW environment will be evaluated through visual analysis of the resulting sun-illuminated image to identify data anomalies or artifacts, and through comparison to prior surveys.

Comparability: Differences in data collection methodologies between earlier USACE single-beam bathymetric surveys and this multibeam survey may result in limitations in data comparisons. However, comparability should be within 0.5 ft in areas with no significant change in bottom elevation between surveys (i.e., sediment scour or deposition).

Completeness: The objective of the survey is to provide bank-to-bank coverage where the survey vessel can safely navigate. The targeted water elevation for surveying shorelines is ≥ 5 ft above MLLW. The following factors will affect the ability to collect bank-to-bank data: 1) satellite geometry (the number of satellites and their location will impact the accuracy of global positioning system [GPS] data), 2) tidal stage (increased water depth allows for increased coverage toward shore from the survey vessel), 3) obstructions along the shoreline such as docks, vessels, or pilings (which may restrict vessel operations or block sonar signals), and 4) bank slope (a long shallow bank will not be mapped as close to shore as a steep bank). It is expected that there will be data gaps that cannot be avoided, such as those caused by obstructions[3] or shallow areas. These areas will be evaluated on a case-by-case basis and an assessment will be made, in consultation with EPA and Ecology, to determine if alternative methods are required to fill data gaps.

Sensitivity: Data will not meet target vertical criteria beyond 60° on a flat bottom, so offshore survey lines will clip the starboard beams at 60° or less (depending on refraction and cross-line analysis) during processing.

2.5 SPECIAL TRAINING/CERTIFICATION

DEA personnel have specialized training and extensive experience in conducting high-resolution multibeam surveys. DEA's project manager and field operations manager are both certified hydrographers under the American Congress on Surveying and Mapping Hydrographer Certification Program. DEA's project manager is also a licensed professional Engineer and Land Surveyor in the State of Oregon. He is active in professional societies and often presents papers at hydrographic conferences. His training has included:

- An Overview of Hydrographic Surveying presented by the American Congress on Surveying and Mapping and the American Society of Photogrammetry (November, 1985 – Seattle, Washington)

[3] The Port of Seattle does not have day-to-day control over the location of ships and barges in the LDW to enable removal of these types of obstructions prior to the survey.

- Multibeam Training Course presented by the U.S. Army Corps of Engineers (March, 1996 - Mobile, Alabama)
- Hydrographic Surveying for Nautical Charting Short Course presented by Old Dominion University, Center for Coastal Physical Oceanography and the National Oceanic and Atmospheric Administration (April 1998 – Seattle, Washington)
- Coastal Oceanographic's Hypack Training
- Caris® Hydrographic Information Processing System (HIPS) (January 1999 – Portland, Oregon)

Other DEA hydrographic staff have also had training in Coastal Oceanographic's Hypack Training and Caris® HIPS.

2.6 DOCUMENTATION AND RECORDS

Multibeam bathymetric data will be presented as a series of maps that can be overlaid on hill-shade images of the bathymetric digital terrain model (DTM). Drawings will be compiled in AutoCAD® at a mutually agreed upon scale. The maps will be projected in NAD 83 Washington State Plane North (ft) and will include 2-ft contours. The multibeam hill-shade maps will represent a full coverage survey over the area imaged and will provide detail of riverbed features. Hill-shade images will be produced in color. The multibeam data will also be imported into an ASCII format for use in a geographic information system (GIS).

The following information will be provided in the project data report:

- Written report of the survey describing survey methodology, equipment, and analysis (submitted as draft and final versions)
- Field records of the Geodetic Control Survey
- Documentation of QC checks and identification of QC issues (including trackline plot with tracklines identified by name, with start time, direction of trackline, and tide data)
- Contour maps at a mutually agreed upon scale
- Hill-shade maps at same scale and layout as contour maps
- Electronic versions of data products, which will include Microsoft Word files for reports, AutoCAD® files (dwg format) of contours and imagery, Arcview shape files of contours, and georeferenced TIFF (tagged image file format) files of imagery
- ASCII files of 1-m binned data sets
- Metadata for digital data

The project data report, including ASCII files and QC information, will be provided to Windward, and subsequently to EPA and Ecology for review, in accordance with the schedule presented in Section 3.2.5.

3.0 Data Generation and Acquisition

3.1 SURVEY DESIGN

The bathymetric survey of the LDW will collect precision data in the primary survey area covering approximately 5 mi of the waterway, as shown in Figure 1. An additional survey area south of RM 5 will be surveyed as conditions allow.

The survey will be conducted using multibeam sonar, which allows for the collection of data with up to 100% coverage of the riverbed, compared to single beam methodology, which covers a single track directly below the survey vessel and allows for only partial coverage. Multibeam swaths may cover a width of up to seven times the water depth in a single pass, spaced to provide overlapping coverage. This method allows for the collection of high-resolution bathymetric data. The multibeam bathymetric data will be used to create a digital terrain model of the riverbed morphology from which hill-shade images will be generated.

Data will be collected by running several lines parallel to the shoreline. Several perpendicular crosstie lines will also be surveyed to confirm system calibration and document accuracy.

The survey will be conducted on an established coordinate system, referenced by monuments established or recovered during a geodetic control survey of the site. The horizontal datum for this survey is North American Datum of 1983 through the 1991 adjustment (NAD83/91), State Plane Coordinate System, Washington North Zone, measured in US Survey Feet. Vertical datum for this survey will be mean lower low water (MLLW).

3.2 SURVEY METHODS

This section describes the survey vessel and crew, control network, positioning, and acquisition of multibeam data. Safe working practices for conducting this survey are described in the Health and Safety Plan (HSP), attached to this document as Appendix A.

3.2.1 Survey vessel and crew

The survey vessel will be the *John B. Preston*, or equivalent, a 9-m custom aluminum survey boat owned and operated by DEA. This vessel is equipped with an integrated navigation and data acquisition system and a custom mount for the SeaBat 8101 sonar head, and is ideal for shallow-water survey operations in tight quarters. The

hydrographic survey crew will consist of a lead hydrographer and an assisting hydrographer from DEA.

3.2.2 Control network

Prior to the multibeam survey, a control network along the LDW will be established based on NAD83/91, Washington North Zone horizontal positions and MLLW elevations. As the primary vertical control for this survey will be provided by real-time kinematic (RTK) GPS observations based on this control network, it will be vital to the project to have an accurate ellipsoid separation model for on-the-fly conversion from the WGS84 ellipsoid (ellipsoid from which GPS heights are derived) to MLLW. This requires ties to existing monuments for which MLLW elevations and NAD83/91 positions are published and placement of new monuments along the project corridor.[4] In addition, the control network will be expanded to include ties to staff gauging sites positioned approximately 1 to 2 mi apart within the study area. If existing staff gauges are not positioned approximately 1 to 2 mi apart, new gauges will be placed along the LDW. Adjustments will be computed for each staff gauge to allow for a real-time comparison to RTK GPS-derived water surface elevations, and to provide future studies or dredging projects with MLLW water surface elevations relative to the bathymetric survey.

A geodetic control survey will be conducted by static GPS techniques from monuments with published positions and elevations. A network of observations will be made with redundant comparisons to document accuracy of the survey. A report will be provided for the geodetic control survey.

3.2.3 Positioning

Horizontal positions will be acquired with an Applanix® Position and Orientation System for Marine Vessels (POS/MV) differential global positioning system (DGPS) and inertial navigation system. This system integrates two GPS receivers with a motion reference unit. Additionally, RTK GPS will be input into the system to improve horizontal positioning accuracy to better than 0.5 m (1.6 ft). The advantage of this system is that it not only provides motion information (i.e., heading, roll, pitch, and heave) to compute X, Y, Z data from the multibeam sonar measurements, but also provides accurate inertial navigation through GPS outages for up to 30 seconds, which has been a major problem with conventional DGPS equipment. These systems are preferred because the use of conventional equipment near bridges and alongside ships, a typical environment in the LDW, causes satellite signals to be blocked and/or reflected from these structures (multi-path), resulting in position jumps or large drifts in position, which can exceed survey tolerances.

[4] The monuments will be placed at each end of the study area, and at staff gauging locations positioned approximately 1 to 2 mi apart within the study area.

Position data will be used in real-time to provide navigation information to the vessel operator. A preliminary coverage plot will be generated in real-time to show multibeam swath coverage. The helmsman will be presented with a plan view of the survey area with the vessel position and track. A color-coded swath of the multibeam coverage will be painted to the screen and used to navigate the survey vessel to fill the area. To check the accuracy of the positioning system and confirm that the geodetic parameters used in the real-time projection to the NAD83/91 Washington North Zone coordinate system are correct, a position check will be conducted daily on an established monument with a known position. Water surface measurements will be obtained by RTK GPS with on-the-fly ambiguity resolution. Water surface elevations obtained by RTK GPS will be checked against a primary National Oceanic and Atmospheric Administration (NOAA) tide station (9447130), located at the Coleman Ferry Terminal in downtown Seattle, at staff gauges placed every 1 to 2 mi along the study corridor, and at an automated water surface gauge deployed at the upper reach of the study area. All soundings will be reduced to MLLW elevations in the delivered data set.

The automated water-level gauge will be deployed continuously during the survey to record and time-tag 1-minute water level observations at the upper reach of the study area. The gauge consists of a pressure transducer and a surface interface and recording device. The following procedures will be followed for deployment:

- A temporary staff gauge will be surveyed in at the gauging site.
- The system clock will be synchronized with the data acquisition computers aboard the survey vessel prior to the survey.
- The pressure transducer will be calibrated relative to the staff gauge.

During the survey, system clock checks and comparisons of staff gauge results to automated gauge results will be conducted periodically.

3.2.4 Multibeam data acquisition

Soundings, or precision water depth measurements, will be acquired with Reson SeaBat 8101 multibeam bathymetric sonar. Using a frequency of 240 kHz, the SeaBat sonar illuminates a 150° (75° to starboard and 75° to port) by 1.5° swath along the riverbed, perpendicular to the ship's track, and resolves a slant-range measurement to the riverbed every 1.5° along the swath. This system results in 101 soundings over seven times the water depth in a single sonar ping. Sonar swaths will be recorded at a minimum rate of 8 Hz as the vessel transits along the survey track line. Additionally, the SeaBat 8101 utilizes a stick projector and includes the optional output of sidescan sonar imagery. The stick projector option on the 8101 improves the system performance in shallow water (depths less than 50 m). With this option, sidescan imagery will be recorded with the multibeam data and will be displayed and used during editing. This imagery will be recorded in Extended Triton Format (XTF).

Multibeam data will be collected by running lines parallel with the shoreline. Although the SeaBat 8101 multibeam sonar can acquire data out to 75° on both port and starboard sides under the standard deployment, data will not meet target vertical criteria beyond 60° on a flat bottom. For this survey, the multibeam sonar head will be mounted with a 15° offset angle for horizontal orientation of the outer starboard beam. This position will enable coverage every 1.5° over a range of 90° from nadir (straight down) to starboard and 60° from nadir to port. With this configuration, shoreline data can be collected as far up the bank as possible, on a steep bank, by making shoreline runs with the starboard side toward shore. Survey lines offshore of the shoreline runs will clip the starboard beams at 60° (or less depending on refraction and cross-line analysis) during processing.

Running with a 120° swath (60° to port and starboard), the system still provides 3.5 times the water depth coverage in a single pass. The total swath width of full coverage mapping in a single pass will vary with the water depth, the cross-line comparison, and refraction analysis. If ships or barges, which may obstruct a planned survey transect, are shallow draft and not too wide, it may be possible to survey under them with the wide swath of the SeaBat 8101 system. The POS/MV system will enable the survey vessel to run near ships at berth with minimal loss of positioning integrity. In addition to several parallel lines down the channel, crosstie lines will be run over the main scheme lines to confirm system calibration and document the accuracy of the survey. In addition, single beam comparison lines will be run in shallow water along the shore to confirm accuracy of the outer beams.[5] The most vital measurement in a multibeam survey is pitch and roll angles. To account for vessel heave (vertical movement), pitch and roll, an Applanix® POS/MV motion reference sensor, or equivalent, will be utilized. The POS/MV system will also be used to record vessel heading (yaw) from which the sonar beam orientation is derived. The POS/MV provides a higher degree of accuracy for heading measurements than a conventional gyrocompass.

Multibeam data will be acquired simultaneously on two systems. The primary acquisition system, Triton-Elics Isis, will provide precise time tagging of the sensor data and real-time data displays for quality control. The secondary acquisition system will be the navigation and survey control PC running Coastal Oceanographics HYPACK MAX software. Both systems acquire and time-tag all sensor data, including multibeam sonar, position, heading, heave, pitch, and roll. The navigation system provides navigation output to the vessel operator's monitor and manages the survey. The acquisition systems can also be used to replay the survey so that the coverage and quality of the data can be reviewed prior to demobilization from the site.

Detailed measurements of the sound velocity profile through the water column are crucial in multibeam surveys. Changes in the sound velocity profile will not only

[5] The *Preston* can collect single beam data in 3 ft of water under optimal conditions (i.e, smooth, gradual bottom with no obstructions).

affect acoustic distance measurements, but can also cause refraction or bending of the sonar path as it passes through layers in the water column at different velocities. Because the velocity of sound is directly related to the density and temperature of water, changes in the sound velocity profile are expected to occur in the LDW due to the mixing of fresh and salt water during tidal changes. For this survey, a Sea-Bird SBE 19 SeaCat CTD profiler, or equivalent, will be used to measure conductivity (from which density is determined), temperature, and depth (CTD) at one-second intervals as the probe is lowered to the riverbed. The CTD measurements will be used to compute an accurate sound velocity profile, which will be applied to the data during processing. It is anticipated that the CTD profile will have spatial and temporal variation. To account for spatial variation, the LDW will be divided into subsections. The size of the survey subsections will be determined at the time of surveying by collecting CTD data and adjusting the length of a subsection so that similar results are obtained at each end. Temporal change will be addressed by taking CTD measurements as the subsection is surveyed. Initial CTD measurements will be taken hourly through at least one tidal stage. Subsequent measurements may be extended to every two hours at the discretion of the lead hydrographer based on the tidal cycle and observed measurement differences.

To confirm alignment of the sensor data with the sonar swath, and verify delay times applied to the time-tagged sensor data, a patch test will be conducted. A patch test is a series of lines run in a specific pattern that are used in pairs to analyze roll, pitch, and heading alignment angles with the sonar swath, as well as latency (time delays) in the time tagging of the sensor data. A bar check and lead line check will be conducted to confirm draft of the sonar head. These tests will be conducted at the beginning and end of the survey and any time there are changes in the instrument configuration.

Data acquisition involves setting the motion sensor to the survey conditions and running slow, uniform lines in a systematic pattern. Adjustments will be made to scale and gain settings, as required, to maximize resolution of the survey.

During the survey, preliminary multibeam bathymetric data will be displayed in real-time on the HyPack computer. Pixels color-coded by depth will be drawn on screen, showing the coverage and agreement between adjacent swaths. At the end of each day, screen grabs of the preliminary coverage will be forwarded to Windward for review, to determine if additional lines should be run to fill gaps in coverage. These coverage maps are preliminary and additional data gaps may not become apparent until after data processing.

3.2.5 Survey schedule

The bathymetric survey will be conducted between August 25 and September 10, 2003. This is the only time period between the August 2003 and February 2004 when the Muckleshoot tribe will not be net fishing on the river; thus conducting the survey during this time period will avoid any conflicts between the fishery and the

bathymetric survey. It is expected that the survey will take approximately 5 days to complete. The project data report will be provided by DEA to Windward no more than 60 working days following completion of the field survey. A draft data report will be submitted to EPA and Ecology 120 working days from the final field event. The final data report will be submitted 30 working days after comments on the draft report are received from EPA and Ecology.

3.3 SAMPLING HANDLING AND CUSTODY

No physical samples will be collected as part of this survey.

3.4 DATA PROCESSING METHODS

Post-processing of multibeam data will be conducted utilizing Caris® HIPS multibeam analysis and presentation software. Patch test data will be analyzed and any alignment corrections will be applied. The Caris® HIPS system allows for simultaneous viewing of the sidescan and multibeam data to analyze anomalies on the riverbed during post-processing. Water-level data will be applied to adjust all depth measurements to MLLW. A sound velocity profile will be generated from CTD measurements taken in the field and used to correct slant range measurements and compensate for ray path bending.

Processing will begin with review of each survey line using Caris® swath editor. Verified water surface correctors will be applied to the data set at this time. Position and sensor data will be reviewed and accepted, if no outliers are present, or rejected if erroneous data are observed. Sounding data will be reviewed and edited for data flyers such as bottom multiples, returns from pilings and passing vessel wakes. These data points will be flagged as rejected and will not be used as part of the final data set. Sounding data, including sonar beams reflecting from sediment in the water column or noise due to aeration in the water column, will be carefully reviewed to determine if data should be flagged as rejected. In each case, data will not be eliminated and can be re-accepted during the subset editing process. Data may be re-accepted if they are needed to fill data gaps and they meet accuracy standards based on comparison to adjacent data.

After swath editing, all data will be reviewed through the Caris® HIPS subset editing program to ensure no flyers remained in the data set, or to re-accept data previously flagged in the swath editor. In the Caris® subset editor, a set of lines will be reviewed together for line-to-line comparison to ensure agreement to one another in a Caris® session. A series of subsets will be made to cover the survey area using multiple lines for each Caris® session.

To take advantage of the level of detail the multibeam survey will provide, a 1-m (3.3 ft) resolution hill-shade model and 1-m gridded data set will be exported from Caris® HIPS. This gridding process will use an inverse distance weighting (IDW) algorithm. The 1-m grid size will allow for comparisons with previous bathymetric surveys that

were conducted with similar high-resolution methods, in order to interpret the possibility of shoaling or scouring, while keeping the file size at a manageable level. All original data will be archived at full resolution. If required at a later date, specific areas of interest can readily be remodeled at a higher resolution. The cross-line analysis for selected soundings will be performed on the data set at this stage. The hill-shade images will be reviewed for survey coverage and analyzed to determine if subtle artifacts remain in the data set, which may require further processing. The hill-shade plots will be exported as a georeferenced TIFF file that can be imported into AutoCAD® or any GIS program for final presentation and plotting.

Export of accepted multibeam data will be imported into TerraModel® software for generation of a DTM from which contours will be generated.

3.5 QUALITY CONTROL

The acquisition system and survey protocols are designed with some redundancy to demonstrate that the required accuracy is being achieved during the survey and to provide a backup to primary systems. Data integrity will be monitored throughout the survey by redundant system comparisons and checks against known values. All raw data are recorded to allow for adjustments to be made to any of the data during processing based on the results of comparisons and checks. During Caris® processing of the data, the vessel configuration file allows for date- and time-stamped changes of any system bias, squat correctors, static draft, or instrument offsets in the event of any changes during the survey. Sound velocity and tide correctors can be modified at any time during processing. Data rejected manually or through filtering are flagged as rejected and not deleted. This approach allows for review of all data to confirm or disprove anomalies.

Positioning: Positions will be recorded and archived in WGS84 geographic coordinates and projected onto NAD83/91 Washington North Zone coordinate system. A geodetic control survey will be conducted to provide positions for monuments within the study area. A position confidence check will be conducted daily on a monument that is accessible from the water. The check will consist of placement of the vessel RTK GPS antenna over a project survey control monument. The obtained position will be compared to the surveyed value to assure the target horizontal and vertical accuracy is being obtained.

Tides: RTK GPS derived heights will be checked daily during the position checks. In addition, staff gauge observations will be made and compared to RTK GPS derived water elevations twice per day. Backup tidal observations from the NOAA automated gauge and the DEA deployed automated gauge will be used to confirm and evaluate any anomalous data in the RTK GPS tidal values.

Sonar draft:

- A bar check will be conducted at the beginning and end of the project to confirm single beam[6] and multibeam sonar draft below the water line. A bar will be lowered below the sonar to specific intervals below the water surface using calibrated marks on the attached chain.
- Sonar draft marks will be observed with the vessel trimmed to zero roll angle to confirm the static draft of the sonar.
- A comparison of multibeam and single beam depth soundings will be performed at the beginning and end of the project to confirm single beam and multibeam sonar draft below the water line.
- A leadline depth observation will be made at the beginning and end of the project to confirm single beam and multibeam sonar draft and sound velocity observations.

Documented changes in draft can be accounted for in the Caris® vessel configuration file, which will accept date- and time-stamped draft offset values.

Motion sensor, positioning system latency, and vessel heading calibration: A patch test will be conducted at the beginning and end of the project to confirm that the sensor mounting angles and timing bias are correctly applied to multibeam sonar data.

Metric-english unit conversions: Multibeam data are collected in metric units and will be converted to US survey ft. A check on horizontal unit conversions will include a comparison of converted control monument locations to their known locations in ft. Vertical checks will be conducted by comparing converted multibeam data to single beam data, which are collected in ft.

Cross-line analysis: A cross-line analysis will be conducted across the full width of the survey, when there is sufficient water depth, to confirm that the beams used meet target accuracy. In addition, single beam comparison lines will be run in shallow water along the shoreline to confirm accuracy of outer beams.

Hill-Shade analysis: A sun-illuminated image (hill-shade) will be generated from a DTM of the accepted bathymetric data set. The image will be reviewed for anomalous data and consistency between adjacent sonar swaths.

3.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Prior to mobilization, the survey vessel and equipment will be inspected and confirmed to be in operating order. The survey vessel is inspected annually by a marine surveyor and a report of the inspection will be provided. The vessel is inspected and maintained daily by the vessel operator.

During mobilization, instrumentation will be tested and system performance testing will be conducted. Performance testing will include a bar check, patch test, leadline

[6] Some selected single beam lines will be run to confirm multibeam measurements.

comparison to multibeam, single beam echosounder comparison to multibeam, and position confidence check.

3.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Equipment calibration is verified through system performance testing (bar checks, position checks, staff or automated gauge comparison, multibeam patch test, leadline comparison, single beam comparison, and cross-line analysis). The exception is the CTD profiler, which is calibrated prior to the survey, verified with a pre- and post-survey bar check, and compared weekly to an independent temperature sensor.

Frequency of observations is as follows:

- Bar check, sonar draft mark observations, leadline and single beam comparison: beginning and end of project or any change in sonar mounting
- Position checks: daily
- Staff or automated gauge comparison: twice daily
- CTD profile: minimum of twice daily
- Multibeam patch test: beginning and end of project or any change in instrumentation
- Cross-line analysis: once per project

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

No significant consumables are required because all data are digitally recorded. The survey vessel is equipped with survey log forms for survey documentation and a supply of rewritable compact discs (CD-RW).

3.9 NON-DIRECT MEASUREMENTS

The geodetic control survey will be based on existing monuments with published positions and elevations. Horizontal positions and elevations based on the North American Vertical Datum of 1988 (NAVD88) will be based on National Geodetic Survey published monuments. MLLW elevations along the LDW will be based on NOAA tidal benchmarks at Station 9447130, Seattle, Washington, and the US Army Corps of Engineers tide datum at Station 92 on the LDW.

3.10 DATA MANAGEMENT

Data from the survey vessel will be backed up to CD-RW at the end of each survey day. Data will not be removed from the acquisition computers until they have been loaded and verified on DEA's hydrographic data server located in the Portland office. This server has the capacity for large hydrographic data sets and is supported with a

RAID-5 array[7] for redundant data storage. Altered files are backed up to tape daily, with full backups to tape weekly along with offsite storage. At the completion of the project, data are archived on two sets of CD-RW, or tapes, and archived in two separate locations.

Figure 2 presents a flowchart illustrating the data flow from acquisition to production of deliverables.

4.0 Assessment and Oversight

4.1 Assessments and Response Actions

No field audits are proposed for this work. The DEA project manager will audit system checks and hill-shade imagery during post-processing.

4.2 Reports to Management

Primary communications will be through the DEA project manager and Windward. Windward will provide all project communications to EPA and Ecology. During field operations, communications between DEA and Windward will be through DEA's field operations manager, with copies of correspondence forwarded to DEA's project manager. This correspondence will primarily consist of e-mails sent every evening during survey operations, which will include coverage images, general overview of survey progress, and any problems encountered during surveying. Windward will forward these daily e-mails to EPA and Ecology for review.

[7] Redundant array of independent disks (RAID) is a way of storing the same data in different places on multiple hard disks

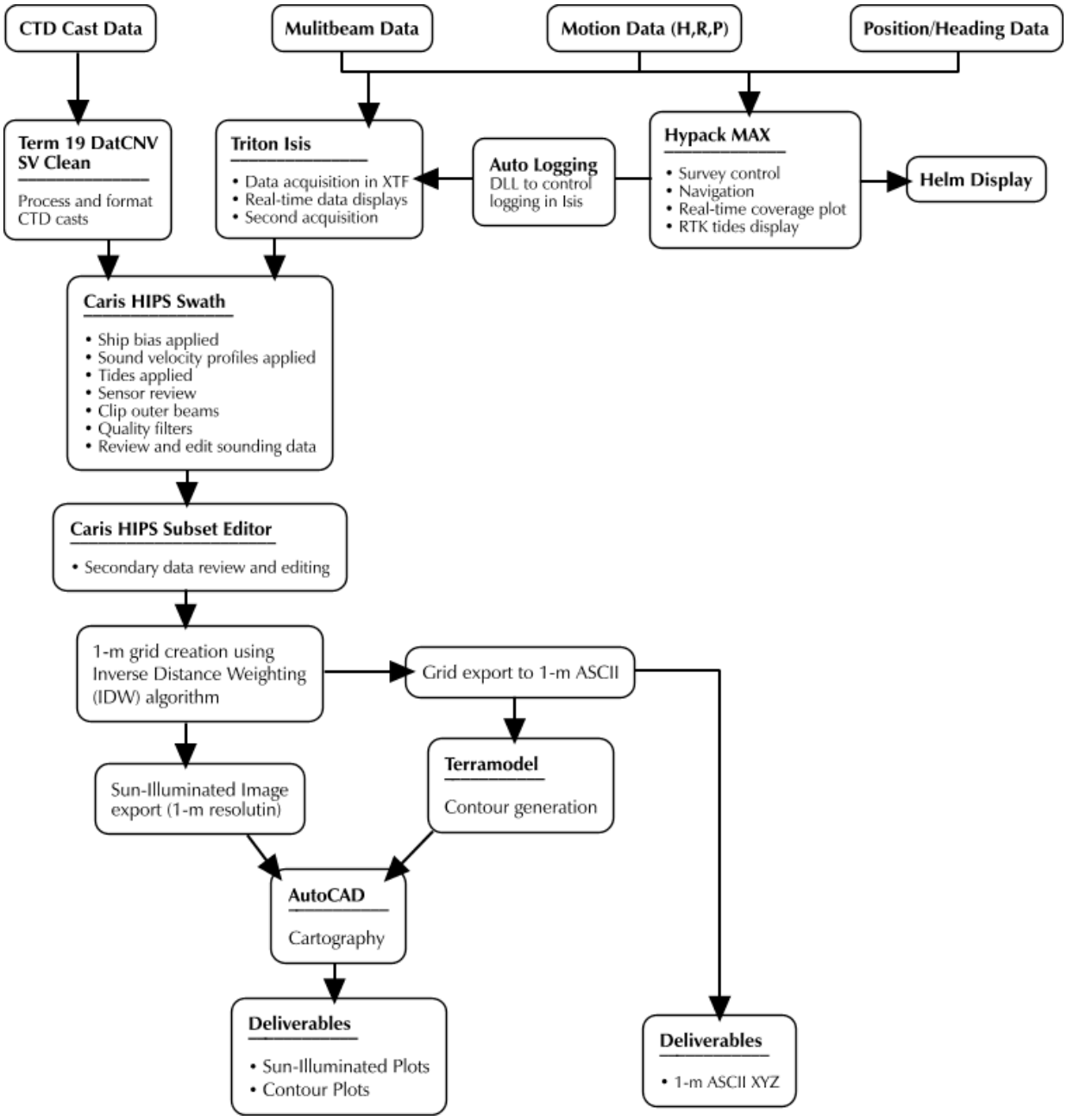

Figure 2. Multibeam data acquisition and processing flowchart

5.0 Data Validation and Usability

5.1 Data Review, Verification, and Validation

Data will be reviewed and verified by evaluation of hill-shade imagery, cross-line analysis, comparison of multibeam data to redundant depth measurement techniques and comparison to adjacent soundings.

5.2 VERIFICATION AND VALIDATION METHODS

Verification of multibeam data will be performed by comparison to intersecting and overlapping swath soundings, single beam data, and (in areas of firm material) leadline soundings. Patch test data will be analyzed and a cross-line analysis will be performed to document the system performance.

Hill-shade images will be reviewed for anomalous data and inconsistency between adjacent sonar swaths. Artifacts in the image will be investigated in Caris® HIPS swath editor by comparing the data to adjacent soundings and swaths.

5.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data quality objectives for accuracy will be achieved by meeting the target horizontal and vertical accuracies at a 95% confidence level for the survey. Methods outlined in Sections 3.5, 3.7, and 5.2, will verify that the target accuracies are being obtained. Other data quality indicators, including completeness, representativeness, and precision, will be evaluated with a color-by-depth, sun-illuminated, coverage image generated in Caris® HIPS. This image processing system provides tools for data quality review (i.e., swath-to-swath comparison, 3-D presentation color-coded by swath, etc.). Final review by the lead hydrographer will include the evaluation of sun-illuminated images for artifacts from system bias, and comparison to prior surveys.

6.0 References

EPA. 2002. Guidance for quality assurance project plans. EPA/240/R-02/009. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC.

USACE. 2002. Engineering design: hydrographic surveying. EM 1110-2-1003. Department of the Army, US Army Corps of Engineers, Washington, DC.

Windward. 2003a. Draft final Phase 1 remedial investigation report. Prepared for Lower Duwamish Waterway Group for submittal to US Environmental Protection Agency, Region 10, Seattle, WA and Washington State Department of Ecology, Bellevue, WA. Windward Environmental LLC, Seattle, WA.

Windward. 2003b. Task 7: Identification of data needs. Prepared for Lower Duwamish Waterway Group for submittal to US Environmental Protection Agency, Region 10, Seattle, WA and Washington State Department of Ecology, Bellevue, WA. Windward Environmental LLC, Seattle, WA.

Appendix A. Health and Safety Plan

By their signature, the undersigned certify that this Health and Safety Plan (HSP) is approved and that it will be used to govern health and safety aspects of fieldwork described in the Quality Assurance Project Plan to which it is attached.

Name Windward Project Manager	Date
Name Corporate Health and Safety Manager	Date
Name DEA Field Operations Manager/Health and Safety Officer	Date

Acronyms

CPR	cardiopulmonary resuscitation
DEA	David Evans and Associates
EPA	US Environmental Protection Agency
FOM	Field Operations Manager
HSM	Project Health and Safety Manager
HAZWOPER	Hazardous Waste Operations and Emergency Response
HAZMAT	hazardous materials
HSO	Field Health and Safety Officer
HSP	health and safety plan
LDW	Lower Duwamish Waterway
OSHA	Occupational Safety and Health Administration
PFD	personal flotation device
PM	project manager
PPE	personal protective equipment
USCG	United States Coast Guard
VHF	very high frequency

A.1.0 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites. This HSP covers elements as specified in 29 CFR 1910§120. The goal of the HSP is to establish procedures for safe working practices for all field personnel.

This HSP addresses all activities associated with collection of bathymetric data in the Lower Duwamish Waterway (LDW). During site work, this HSP will be implemented by the DEA Field Operations Manager (FOM), who is also the designated site Health and Safety Officer (HSO), in cooperation with the Corporate Health and Safety Manager (HSM).

All personnel involved in fieldwork on this project are required to comply with this HSP. The contents of this HSP reflect anticipation of the types of activities to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. The HSP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

A.2.0 Site Description and Project Scope

The surveying area is in the LDW (see Figure 1 in the attached QAPP). The area is affected by tidal fluctuations. The QAPP to which this HSP is attached provides complete details of the bathymetric survey. The survey will be conducted using a 9-m aluminum vessel as described in the QAPP. The duration of the survey is expected to be approximately 5 days.

A.3.0 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HSP.

Windward Project Manager: The PM has overall responsibility for the successful outcome of the project. The PM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The PM, in consultation with the HSM, makes final decisions concerning implementation of the HSP.

DEA Field Operations Manager/Health and Safety Officer: Because of the limited scope and duration of fieldwork, the DEA Field Operations Manger (FOM) and Health and Safety Officer (HSO) will be the same person. The FOM/HSO will direct field surveying activities, coordinate the technical components of the field program

with health and safety components, and ensure that work is performed according to the QAPP.

The FOM/HSO will implement this HSP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FOM/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FOM/HSO or his designee shall be present during surveying operations.

Corporate Health and Safety Manager: The HSM has overall responsibility for preparation, approval, and revisions of this HSP. The HSM will not necessarily be present during fieldwork, but will be readily available, if required, for consultation regarding health and safety issues during fieldwork.

Field Crew: All field crew members must be familiar with and comply with the information in this HSP. They also have the responsibility to report any potentially unsafe or hazardous conditions to the FOM/HSO immediately.

A.4.0 Hazard Evaluation and Control Measures

This section covers potential physical and chemical hazards that may be associated with the proposed project activities, and presents control measures for addressing these hazards. The activity hazard analysis, Section A.4.3, lists the potential hazards associated with each site activity and the recommended site control to be used to minimize each potential hazard.

Confined space entry will not be necessary for this project. Therefore, hazards associated with this activity are not discussed in this HSP.

A.4.1 PHYSICAL HAZARDS

For this project, it is anticipated that physical hazards will present a greater risk of injury than chemical hazards. Physical hazards are identified and discussed below.

A.4.1.1 Slips, trips, and falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, surveying from a boat or other floating platform requires careful attention to minimize the risk of falling down or of falling overboard. The same care should be used in rainy conditions or on the shoreline where slick rocks are found. Slips can be minimized by wearing boots with good tread, made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat, in a cluttered work area, or in the intertidal zone where uneven substrate is common. Personnel will keep work areas as free as possible from items that interfere with walking.

Falls may be avoided by working as far from exposed edges as possible, by erecting railings, and by using fall protection when working on elevated platforms. For this project, no work is anticipated that would present a fall hazard. However, some of the surveying will be done from a boat. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn while working on deck or working from an open boat. PFDs need not be worn while working inside an enclosed cabin, but must be readily available when going on deck from the cabin area. An individual in the water shall be considered a "person overboard" and appropriate rescue actions shall be taken immediately to prevent hypothermia.

A.4.1.2 Manual lifting

Equipment and samples must be lifted and carried. Back strain can result if lifting is done improperly. During any manual handling tasks, personnel should lift with the load supported by their legs and not their backs. For heavy loads, an adequate number of people will be used, or if possible, a mechanical lifting/handling device will be used.

A.4.1.3 Heat stress, hypothermia, or frostbite

Surveying operations and conditions that might result in the occurrence of heat stress, hypothermia, or frostbite are not anticipated. The surveying will occur during the time of year when extreme weather conditions are not expected to occur. Nonetheless, the vessel crew and other personnel shall have adequate clothing and foul-weather gear in their possession prior to vessel departure.

A.4.1.4 Weather

In general, field team members will be equipped for the normal range of weather conditions. Work shall be preceded by an evaluation of weather reports and conditions by the FOM/HSO and vessel pilot to ascertain that safe working conditions exist and safe refuge of personnel is assured. An alternate safe harbor shall be designated for emergency situations. Field personnel shall maintain monitoring of the local area weather broadcasts or other readily available weather forecasting services. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

A.4.2 CHEMICAL HAZARDS

Previous investigations have shown that some chemical substances are present at higher-than-background concentrations in sediments from the surveying area. However, no direct contact with contaminated sediments is expected during this survey. Consequently, no chemical hazards are expected.

A.4.3 ACTIVITY HAZARD ANALYSIS

The activity hazard analysis summarizes the field activities to be performed during the project, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the risk of the hazard occurring.

Table A-1 presents the activity hazard analysis for conducting the bathymetric survey from the surveying vessel.

Table A-1. Activity hazard analysis

ACTIVITY	HAZARD	CONTROL
Surveying from a boat	Falling overboard	Use care in boarding/departing from vessel. Deploy and recover the sonar head according to protocols specified in the QAPP and by the vessel captain. Wear PFD when on deck. Follow safe work practices related to vessel operations specified in Section A.6.0.

A.5.0 Work Zones and Shipboard Access Control

Because no direct contact with contaminated media is expected and no physical sample collection or processing will occur, there will be no designated work zone to which access must be controlled. Security and control of access to the boat will be the responsibility of the FOM/HSO and boat captain. Boat access will be granted only to necessary project personnel and authorized visitors. Any security or access control problems will be reported to the client or appropriate authorities.

A.6.0 Safe Work Practices

Due to the nature of the survey, safe work practices are primarily related to vessel operations. All employees actively working on projects involving vessel operations will be thoroughly trained in the applicable safety, underway, docking, fueling, and various necessary operational procedures. The minimum responsibilities of the vessel crew members are as follows:

During all vessel operations the boat captain is in charge and takes full responsibility for safe operation of the vessel.

1. All vessel operators shall have adequate knowledge of the US Coast Guard (USCG) regulations, "Rules of The Road" and shall be approved for vessel operation by the FOM.
2. Vessels over 20 ft shall be inspected annually by a qualified marine surveyor to ensure structural integrity and safe operating conditions exist. Records of inspections shall be maintained on the vessel for vessels over 20 ft and shall be available to the designated authority.
3. When the vessel is brought onto a job site, it shall be inspected and tested by the vessel crew and determined to be in safe operating condition prior to the initiation of prescribed work.
4. Any vessel found to be in an unsafe condition shall be taken out of service and its use prohibited until the specified unsafe conditions have been corrected.
5. Prior to vessel departure from the dock, all onboard personnel shall be familiar with their duties and responsibilities in the event of an emergency, and the location of the vessels emergency first-aid and fire fighting equipment, as verbally communicated by a qualified member of the vessel crew.
6. All vessels shall be equipped with a PFD for each person onboard, a VHF marine radio and all USCG required safety equipment.
7. Navigation lights, radar systems, radios, depth sounders, and other navigational equipment shall be operated, inspected, and recorded each week and prior to each job by qualified personnel to ensure their proper operation.
8. A detailed daily work schedule that includes the approximate times, site locations, access points and other pertinent information necessary to locate crew members in the event of emergency, will be filed with the local field office or appropriate shore-side personnel.
9. Prior to departure from the dock, the vessel's fuel capacity will be checked to assure adequate fuel is available to complete the days work and maintain sufficient fuel reserves to allow for a reasonable margin of safety.
10. Fuel used on the outbound trip to assigned work areas shall not exceed one-third of the total fuel reserves. The pilot shall monitor fuel consumption throughout the work day and begin the inbound transit when remaining fuel reserves approach 150% of the fuel quantity used during the outbound transit.
11. Coast Guard approved PFDs shall be worn by all personnel when on deck or in an open vessel, regardless of other safety devices utilized. All safety

devices must be inspected for defects prior to each use and those found to be defective replaced immediately. PFDs need not be worn while working inside an enclosed cabin, but must be readily available when going on deck from the cabin area.

12. Additional emergency/rescue equipment onboard vessels will include, but not be limited to, throw rings, throw ropes, dye markers, strobes, flares, boat hooks, and other safety equipment required by the USCG.
13. Vessel fuel valves shall be in the closed position when shutting down boat operations for the night or more than eight hours.
14. Smoking shall be prohibited on the boat at all times and/or within 20 ft of fuel tanks.
15. A minimum of one ten-pound A-B-C fire extinguisher will be properly certified, maintained, and located conspicuously onboard all motor-driven vessels.
16. Work areas and access-ways shall be kept clean and clear of obstructions at all times.
17. A proper watch shall be maintained in order to avoid other vessels, floating debris, deadheads, and other obstructions.
18. When conducting night operations or working in reduced visibility, proper navigation lights shall be displayed, a safe speed (as warranted by the conditions) shall not be exceeded, and a proper watch shall be posted.

Other general safety rules will also be followed on site:

- Do not climb over or under obstacles of questionable stability
- Work only in well-lighted spaces
- Make eye contact with equipment operators when moving within the range of their equipment
- Be aware of the movements of shipboard equipment when not in the operator's range of vision
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries
- Always use the buddy system
- Be alert to your own and other workers' physical condition
- Report all accidents, no matter how minor, to the FOM/HSO
- Do not do anything dangerous or unwise even if ordered by a supervisor

A.7.0 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. For this survey, a PFD is the only required PPE when working aboard the boat. In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will also be provided. Equipment for the field team will include:

- A copy of this HSP
- First aid kit adequate for the number of personnel

The FOM/HSO will ensure that the safety equipment is aboard. Equipment will be checked daily to ensure its readiness for use.

A.8.0 Monitoring Procedures for Site Activities

For this project, the monitoring program will consist of all workers monitoring themselves and their co-workers for signs that might indicate physical stress or illness. All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Symptoms of heat stress
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Shivering
- Blue lips or fingernails

If any of these conditions develop, work shall be halted immediately and the affected person(s) evaluated. If further assistance is needed, personnel at the local

hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the direct result of sample collection or handling activities, procedures will be modified to address the problem.

A.9.0 Decontamination

Because the surveying equipment and PPE will not come in contact with contaminated media, no decontamination will be necessary.

A.10.0 Disposal of Contaminated Materials

No contaminated materials will be generated during the conduct of this survey.

A.11.0 Training Requirements

Project-specific training is described in Section 2.5 of the QAPP. Because no contact with contaminated media is expected, HAZWOPER training for surveying personnel is not required. At least one member of the field team must have first-aid and cardiopulmonary resuscitation (CPR) training. Documentation of which individuals possess first-aid and CPR training will be kept in the project health and safety files.

A.12.0 Medical Surveillance

A medical surveillance program conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members because they do not meet any of the four criteria outlined in the regulations for implementation of a medical surveillance program:

- Employees who are or may be exposed to hazardous substances or health hazards at or above permissible exposure levels for 30 days or more per year (1910.120(f)(2)(I)
- Employees who must wear a respirator for 30 days or more per year (1910.120(f)(2)(ii))
- Employees who are injured or become ill due to possible overexposures involving hazardous substances or health hazards from an emergency response or hazardous waste operation (1910.120(f)(2)(iii))
- Employees who are members of HAZMAT teams (1910.120(f)(2)(iv))

As described in Section A.8, employees will monitor themselves and each other of any deleterious changes in their physical or mental condition during the performance of all field activities.

A.13.0 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (see Attachment 1). If necessary, accident/incident report forms and OSHA Form 200s will be completed by the FOM/HSO.

The FOM/HSO or a designee will maintain a health and safety field logbook that records health- and safety-related details of the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety logbook will not be required. The logbook must be bound and the pages must be numbered consecutively. Entries will be made with indelible blue ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel onboard
- Weather conditions
- Type of fieldwork being performed

The person maintaining the entries will initial and date the bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous workday's entries.

A.14.0 Emergency Response Plan

As a result of the hazards onboard and the conditions under which operations will be conducted, the potential exists for an emergency situation to occur. Emergencies may include personal injury, fire, or explosion. OSHA regulations require that an emergency response plan be available for use onboard to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations. The local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying an emergency situation, providing first aid if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following sections identify the onboard individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions and a map for getting from any surveying location to a hospital.

A.14.1 PRE-EMERGENCY PREPARATION

Before the start of field activities, the FOM/HSO will ensure that preparation has been made in anticipation of emergencies. Preparatory actions include the following:

- Meeting with the FOM/HSO and equipment handlers concerning the emergency procedures in the event that a person is injured
- A training session given by the FOM/HSO informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures
- A training session given by senior staff operating field equipment, to apprise field personnel of operating procedures and specific risks associated with that equipment
- Ensuring that field personnel are aware of the existence of the emergency response plan in the HSP and ensuring that a copy of the HSP accompanies the field team

A.14.2 PROJECT EMERGENCY COORDINATOR

The FOM/HSO will serve as the Project Emergency Coordinator in the event of an emergency. He will designate his replacement for times when he is not onboard or is not serving as the Project Emergency Coordinator. The designation will be noted in the logbook. The Project Emergency Coordinator will be notified immediately when an emergency is recognized. The Project Emergency Coordinator will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing interim actions onboard before the arrival of emergency response units. The Project Emergency Coordinator will notify the HSM and the Project Manager as soon as possible after initiating an emergency response action. The Project Manager will have responsibility for notifying the client.

A.14.3 EMERGENCY RESPONSE CONTACTS

All onboard personnel must know whom to notify in the event of an emergency situation, even though the FOM/HSO has primary responsibility for notification. Table A-2 lists the names and phone numbers for emergency response services and individuals.

Table A-2. Emergency response contacts

CONTACT	TELEPHONE NUMBER
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
Emergency Responders	
U.S. Coast Guard	
Emergency General information	(206) 286-5400 (206) 442-5295 UHF Channel 16
National Response Center	(800) 424-8802
EPA	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Emergency Contacts	
Project Manager	
Kathy Godtfredsen	(206) 577-1292
Corporate Health and Safety Manager	
Tad Deshler	(206) 577-1285
Field Operations Manager/Field Health and Safety Officer	Site cellular telephone:
Nicholas Lesnikowski	(206) 419-4595

A.14.4 RECOGNITION OF EMERGENCY SITUATIONS

Emergency situations will generally be recognizable by observation. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first-aid techniques.

A.14.5 EMERGENCY PROCEDURES RELATED TO VESSEL OPERATIONS

In deteriorating weather/sea conditions, radio the field office or USCG with your location, direction of travel, and approximate speed before a dangerous situation can develop. In an emergency, contact the USCG on VHF channel 16. Emergency VHF radio broadcasts should be proceeded by "Pan-Pan, Pan-Pan, Pan-Pan" for non-life threatening emergencies and "Mayday, Mayday, Mayday" for life threatening situations. Be prepared to provide your vessel name, location and the nature of the emergency. Don life jackets and/or survival suits, take necessary measures to prevent hypothermia, and wait for the search and rescue.

A.14.6 FIRE

Field personnel will attempt to control only small fires, should they occur. If an explosion appears likely, personnel will follow evacuation procedures specified during the training session. If a fire cannot be controlled with a fire extinguisher on board that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the boat as specified in the training session.

A.14.7 PERSONAL INJURY

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

- Administer first aid, if qualified
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit
- Notify the Project Emergency Coordinator of the incident, the name of the individual, the location, and the nature of the injury

The Project Emergency Coordinator will immediately do the following:

- Notify the boat captain and the appropriate emergency response organization.
- Assist the injured individual.
- Follow the emergency procedures for retrieving or disposing equipment reviewed in the training session and leave the site en route to the predetermined land-based emergency pick-up.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs, i.e., injury where death is imminent without immediate treatment, the FOM/HSO or boat captain will call 911 and arrange to meet the Medic One unit at the nearest accessible dock. Otherwise, for emergency injuries that are not life threatening (i.e., sprains, minor lacerations, etc.) the Project Emergency Coordinator will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location of his choice if that would be more expedient.
- Notify the HSM and the Project Manager.

If the Project Emergency Coordinator determines that emergency response is not necessary, he or she may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions and a map showing the route to the hospital are in Section A.14.10.

If a worker leaves the boat to seek medical attention, another worker should accompany them to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach, and notify the Project Emergency Coordinator.

The Project Emergency Coordinator will have responsibility for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

A.14.8 OVERT PERSONAL EXPOSURE OR INJURY

No overt exposure to toxic materials is expected to occur. Accordingly, no emergency procedures related to such exposure are required for this project.

A.14.9 SPILLS AND SPILL CONTAINMENT

No bulk chemicals or other materials subject to spillage are expected to be used during this project. Accordingly, no spill containment procedure is required for this project.

A.14.10 EMERGENCY ROUTE TO THE HOSPITAL

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

Harborview Medical Center
325 - 9th Ave.
Seattle, WA
(206) 323-3074

Directions from the vicinity of LDW to Harborview Medical Center are as follows:

- Dock the vessel at the 1st Ave S boat launch
- Drive east on S River Street
- Turn left on Occidental Ave S
- Turn left on E Marginal Way S
- Turn right on S Michigan Street
- Look for entrance ramps to I-5 Northbound
- Head north on I-5
- Take the James Street exit
- Head east on James Street to 9th Avenue
- Turn right on 9th Avenue
- Emergency entrance will be two blocks south on the right

Attachment A1. Field Team Health and Safety Plan Review

I have read a copy of the Health and Safety Plan, which covers field activities that will be conducted to investigate potentially contaminated areas in the LDW. I understand the health and safety requirements of the project, which are detailed in this Health and Safety Plan.

Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date