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

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

QUALITY ASSURANCE PROJECT PLAN: CLAM, CRAB, AND SHRIMP 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

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TITLE AND APPROVAL PAGE
LDW CLAM, CRAB, AND SHRIMP SURVEYS
QUALITY ASSURANCE PROJECT PLAN

Windward Project Manager _____ _____
Name Date

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Name Date

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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Acronyms

CPUE	catch per unit effort
EPA	US Environmental Protection Agency
ERA	ecological risk assessment
GPS	global positioning system
HHRA	human health risk assessment
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MLLW	mean lower low water
QAPP	quality assurance project plan
RI	Remedial Investigation
WDFW	Washington Department of Fish and Wildlife
Windward	Windward Environmental LLC

1.0 Introduction

This quality assurance project plan (QAPP) describes the methods and quality control procedures for conducting clam, crab, and shrimp surveys for the Lower Duwamish Waterway (LDW) study area. 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 – assessment and oversight
- Section 4 – data generation and acquisition
- Section 5 – data validation and usability
- Section 6 – references

2.0 Project Management

2.1 PROJECT ORGANIZATION

The surveys will be conducted by Windward Environmental LLC (Windward). Windward will be responsible for conducting the surveys, as well as 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), the US Environmental Protection Agency (EPA), and the Washington Department of Ecology on schedule, deliverables, any significant deviations from the QAPP, and administrative details.

Tad Deshler will serve as the Windward project manager and point of contact and can be reached as follows:

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2.2 PROBLEM DEFINITION/BACKGROUND

A Remedial Investigation (RI) is currently being conducted for the LDW, with Phase 1 of this work nearing completion (Windward 2003). As part of the Phase 1 RI, ecological and human health risk assessments were conducted using existing data. However, for the Phase 2 RI, additional data will be collected that will be used along with the existing data. As part of the Phase 2 RI, baseline human health and ecological risk assessments will be conducted. This QAPP supports the collection of additional data for use in the baseline risk assessments.

The human health risk assessment (HHRA) for the Phase 1 RI estimated risks from consuming seafood from the LDW. Separate site-specific consumption rates were derived for benthic fish, pelagic fish, and shellfish, including crabs and mussels. The site-specific clam consumption rate was assumed to be zero for the Phase 1 HHRA because of the uncertainty associated with the presence of harvestable populations of these animals in the LDW. The site-specific consumption rates of other seafood were derived from studies of human populations that harvest seafood from throughout King County (Asian and Pacific Islanders – EPA 1999) and Puget Sound (Suquamish Tribe 2000), including areas outside the LDW.

Marine shellfish abundance in Puget Sound may be higher than marine shellfish abundance in the LDW, but available data are insufficient to evaluate this hypothesis. Data compiled by Windward (2003) as part of the Phase 1 RI indicate that crabs, clams, and mussels are present in the LDW (Windward 2000, Environmental Solutions Group 1999, King County 1999), but harvestability estimates for these species cannot be

made. Other invertebrate seafood consumed by the Suquamish Tribe, such as oysters, geoduck, scallops, squid, sea urchins, and sea cucumbers, have not been observed in the LDW. For the purposes of the Phase 1 RI, it was assumed that these species are not present in the LDW. For the Phase 2 RI, information from local biologists and past field work/surveys will be used to confirm that these other species are not expected to be present in the LDW. Therefore, the surveys outlined in this QAPP will provide the necessary data to assess the abundance of harvestable populations of crabs, shrimp, and clams. The data obtained from these surveys will be used to derive site-specific shellfish consumption rates for the Phase 2 HHRA. The specific data analysis methods to be used to derive these consumption rates will be determined at a later date and are not described in this QAPP. However, Section 2.3 provides some general indications of how the data from these surveys will be used.

2.3 PROJECT DESCRIPTION

Windward will conduct semi-quantitative surveys of invertebrate populations in the LDW. This will be done in two surveys: 1) crabs and shrimp and 2) intertidal clams. The survey area covers approximately 6 miles of the waterway, as shown in Figure 1.

The first survey will be conducted in August 2003 to estimate shrimp and crab harvestability in the study area using crab and shrimp pots deployed throughout the study area. Catch-per-unit-effort (CPUE) will be calculated for each pot to determine potential harvest rates by recreational and subsistence fishers. This procedure will be repeated on a quarterly basis to gain representative harvest rate data during each season (see Section 3.1.1 for further details). The CPUE rate will be determined by the number of crabs or shrimps per pot per pull or deployment. The CPUE data will be used in a weight-of-evidence approach to derive site-specific consumption rates for use in the Phase 2 HHRA. The weight-of-evidence approach will be based on assumptions about the number of people potentially harvesting crabs in the LDW and a reasonable level of effort for those individuals to invest in catching crabs.

The second survey will provide data to estimate the potential harvest of clams in the exposed intertidal zone of the LDW by surveying potential clam beaches throughout the LDW during a low tide event. A reconnaissance survey will be completed in July 2003 to locate beaches in the study area that may support clams. These areas will then be revisited during low tide in August 2003 and sampled for clams using methods based on Washington Department of Fish and Wildlife (WDFW) clam and oyster guidance (Campbell 1996). Mean number and weight of clams per species will be calculated per productive area of each beach included in this survey. In addition, physical measurements of beach substrate, including interstitial salinity and percent fines, and observations of other intertidal invertebrates, such as oysters and shore crabs, will be recorded during this survey. Additional qualitative observations of mussels on hard surfaces other than intertidal beaches (e.g., pilings) will be made during transit between beaches.

Similar to data from the crab and shrimp survey, data from the clam survey will be used in a weight-of-evidence approach to derive site-specific consumption rates for use in the Phase 2 HHRA. The weight-of-evidence approach will be based on assumptions about the number of people potentially harvesting clams in the LDW and a reasonable level of effort for those individuals to invest in harvesting clams.

The presence of other intertidal species, such as oysters and shore crabs, will be noted during the quantitative clam sampling survey, but no systematic search strategy will be employed. This level of effort is appropriate as the presence of these organisms is assumed to be limited due to habitat availability and freshwater influence in the LDW. The presence of mussels on hard surfaces will also be documented while transiting between sampling beaches. The purpose of the incidental survey of mussels is to assess the geographic distribution of these animals within the LDW.

The data collected during the clam, crab, and shrimp surveys will be used not only to derive site-specific consumption rates for use in the Phase 2 HHRA, but as the basis for collecting additional tissue chemistry data in Phase 2. No tissue samples for chemical analysis will be collected as part of the surveys described in this QAPP. A separate tissue chemistry QAPP will be prepared in 2004 to describe these efforts. In addition, the data from the surveys will also provide additional qualitative information for the Phase 2 ecological risk assessment (ERA) on the presence and absence of particular invertebrate species in the LDW and the locations and depths where these species are found. For example, the clam sampling results will be used to qualitatively determine the relative abundance of clams in the top 15 cm of sediment compared to deeper sediments. The 15 cm depth was used in the Phase 1 RI and risk assessments to distinguish surface sediment from subsurface sediment.

2.4 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The primary data quality objective for this survey is to ensure that data collected on the relative abundances of crabs, shrimp, and clams in the LDW are adequate to meet the needs of the RI. Performance and acceptance criteria are often expressed in terms of data quality indicators (EPA 2002). The principal indicators of data quality are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. Each element is described in a separate section below.

2.4.1 Precision

Precision is difficult to measure in biological surveys because of differences in physical variables (e.g., weather) and animal behavior, but several procedures will be followed to maximize the precision between repeated measurements of the same variables.

- All sampling gear will be consistent within and between the sampling events
- All field personnel will receive standardized training for the field methods described in Section 3.2

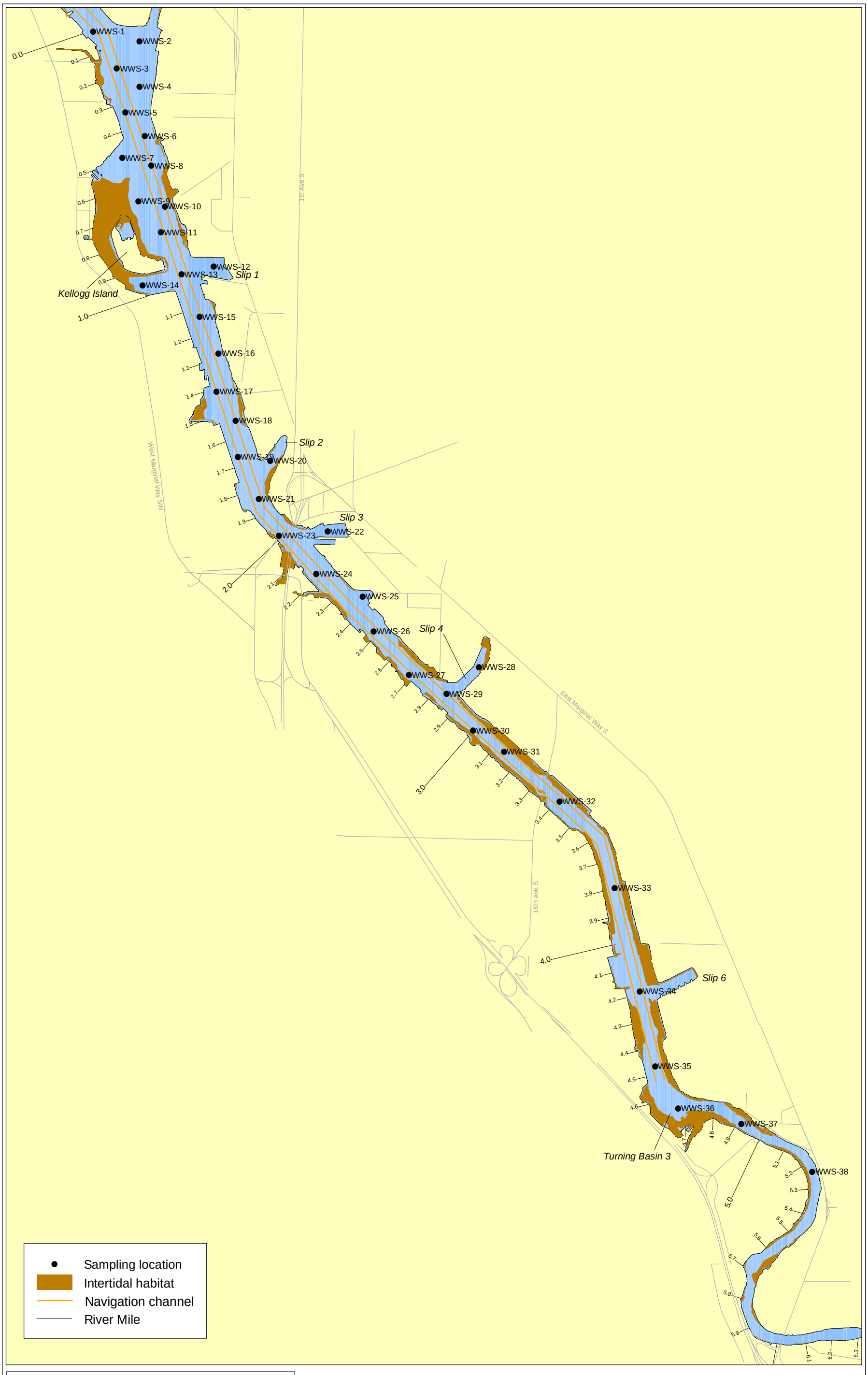

Figure 1. Intertidal habitat and crab and shrimp sampling locations in the Lower Duwamish Waterway

- A subset of the taxonomic identifications will be performed by two separate individuals. Additional taxonomic expertise for vouchered specimens will be obtained if the separate identifications are not in agreement with each other
- A subset of the physical measurements such as wet sieving for percent fines will be conducted by two separate individuals on splits of the same sample using the same field equipment

2.4.2 Bias

Bias in biological surveys is unavoidable because the observation methods can only imperfectly characterize the biological system of interest. The largest source of bias, particularly for the crab and shrimp survey, is the selectivity of the sampling gear for certain sizes and behavior types. Crabs and shrimp smaller than the wire mesh of the pots will not be effectively captured. Sometimes the success of a crab pot at accurately sampling the available crab population can be compromised by the presence of dominant individuals who prevent other crabs from entering the pot. It is difficult to control for biases such as these, but recognizing them is critical when assessing the comparability of data from this survey to data from other surveys (see Section 2.4.5).

Another source of bias is the length of soak time for crab and shrimp pots. A pilot study of soak times will be conducted prior to the first quarterly crab and shrimp survey. The pilot study will be conducted at several of the proposed sampling locations (see Section 3.2.1) located at the downstream end of the study area where crabs and shrimp are more likely to be found. Crab and shrimp pots will be deployed at each location and retrieved after 4 hours. The catch will be recorded, and then the pots will be rebaited and redeployed for an additional 24 hours. The catch rates, on a per pull basis, will be compared to determine whether a 4-hour or 24-hour soak time will result in a larger catch. The initial analysis of commercial crab catch data (described below) suggests a 24-hour soak time may be more appropriate for this study.

CPUE rates determined from the crab survey in the LDW were compared to data collected in November 2002 for the WDFW Dungeness Crab Management Commercial Test Fishery conducted in Region 4 to assess this potential bias. Pot soak times in this test fishery ranged from 0.5 to 72 hours with an average soak time of 22 hours. Preliminary analysis of these data suggests CPUE rates decrease with soak time such that pots set for 0.5 to 5 hours averaged 1.2 crabs per hour whereas pots set for 20 to 25 hours averaged 0.3 crabs per hour. However, the variation within each time period (0.5 to 5 hours and 20 to 25 hours) was quite high. In addition, on a per pull basis (versus an hourly soak time), twice as many crabs on average were collected in the 20-25 hour soaks versus the 0-5 hour soaks. Pots soaked for longer than 25 hours had very similar yields per pull to the 25-hour soaks.

2.4.3 Accuracy

No data on shellfish populations have been reported for the LDW; thus, no previous estimates of the variability of shellfish populations or harvests are available for assessing the accuracy of data generated from these surveys. The methods employed for the clam survey are based on methods that take into account the variability of clam populations elsewhere in Puget Sound (Campbell 1996). Consequently, the accuracy of the data generated from this survey may be similar to the accuracy of the data generated by WDFW during other surveys. However, the WDFW survey methods were designed to quantify abundances of only three clam species (Campbell 1996) from beaches that are likely to be more productive than LDW beaches. Other clam species present in the LDW, such as *Mya arenaria* and *Macoma* sp., but not regularly surveyed by WDFW at other Puget Sound beaches, may have different population distributions that may not be accurately characterized by the proposed methods. Because of the differences in potential productivity between LDW beaches and other regularly sampled Puget Sound beaches, the sampling density for this survey will be higher than that specified in the WDFW methods (see Section 3.2.2).

The accuracy of the crab and shrimp surveys should be comparable to the accuracy of other surveys using similar gear, but the inherent bias in the gear used for this survey (see Section 2.4.2) and the natural variability in biological populations make it difficult to quantify the accuracy of these surveys.

2.4.4 Representativeness

Given the known bias in the sampling gear to be used in these surveys, it is important to discuss the representativeness of the data to be obtained within the context of the survey objectives. The methods employed for the crab and shrimp survey are designed to estimate the potential for harvest (as catch per unit effort) of these organisms throughout the LDW, not to estimate population abundances. The methods used in this survey to sample shrimp and crab are designed to be more effective at retaining adults than smaller-sized individuals. While other methods, such as trawling, would be more effective at sampling smaller-sized individuals, these methods would not reflect what the average harvester might be obtaining using the common pot method, which is the purpose of this survey. The methods employed for the intertidal clam survey are designed to estimate population abundances in the exposed intertidal areas of the LDW. These clam abundance estimates can then be used to infer the potential for harvest of clams in the LDW. Within the harvestable portion of the total populations of these shellfish species, representativeness will be ensured by:

- Sampling gear will be similar to gear likely used by recreational and subsistence harvesters of these species

- Surveys will be conducted over the entire LDW; all beaches with clam presence potential, as determined during the reconnaissance survey (see Section 3.2.2) will be sampled for clams and 38 shrimp and crab pots will be deployed throughout the study area

2.4.5 Comparability

Methods used in this survey to estimate potential harvestability of shellfish populations are the same as those used by WDFW and tribal biologists throughout Puget Sound. Therefore, comparisons could be made with data from these other regions. However, historical data on shellfish abundance in the LDW do not currently exist; therefore, the site-specific comparability of the data to be collected during these surveys cannot be assessed.

2.4.6 Completeness

LDW areas with the potential to support crab, shrimp, and clam populations will be surveyed. For the clam survey, potential clam beaches will first be identified by elevation. Previous identification of exposed intertidal habitat from aerial photographs suggests that large areas of exposed intertidal habitat exist in the LDW, particularly upstream from Slip 4. Some proportion of these areas may consist of marginal clam habitat such as hardpan sediment. Therefore, these areas will be identified during the reconnaissance survey by on-the-ground inspection. All clam beaches will be ranked during the reconnaissance survey for clam potential based on clam presence and substrate and placed into three categories based on clam habitat potential: good, medium, and poor. The majority of the sampling effort will be on the good quality beaches, although beaches from each category will be sampled during the survey. This method will ensure that a range of habitats, possibly with varying clam abundances, are assessed during the survey.

The crab and shrimp survey is designed to adequately sample the LDW for potential crab and shrimp harvestability. Repeated sampling throughout the year will ensure that seasonal fluctuations in crab and shrimp populations will be documented.

2.4.7 Sensitivity

Because of the environmental and biological variables that control the abundance of the target invertebrate species, the sampling gear is not highly sensitive. Small differences in catch between sampling locations may not be biologically significant. However, the selected sampling methods are consistent with accepted scientific practice. More sensitive methods than those selected for this study may not exist, and in any case, are not needed for the stated objectives.

2.5 SPECIAL TRAINING/CERTIFICATION

Windward field personnel are trained environmental scientists with extensive experience doing field research. All personnel will be well versed in crab, clam, and shrimp identification and will use identification manuals for species identification. In instances where a specimen can not be positively identified in the field, Windward will take a digital photo of the specimen in question or collect a voucher specimen to be identified after consulting an invertebrate expert. Windward field personnel are also knowledgeable boat handlers.

The field crew leader for the intertidal clam survey, Maryann Welsch, was trained on June 18, 2003 by WDFW shellfish biologists at Sequim Bay State Park to use the WDFW clam survey methodology (Campbell 1996). During this training, Maryann learned how to apply the survey techniques among differently shaped beaches, to dig holes to the proper depth while preventing hole collapse, and to identify the common species of clams including: manila and native littlenecks, butter, horse, eastern soft shell, and bent-nosed and sand macomas. Kevin Li (King County field biologist) is responsible for all the County's clam sampling and will also provide expert advice to the LDWG field team.

The field crew leader for the crab and shrimp survey, Bob Complita, has had extensive experience catching Dungeness crab throughout the West Coast, and has conducted similar surveys for crayfish in the Willamette River in Portland, OR.

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. 29 CFR 1910.120 requires training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary. The 40-hour course meets the requirements of the OSHA regulation 29CFR§1910.120(e)(3). However, individuals without HAZWOPER training will be allowed to attend sampling events, but will not be allowed to participate in digging clam holes or other activities that would place them in contact with the sediment.

2.6 DOCUMENTATION AND RECORDS

All Windward field staff, as well as the project manager in the office, will have a copy of the most current and approved QAPP.

A complete record of all field activities will be recorded in a field logbook maintained by the field team leaders. The field logbook will provide a description of all sampling activities, discussions among field crew associated with field sampling activities, sampling personnel, weather conditions, and a record of all modifications to the procedures and plans described in this QAPP. The field logbook will consist of bound,

numbered pages. All entries will be made in indelible ink. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

After sample collection, the following information will be recorded on the field log sheet:

- date and time of collection and name of person logging sample
- names of crew members
- project name
- weather conditions
- sample location coordinates
- time of high and low tides for day
- information on collected specimens: species, size, collection depth, and sex (if possible)
- comments

The data report package for the intertidal clam survey and crab and shrimp survey will include a table with species identification, count, size, and location. A data memorandum will be produced after each of the quarterly crab and shrimp survey events and a final data report will be produced at the completion of the four quarterly surveys. Information on species, size, and location, and date will be included. Additionally, information about tidal stage and time of day will be included.

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

- Written report of the intertidal clam survey and crab and shrimp survey including survey methodology, equipment, and analysis
- Field records including logbook entries and survey forms
- Maps of survey sampling locations
- Analysis of clam, crab, and shrimp abundance data
- Qualitative analysis of other shellfish presence throughout LDW that may be harvested (e.g., mussels, oysters, shore crabs).

3.0 Data Generation and Acquisition

3.1 SURVEY DESIGN

Two types of surveys will be conducted to estimate the potential harvestability of shellfish populations of the LDW. The crab and shrimp survey will assess the crab and

shrimp populations available for potential subsistence and recreational harvest throughout the LDW. The intertidal clam survey will assess the clam populations on the exposed intertidal areas of the LDW. Incidental observations of other intertidal invertebrate organisms, including shore crabs and oysters, will be made during the latter survey. Detailed information on experimental design is discussed in the following sections.

3.1.1 Crab and shrimp survey

The crab and shrimp survey will be conducted to estimate the potential harvest rate of shrimp and crabs by subsistence and recreational fishers in the LDW. Potential crab species that may be caught in this survey include Dungeness crab (*Cancer magister)*, red rock crab (*Cancer productus*), and the slender crab (*Cancer gracilis).* Potential shrimp species include spot prawn (*Pandalus platyceros),* sidestripe shrimp (*Pandalopsis dispar),* dock (coonstripe) shrimp (*Pandalus danae),* humpback (coonstripe) shrimp (*Pandalus hypsinotus),* humpy (coonstripe) shrimp (*Pandalus goniurus),* Northern (rough) pink shrimp (*Pandalus eous),* and ocean (smooth) pink shrimp (*Pandalus jordani).* To meet the study objectives, the crab and shrimp population in the LDW will be surveyed at 38 sampling locations throughout the LDW study area (Figure 1). Sampling locations have been placed throughout the study area with a relatively uniform sampling density by area. Consequently, there are more sampling locations in the northern portion of the study area because the river channel is wider there compared to the southern part of the study area. Sampling locations were not placed in intertidal areas where shallow depths and tidal influence may expose the traps at low tide, rendering them ineffective.

Crab and shrimp pots will be used for this survey because they can be used over relatively long time periods to reflect daily variability in tides and other environmental variables. While other methods such as trawling or ring nets are also commonly used, trawling is not used for harvesting shrimp in the LDW and ring nets are less efficient than pots at retaining individuals over the long soak times. Pots will be deployed at 13 locations at a time. Pots will be placed more than 100 m apart, so as to provide adequate spatial coverage over the entire LDW with a reasonable number of pots and to avoid pot competition. Pots will be allowed a 4-hour or 24-hour soak time after deployment, depending on the results of the pilot study described in Section 2.4.2. A 24-hour soak time would allow for sampling during both high and low tide, during which time crab and shrimp abundances may change. If the pilot study results suggest a 4-hour soak time would be more appropriate for this study, the tidal stage will be considered when deciding when to deploy and retrieve the pots. Regional crab biologists will be consulted to determine the optimal deployment schedule to maximize the catch. If 4-hour soak times will be used, LDWG will consult with EPA on the deployment schedule prior to conducting the first quarterly crab and shrimp survey. After the designated soak time has elapsed, the pots will be revisited and

pulled in quickly at a constant speed with the aid of a rope grip to avoid shrimp escape.

All species caught will be examined and their pertinent information recorded. Specimens will then be released to the LDW. Because sampled crab and shrimp will be re-released in the LDW where they were caught, there is some potential for recapture of the same specimens in pot deployments farther upstream. Recapture is likeliest between the upstream end of one day's deployments and the downstream end of the next day's deployments. This will not adversely affect the data usability, however, because one of the goals of this survey is to make a qualitative estimate of potential crab and shrimp catch rates throughout the LDW, not just at a specific area where the pot was deployed. After retrieval and data collection, pots will be rebaited and moved to the next 13 upstream sampling locations. This process will be repeated for 3 consecutive days until all locations have been sampled.

Windward will repeat this crab and shrimp survey four times throughout the year. This will estimate seasonal variation of the potential harvestability of crabs and shrimp throughout the year. The quarterly surveys will be conducted in August, October, January, and late April. These sampling times were chosen so as to avoid sampling during the annual molt of larger Dungeness crabs in central Puget Sound (late January to early April), when molting crabs are not likely to be caught because they do not feed during molting (Childers 2003). This also ensures sampling in the late summer when tides are higher and river flows are lower. During this time of year, the LDW will be more saline due to increased saltwater influence and decreased freshwater outflow. During this period of increased salinity, there will be a higher likelihood that crab abundances will increase as crabs move farther up into the system from Elliott Bay (Childers 2003). After the first quarter of sampling in August, where sampling protocol and design will follow this QAPP, Windward may consider modifying the QAPP in order to be responsive to any obstacles or issues that arise during or after the first sampling event. Any potential modifications to the study design will be discussed with EPA and Ecology prior to implementing the second quarterly survey.

3.1.2 Intertidal clam survey

The intertidal clam survey is designed to estimate the harvestable populations of all clams present in intertidal areas within the LDW, including, but not limited to, Manila clam (*Tapes philippinarum*), native littleneck clam (*Protothaca staminea*), butter clam (*Saxidomis giganteus*), eastern soft-shell clam (*Mya arenaria*), sand clam (*Macoma secta*), bent-nosed clam (*Macoma nasuta*), and inconspicuous macoma clam (*Macoma inconspicua*).

The first phase of the intertidal clam survey will be a reconnaissance boat survey to locate potential clam beaches throughout the LDW. The Phase 1 RI for the LDW (Windward 2003) identified intertidal areas based on aerial photographs taken during

a negative tide (-2 ft MLLW) (Figure 1). These areas will be visited during the reconnaissance survey, in addition to any other beaches that may potentially support clams based on substrate and elevation. The location of each beach will be recorded, mapped, and re-visited in the second phase of the clam survey. All beaches will be ranked based on best professional judgment of the quality of the habitat and the presence of clams and placed in three categories: good, medium, and poor. Sampling will focus on the good quality beaches but medium and poor quality beaches will also be included. Sampling events of the second phase will take place during a four-hour period centered on the lower low tide on days with the lowest negative tide (-2 to -3 ft MLLW) during the first half of August 2003. Conducting surveys at the lowest negative tide will ensure that the maximum area is exposed for sampling clams to assess the maximum potential harvest.

Clam survey methods will be based on the WDFW guidance (Campbell 1996). The study area of each beach will be defined by designated physical boundaries perpendicular to the shoreline and by the top of the clam band (the highest elevation that clams are found on the beach as determined by test holes) and the waterline. For each survey, transects will be laid out perpendicular to the water and sampling points will be located along each transect. Sampling point densities will depend on the size of the beach (see Section 3.2.2). At each sampling point, 0.028 m^3 of substrate will be removed and placed in a sorting bin. All clams present within the substrate will be removed and placed in plastic bags for later identification and measurement in the laboratory.

Descriptions of the substrate will also be recorded at each beach and will include measurements of percent fines and interstitial salinity. The percent fines and interstitial salinity data will be used to qualitatively describe the substrate for each distinct sample area. The species and number of clams found at each beach will be compared to the type of substrate at that beach to qualitatively assess the abundance of clams per beach throughout the LDW. These data will not be used to make statistical comparisons of habitat type and clam abundance. In addition to clams, observations of other invertebrate species identified during the intertidal survey will be recorded. These species may include, but are not limited to, oysters and shore crabs. Additional observations of mussels on hard surfaces other than intertidal beaches (e.g., pilings) will be made during transit between beaches.

3.2 SURVEY METHODS

3.2.1 Crab and shrimp survey

Crab and shrimp samples will be collected using Ladner 30″ SS rubber-wrapped crab traps and Ladner 30″ nestable shrimp pots. Zinc anodes will be attached to the pots to prevent corrosion in the estuarine water. If 24-hour soak times are used (see Section 3.1.1), 24- hour zinc time float releases will be used to submerse the buoys of

pots deployed in the navigation channel, therefore avoiding impeding boat traffic. After 24 hours, the time float release connection will break, releasing the buoy to the surface for retrieval. A small pilot survey will be conducted prior to the first quarterly crab and shrimp survey to evaluate the behavior of the zinc timers in estuarine salinities. This pilot survey will be part of the study described in Section 2.4.2 designed to evaluate soak times. The timers are calibrated for full salinity for a variety of different water temperatures. Several different timers will be tested at several different locations. If a 24-hour timer does not release within 24 hours (plus or minus 2 hours) for a particular location during the pilot study, timers will not be used at that or other locations with similar salinity during the quantitative survey.

Prior to each field sampling event, the following materials will be assembled:

- 15-20 crab pots, mesh size of 1.0 in
- 15-20 shrimp pots, mesh size of 0.5 in
- 15-20 bait bags or bait jars
- 30-40 buoys
- 250 m of leaded 5/16" diameter Manline line
- 15 lbs of shrimp pellet bait
- 50 lbs of commercial crab bait (a mixture of fish, squid, and clams)
- field forms and field notebook with pens
- digital camera
- GPS unit
- Calipers
- Collection buckets
- ID guides
- Gloves
- 15-20 24-hour zinc time float releases (if needed based on the designated soak times)
- Maps

All material will be collected and inspected by the field team leader before each day of sampling. Pots will be inspected for holes or damage before each deployment. Sample locations (Table 1) will be located using a Magellan Color TRAK GPS unit. If any of the sampling locations are found to be inaccessible due to boat traffic or other physical obstacles, the target location will be moved upstream or downstream, depending on which is most accessible, as needed to avoid the obstacle. Windward will coordinate

with the Muckleshoot Tribe to avoid placing pots during tribal fishing seasons to avoid potential entanglement in gill nets.

Sample deployment will begin at the most downstream sample location and move upstream. At each sampling location, crab and shrimp pots will be baited and attached to separate lines, buoys, and zinc time float releases before being lowered overboard. Buoys will be attached with zinc time float releases as close to the pot as possible, without inhibiting pot function. Crab pots will be baited by filling a nylon bait bag with appropriate amounts of bait, and attached to the inside of the crab pot. Each shrimp pot will be baited with shrimp pellet bait. Date, time, and location of each pot's deployment, as well as the times of high and low tides for the day, will be recorded in the field sampling form. Thirteen pots of each type will be deployed on each sampling day.

Table 1 Sample locations for crab and shrimp survey

LOCATION	LATITUDE [a]	LONGITUDE [a]	NORTHING [b]	EASTING [b]
WWS-1	47 34.13689	122 21.04283	211228	1265856
WWS-2	47 34.10889	122 20.82347	211040	1266755
WWS-3	47 34.02146	122 20.92764	210517	1266316
WWS-4	47 33.96449	122 20.81927	210162	1266755
WWS-5	47 33.88106	122 20.88297	209660	1266483
WWS-6	47 33.80662	122 20.78941	209200	1266859
WWS-7	47 33.73629	122 20.89407	208781	1266420
WWS-8	47 33.71411	122 20.75609	208635	1266985
WWS-9	47 33.59982	122 20.81378	207945	1266734
WWS-10	47 33.58421	122 20.68864	207840	1267247
WWS-11	47 33.50142	122 20.70422	207338	1267173
WWS-12	47 33.39470	122 20.45201	206669	1268198
WWS-13	47 33.36867	122 20.60388	206523	1267570
WWS-14	47 33.33187	122 20.78558	206314	1266818
WWS-15	47 33.23477	122 20.51567	205702	1267917
WWS-16	47 33.11985	122 20.42218	204996	1268288
WWS-17	47 32.99738	122 20.42763	204252	1268251
WWS-18	47 32.90697	122 20.33462	203695	1268623
WWS-19	47 32.79082	122 20.32227	202988	1268660
WWS-20	47 32.78068	122 20.16841	202914	1269292
WWS-21	47 32.65761	122 20.21905	202170	1269069
WWS-22	47 32.55797	122 19.89083	201538	1270408
WWS-23	47 32.54276	122 20.12024	201464	1269462
WWS-24	47 32.42273	122 19.94112	200720	1270185
WWS-25	47 32.35325	122 19.71973	200280	1271088

LOCATION	LATITUDE [a]	LONGITUDE [a]	NORTHING [b]	EASTING [b]
WWS-26	47 32.24292	122 19.66506	199605	1271300
WWS-27	47 32.10614	122 19.49473	198760	1271985
WWS-28	47 32.13629	122 19.16519	198917	1273345
WWS-29	47 32.04876	122 19.31623	198397	1272713
WWS-30	47 31.93414	122 19.18663	197690	1273233
WWS-31	47 31.86877	122 19.04023	197281	1273828
WWS-32	47 31.71331	122 18.77395	196315	1274906
WWS-33	47 31.44158	122 18.50441	194642	1275984
WWS-34	47 31.11287	122 18.37756	192634	1276468
WWS-35	47 30.87533	122 18.29873	191184	1276765
WWS-36	47 30.74221	122 18.18667	190366	1277211
WWS-37	47 30.69721	122 17.88745	190069	1278438
WWS-38	47 30.54856	122 17.54916	189139	1279814

[a] NAD83 GCS

[b] Washington State Plane North coordinates, NAD83, US survey feet

All pots will be retrieved in the same order as they were deployed. If any pot can not be relocated from a visual search at the water's surface, an attempt will be made to retrieve it as soon as practical using SCUBA divers. This ensures that lost pots will not continue to fish indefinitely, thereby harming the local crab or shrimp population. Any pots lost during sampling will be replaced and all pots will be outfitted with a degradable latch to ensure that escape holes will open if the pot is lost. The date, time, and location of the pot will be recorded after each pot is pulled out of the water. Specimens collected will be removed from the pots and the species, length, and sex will be recorded for crabs and the number of ovigerous females will be recorded for shrimp. Crab length will be determined by measuring, with calipers, at the widest part of the shell, just in front of the rear-most tips. Shrimp length will be determined by measuring from the base of the eyestalk to the top rear edge of the carapace. Specimens will then be returned alive to the area from which they were collected. If species identification is impossible or uncertain in the field, a digital photo and voucher specimen will be taken to be reviewed by an invertebrate specialist.

The following data will be recorded in the field sampling form for each pot:

- Date
- Time of high and low tides for day
- Names of field crew
- Field recorder's initials, measurer's initials
- Sample (pot) number
- Time of pot retrieval

- Species
- Length
- Sex

An example field form is shown in Table 2.

Table 2. Crab and shrimp survey: field survey sheet

Page ____ of ____

Deployment date: _____ Deployment date: _____

High tides: _____ High tides: _____

Low tides: _____ Low tides: _____

Crew: _____

Sample #	Location		Depl. time	Retr. time	Species	Length	Sex	Comments
	Latitude	Longitude						

3.2.2 Intertidal clam survey

Windward will conduct a reconnaissance survey by boat in the LDW during a negative tide on July 16, 2003. Potential study areas, or clam beaches, will be identified based on type of substrate and size, and previous identification of exposed intertidal habitat from aerial photographs (as indicated in Figure 1). Areas will be further investigated for clams in the second phase of the survey if there is a substantial amount of area exposed during low tides and if the majority of the substrate does not consist of large rocks or debris that would be difficult to move. Areas that will not be considered are those that are entirely covered in large rocks or riprap, bulkheads, or other overwater structures or if the exposed beach area is small and not likely to attract many recreational and subsistence harvesters. The location and size of each clam beach will be recorded in the field notebook using GPS coordinates.

A second reconnaissance survey will take place during negative tides on July 29th and 30th, 2003. Each area identified in the first reconnaissance survey will be visited and an on-the-ground assessment of the quality of habitat for clams and the presence of clams will be made. The assessment will be qualitative and will rely on the best professional

judgment of the shellfish biologists conducting the survey. Each area will then be ranked, based on the assessment of the habitat quality and the presence of clams, and placed into three categories: good, medium, and poor. LDWG will consult with EPA and tribal biologists on the qualitative habitat ranking prior to beginning quantitative clam sampling. Because surveying all the exposed intertidal habitats will not be possible, surveying will focus on the good quality beaches with some additional effort to include some of the medium and poor quality beaches.

Following the reconnaissance surveys, potential clam beaches will be re-visited during the second phase of this survey, which will take place from August 8 to August 13, 2003. Prior to each field sampling event, the following materials will be assembled:

- Maps of the waterway and beaches
- Approximate size and sampling density (i.e., sample block size) for each study area determined during the reconnaissance survey
- Tidal information (time and height)
- Survey forms, sample processing forms, field notebooks, pens, pencils, and random number table
- Surveyor flags and compass, staff gages for elevation measurements
- Quadrat outline (0.093-m^2 hoop), garden spades, shovels, and bins for sample sorting
- Refractometer, 10 cc syringe, #2 Whatman filters, 63-µm sieves, 50 mL beaker, 100 mL graduated cylinder, spatulas, carboy of water, water bottles
- Intertidal invertebrate identification guide

A two-stage[1] random sampling plan will be employed in which the study area is surveyed from the top of the clam band to the waterline. Sampling densities per beach will be determined based on the area of each beach within the boundaries and the habitat quality assigned to each beach during the reconnaissance survey. Block sizes will range from 93-370 m^2 (1000-4000 ft^2) for each beach. The smallest block size (i.e., the highest sampling density) will be used at the high quality beaches. An intermediate block size of 186 m^2 will be used for the medium quality beaches and the largest block size of 370 m^2 (i.e., the WDFW default block size) will be used for the low quality beaches. LDWG, EPA, and Tribal representatives will hold a conference call following the first day of sampling high quality beaches to discuss the suitability of the block sizes. The block size to be used for the remainder of the sampling may be altered during the conference call, based on an analysis of the variability in the population estimate at each beach. The WDFW data analysis methods (Campbell 1996) specify

[1] The two stages refer to the reconnaissance survey followed by a quantitative survey

several equations that can be used to estimate the sampling variability. The population total is calculated according to Equation 1.

$$\hat{T} = N\hat{\mu}$$ **Equation 1**

where:

$\hat{T}$	=	population estimate (number of clams) in sampled area
N	=	productive area of the beach sampled (ft²)
$\hat{\mu}$	=	the mean number of clams per sample (assuming a 1 ft² [0.093 m²] sampling quadrat

The bounds on the error surrounding this estimate is given by Equation 2.

$$B = 2\sqrt{N^2 \frac{\sigma^2}{n}}$$ **Equation 2**

where:

B	=	bounds on the error of the population estimate (i.e., one-half the length of the 95% confidence interval
σ^2	=	estimated variance of the samples
n	=	number of samples

According to WDFW methods, if B is within 30% of $\hat{T}$, the sampling density is sufficient for the observed variability. The number of samples that should be taken within each beach to achieve this level of precision can be calculated according to Equation 3 by setting B equal to 30% of $\hat{T}$.

$$n = \frac{N^2 \sigma^2 4}{B^2}$$ **Equation 3**

The data collected during the first day's sampling will be quickly analyzed according to these equations in time for the afternoon sampling design conference call. Regardless of the results of this analysis, block sizes would not be increased above 370 m², which is the default block size used by the WDFW to survey beaches where no previous clam population data have been collected (Campbell 1996). The schematic on Figure 2 shows a hypothetical sampling design for this default block size.

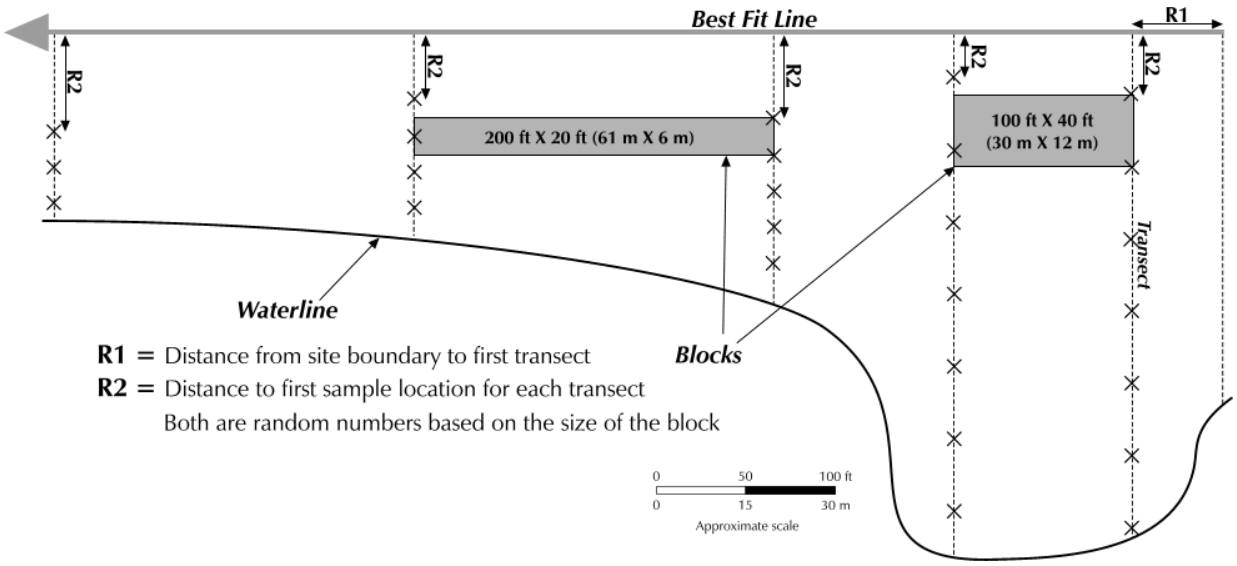

Figure 2. Intertidal clam survey sampling design schematic

Sampling density may also change relative to the presence of clams. In areas where clam abundance is zero in 10 consecutive samples or in all samples from 3 consecutive transects, whichever is greater, the sampling effort may be reduced such that transects will still be laid at the same frequency and distance apart but only one sampling location per transect will be sampled. The single sample for each transect will be randomly selected. This will ensure that clam presence in this area will still be assessed in an efficient manner. Once a change in clam presence or substrate is observed, sampling effort will resume at the block size originally designated for that beach.

The sampling grid for each beach will be laid out by surveying a "best fit" baseline, which runs parallel to the shoreline near the top of the clam band (Figure 2; Campbell 1996). Test holes are dug in the vicinity of the baseline to determine the top of the clam band. If no clams are found in the test holes, an approximate elevation of +6 ft MLLW will be used as the top of the clam band. Elevation will be estimated to the nearest foot using two staff gages, one at the water line and one at the upper intertidal target location. A third crew member will observe the two staff gages simultaneously from a sufficient distance down the beach to determine the elevation differences between the two gages. Low abundances of clams are likely to be found above +6 ft MLLW in the LDW. Transects are laid out perpendicular to the baseline and the distance of the first transect from the study area boundary will be chosen from a random number table based on the targeted block size for that beach. The first quadrat locations will be placed along the transect using a random number within the specified block size. Subsequent transects and quadrats will be placed using the decided block size for that study area (63-125 m^2). For example, for a stretch of exposed intertidal beach in the LDW measuring 400 m in length and 8 m in width (from waterline to approximately

+6 ft MLLW), transects would be laid approximately 35 m apart along the baseline and sampling quadrats would be placed approximately 2 m apart along each transect (for a block size of 70 m^2). Survey flags will be placed at each quadrat and the location will be recorded.

The location of any distinguishing landmarks, such as large debris or rocks or the presence of piers, will be noted for each study area. To accommodate curves, turns, spits, peninsulas, or large obstacles in the study area, the best fit line will be amended using the "stair step" method (Campbell 1996). This is accomplished by traveling along the last possible transect to a point where the best fit line can be extended by either using the same compass bearing or in the case of turns or curves, using a new compass bearing which may be perpendicular to the original best fit line. New compass bearings of the best fit line and subsequent transects will be accurately recorded. If sampling a particular quadrat is not possible due to the presence of a large, unmovable obstacle, the quadrat location will be moved the least distance possible up or down the transect. If the least distance is greater than half the distance to the next quadrat, the sample location will be eliminated.

A survey form (Figures 3 and 4) will be completed to map the exact sampling locations for each beach and will include the following items:

- Beach name, date, surveyors' initials
- Photo locations
- Tidal height and time, block size, direction of survey
- Boundary designation and GPS coordinates, locations of distinguishing landmarks
- Direction of best fit line and distance to the top of the clam band (based on test holes)
- Direction and distance to first transect and first sample quadrat per transect (random number) from boundary, distance between subsequent transects and sample quadrats (based on block size), and distance from last sample to the water
- Any changes in direction of best fit line and transects and any eliminated quadrat locations due to obstacles
- Transect and sample numbers
- Dominant substrate type and measurements of percent fines and interstitial salinity of the study area. Changes in substrate will be noted per sample quadrat.

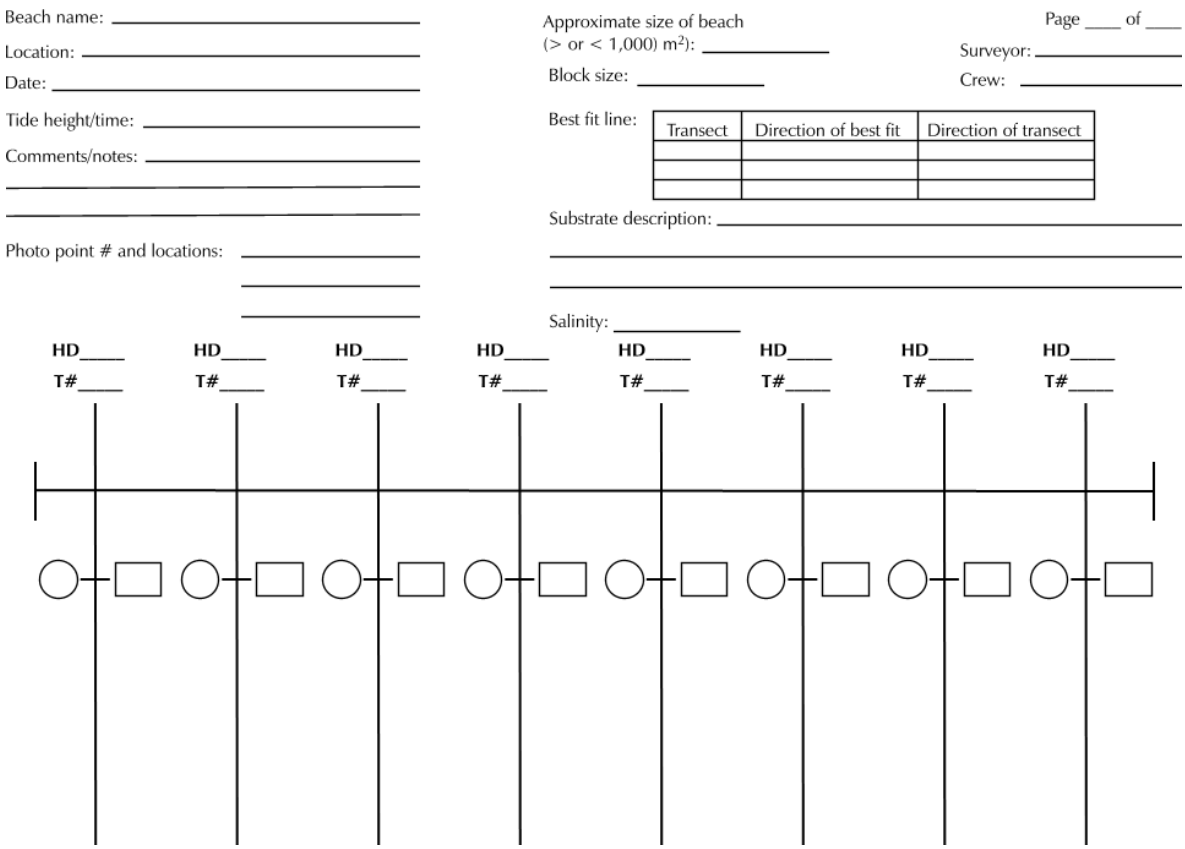

Figure 3. Intertidal clam survey: field survey sheet

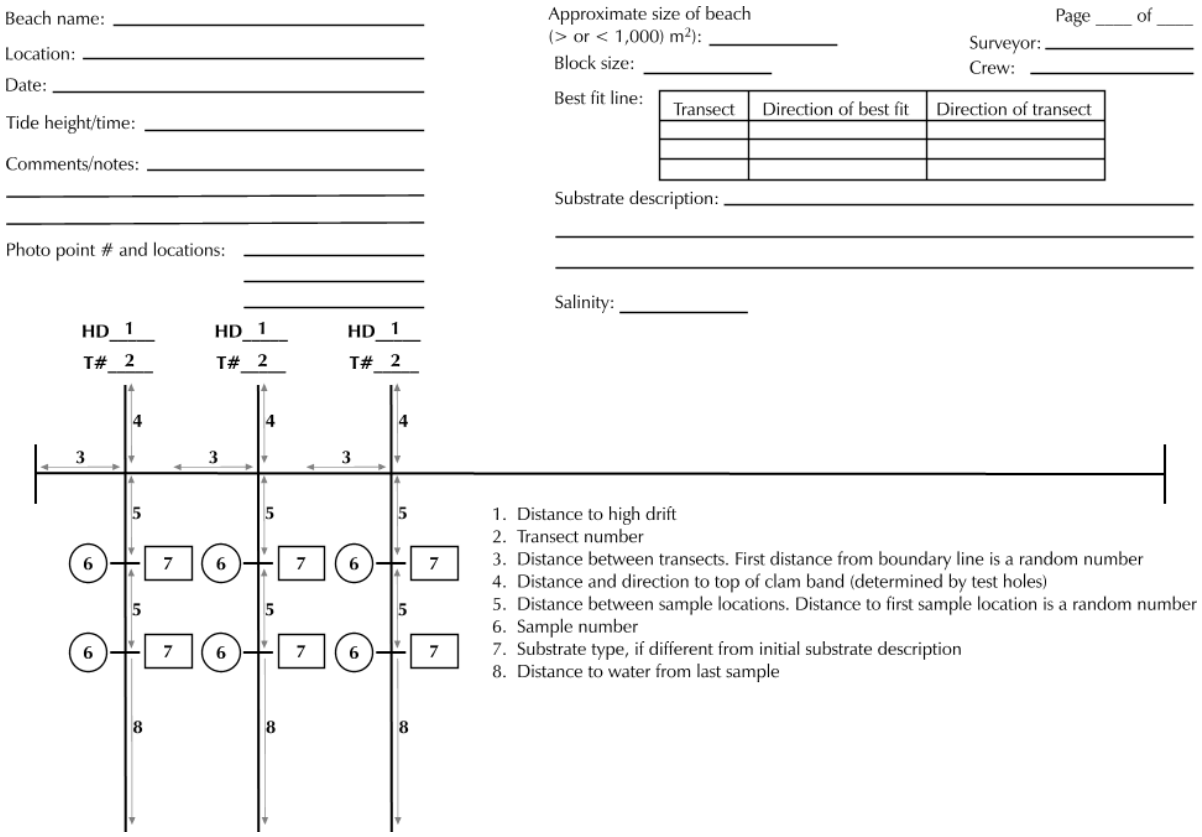

Figure 4. Instructions for Intertidal clam survey: field survey sheet

After each sampling quadrat location has been surveyed, flagged, and recorded, a 0.093-m² hoop will be placed on the sampling location and centered on the survey flag. This is the size of the WDFW sampling quadrat. A hole the exact size of the hoop will be excavated to a depth of 30 cm, as specified by Campbell (1996), and sediment placed in a sorting bin. All clams will be removed from the substrate and placed in plastic bags. In the laboratory, each clam will be identified, numbered, and recorded on the data sheet. The length of each clam will be measured at the widest point of the shell using calipers and the weight will be measured using a bench-top scale. All clams weighing less than 0.10 g and/or measuring less than 2 cm in length will be counted and grouped and the cumulative weight of clams per species in each sample will be measured and recorded. Clams embedded in the sides of the hole will be included in the count only if >50% of the clam extends into the hole. A sample processing form will be completed for each beach and will include the following information (Table 3):

- Beach name, date, number of samples
- Form recorder's initials, measurer's initials

- For all clams within each quadrat sample: quadrat number, species identification, number of clams/species, and length and weight of each individual clam
- If a clam has a broken shell and is missing pieces of the shell, the above information is recorded except the length and weight which will be replaced with the word "broken"

Table 3. Intertidal clam survey: field sample sheet

Beach name _____ Caliper type _____ Page ____ of ____

Location _____ Samples _____ to _____ Recorders: _____

Date _____ Measurers: _____

Sample number	Species	#	Shell length	Weight		Sample number	Species	#	Shell length	Weight

Interstitial salinity measurements will be taken using methods from PERL (1990). A single sediment core from each beach will be collected within 1 m of the waterline with a 2.5 cm-diameter core tube to a depth of 30 cm. Cores will be taken from sediment that is saturated to ensure that a sample of interstitial water can be expressed from the sample. Subsamples from the top (surface), middle, and bottom (~30 cm) of each core will be composited together and loaded into a 10-mL plastic syringe lined with #2 Whatman filter paper. The plunger is then inserted into the syringe and a drop of water is forced into the refractometer. A temperature compensated refractometer with a range of 0-150 ppt will be used for this analysis. The salinity of each subsample per beach will be recorded on the Field Survey Form (Figure 3).

Percent fines will be estimated in the laboratory using a rapid wet sieving technique (Gibson 2000). Several grab samples of substrate will be collected throughout the study area on each beach. These collections will be composited together and a 50 mL subsample will be analyzed. The subsample will be washed through a 63-µm standard sieve using water bottles filled with fresh water. Sediment remaining on the sieve will

be carefully placed into a 100-mL graduated cylinder using a stainless steel spatula and a water bottle. After the sediment and water mixture in the cylinder settles for five minutes (and the supernatant water is relatively clear), the volume of the coarse-grained fraction is recorded and is subtracted from the original volume to obtain the fine-grained fraction. This volume divided by the original volume will yield an estimate of the percent fines. Percent fines will be recorded for each beach on the Field Survey Form (Figure 3).

Information on the presence of other intertidal shellfish will be recorded for each beach. These shellfish may include oysters, mussels, and shore crabs. Formal surveys for these organisms will not be conducted, but attempts will be made to make observations throughout the beach during the clam survey (i.e., looking under logs, debris, rocks, etc). The number, location, and identification, if possible, will be recorded for each observation. This information will be used as qualitative evidence of other potentially harvestable intertidal organisms that may be collected by recreational and subsistence harvesters from the LDW.

On the last day of sampling (August 13, 2003), areas of highest clam abundance, among those sampled earlier in the survey, will be revisited to assess potential CPUE at each site. Individuals will target specific locations within each beach based on observations of clam siphon holes. Holes will not be limited to a specific depth (e.g., 30 cm) because the intent of the targeted sampling is to locate clams, not to randomly sample a particular volume of sediment. Holes may be deeper than 30 cm if the field biologist believes a clam can be found in a particular hole below 30 cm. The length of time spent digging at each beach and the number of clams collected will be recorded so that CPUE rates can be calculated.

3.3 SAMPLE HANDLING AND CUSTODY

Each clam collected during the survey will be placed into bags identifying the collection location, transect, and hole, and then placed on ice. Data on species and size of collected specimens will be recorded in the laboratory. A single voucher specimen of each clam and shore crab species will be collected for archival and taxonomic verification purposes. Voucher specimens of Dungeness and red rock crab will not be collected because they are very easy to identify in the field, although a digital photograph of one individual of each species will be taken. Each clam specimen will be sacrificed in the field by removing the soft body parts from between the shells. Care will be taken to preserve the hinge on each pair of shells. Shore crab specimens will be placed in 10% ethanol and stored in a glass jar.

3.4 DATA PROCESSING METHODS

3.4.1 Crab and shrimp survey

Crab and shrimp data collected during the survey will be summarized by number and mean length of each species per sampling pot. CPUE will be calculated for each crab and shrimp species collected per pot by counting the number of individuals of each species for each pull of the pot.

Potential crab and shrimp harvest data will be summarized per sampling pot and for the entire LDW and presented in tables in the data reports.

3.4.2 Intertidal clam survey

Clam data collected during the intertidal clam survey will be summarized by mean number and weight of each clam species by productive area for each beach.

To summarize the harvest per beach, the "productive" area of each beach will first be calculated by multiplying the length of each transect by the width of the block and summing all the block areas surveyed within the study area. The mean number and weight of clams per species is determined and multiplied by the productive area of each beach for the total number and weight of clams per species throughout the LDW. Potential clam harvest data will be summarized per beach and for the whole LDW and presented in tables in the survey report.

The volume of the fine-grained fraction of the substrate will be calculated for each beach included in the clam survey by subtracting the volume of the coarse-grained fraction from the volume of the total sample. Percent fines is then calculated by:

volume of fine-grained fraction/volume of total sample

In addition, evidence of other shellfish such as shore crabs and oysters that were found during the clam survey will be presented in a table in the clam survey report. This table will include type of organism, species identification (if possible), location, and an approximate count of number of individuals per species.

3.5 QUALITY CONTROL

3.5.1 Crab and shrimp survey

Within-sampling-unit variability may occur in the crab survey. The presence of one or more crabs in a pot, especially red rock crabs, may prevent additional crabs from being captured by the same pot. This is due to the aggressive and territorial behavior of some crab species (Miller 1980 as cited in Abbe and Stagg 1996). This will not negatively affect this study, however, because this decreased catch rate would also be experienced by recreational and subsistence fishers. As the study goal is to determine potential catch rates for recreational and subsistence fishers, this sampling bias will not compromise the value of the data.

Between-sampling-unit variability may exist as a result of the natural habitat variation within the sampling area. This will be remedied by placing enough sampling units throughout the study area to sufficiently sample all potential habitat types where crabs and shrimp may be found. Between-sampling-unit variability will be calculated for the crab and shrimp survey, but because no comparable site-specific population data exist, the magnitude of the survey bias cannot be quantified.

3.5.2 Intertidal clam survey

Variability of clam numbers and weights will exist between sampling quadrats as a result of the irregular distribution of clams and natural habitat variation of each beach. However, the variability of clam data between quadrats will be reduced by the number of quadrats sampled within a study area. The recommended maximum block size (number of quadrats) is based on data collected from a number of beaches with variable habitat conditions over several years during WDFW surveys (Campbell 1996). However, the WDFW clam population data are collected from saltwater environments and do not include freshwater-influenced sites such as those found in the LDW. Because no previous data exist on clam population size and variability in the intertidal zone of the LDW, it is not possible to assess the magnitude of variability within the clam population prior to the field effort. As discussed in Section 3.2.2, the variability in clam population estimates will be discussed in a conference call with LDWG, EPA, and Tribal representatives following the first day's sampling. Modifications to the block size to be used for the remainder of the sampling may be made at that time.

Physical measurements of percent fine substrate and interstitial salinity will likely vary within each study area and between beaches throughout the LDW. However, the magnitude of variability for these parameters will not be defined during this survey because this information will be used only for the qualitative description of the intertidal habitat for clams at each beach and throughout the LDW.

3.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. Crab and shrimp pots will be inspected for holes or other damage before each deployment. If pot damage is detected, the damage will either be fixed or the pot will be replaced with a functioning pot. Any crab or shrimp pot loss will be documented and the pot replaced.

All equipment used, including the GPS unit, digital camera, and refractometer, will be tested for use before leaving for the field event.

3.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Any instruments used in the field, such as the refractometer, will be recalibrated, when necessary, according to manufacturer's instructions.

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leaders for each sampling effort will have a checklist of supplies required for each day in the field (see Section 3.2). The field team leaders will gather and check these supplies daily for damage before each field event. Batteries used in the GPS unit and the digital camera will be checked daily and recharged as necessary.

3.9 NON-DIRECT MEASUREMENTS

Tide stage data will be obtained from the Harbor Tides website (www.harbortides.com), which provides monthly tide tables for a station at the Lockheed Shipyard on Harbor Island, Seattle, WA.

3.10 DATA MANAGEMENT

All data will be recorded into field notebooks, which will be checked for missing information by the field team leader at the end of each field day. After sampling efforts are completed, all data from field notebooks will be entered into an excel spreadsheet. A 20% QC check will be done to ensure that data were properly transferred from the field notebook to the spreadsheet (see Section 5.2). This spreadsheet will be kept on the Windward network drive, which is backed up daily. Field notebooks will be kept in the Windward library for reference needs.

Crab and shrimp data will be compiled by species, location, size, and date. A sample data spreadsheet is shown in Table 4.

Table 4. Crab and shrimp survey results

SAMPLE NUMBER	DATE	TIME	LATITUDE	LONGITUDE	SPECIES	SEX	LENGTH

Clam survey data will be compiled by species, location, size, and date (Table 5). Salinity and substrate data collected during the intertidal clam survey will also be compiled per location.

Table 5. Intertidal clam survey results

SAMPLE NUMBER	DATE	LOCATION	SPECIES	LENGTH	WEIGHT	SALINITY	SUBSTRATE (%FINES)

Additional invertebrates found during the intertidal clam survey will be compiled according to species, location, date, and estimated number of individuals (Table 6).

Table 6. Other invertebrates found in the intertidal clam survey

SAMPLE NUMBER	SPECIES	LOCATION	DATE	ESTIMATED NUMBER OF INDIVIDUALS

4.0 Assessment and Oversight

4.1 Assessments and Response Actions

EPA, Ecology, or other management agencies may observe survey methods during each sampling event, as needed. If situations arise where there is an inability to follow QAPP methods precisely, the project manager will be contacted and he will determine the appropriate actions.

4.2 Reports to Management

Progress reports during the surveys will be emailed to EPA and Ecology on a daily basis. Windward staff will prepare all data reports including the intertidal clam survey report, each quarterly memorandum following crab and shrimp events, and the final data report. All data reports will be submitted to EPA and Ecology.

5.0 Data Validation and Usability

5.1 Data Review, Verification, and Validation

The following checks will be conducted to ensure data quality:

- Species identification conducted in the field will be verified to ensure accuracy
- Physical measurements taken in the field will be tested to ensure data reliability
- Checks on data management will be instituted to ensure accurate data transfer.

5.2 Verification and Validation Methods

Species identification will be verified through the collection of voucher specimens and photodocumentation. Representatives of each clam species found in the surveys will be collected for identification verification following the field effort. Verification of each voucher specimen will be conducted by Camille Speck, WDFW shellfish biologist at the Point Whitney Shellfish Laboratory. Crab, shrimp, and other invertebrate species observed will be photodocumented for identification verification by Rich Childers, WDFW shellfish biologist at the Point Whitney Shellfish Laboratory.

To ensure data reliability, replicate measurements of percent fines and interstitial salinity will be conducted by two separate individuals using the same equipment at a randomly selected beach included in the clam survey.

Accuracy in data transfer will be ensured through the use of quality control checks. Following data entry into an Excel spreadsheet, data will be validated by conducting a 20% QC check. A random 20% of the sample data entered into the spreadsheet will be double checked against the hard copy field forms. For example, if there are 100

samples collected, the data entered for every 5th sample will be double checked. This will be conducted by a Windward employee who was not involved in entering the data into the spreadsheet. If any mistakes are found in the 20% check, a full 100% check will be completed and all mistakes corrected. All calculations in the spreadsheet used to compile and evaluate data will also be double checked by a second Windward employee to ensure accuracy.

5.3 RECONCILIATION WITH USER REQUIREMENTS

The actions outlined in Section 5.2 will be conducted to ensure quality and reliability of the data collected. The results of the data verification and the corresponding analysis of data quality will be presented in the data reports produced after each field event. Additionally, any deviations from the QAPP that occurred will be addressed. Windward will discuss in the data reports how these deviations may have affected data quality and what corrective measure, if any, had to be taken. Windward will evaluate the methods that were used and the data obtained to ensure the objectives of the study, as outlined in this document, were met.

6.0 References

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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 Project Manager	Date
Name Corporate Health and Safety Manager	Date
Name Field Coordinator/Health and Safety Officer	Date

Acronyms

CPR	cardiopulmonary resuscitation
EPA	US Environmental Protection Agency
FC	field coordinator
HSM	Project Health and Safety Manager
HSO	Field Health and Safety Officer
HSP	health and safety plan
OSHA	Occupational Safety and Health Administration
PSEP	Puget Sound Estuary Program
PCBs	polychlorinated biphenyls
PFD	personal flotation device
PPE	personal protective equipment
TBT	tributyltin

A.1.0 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites and for handling potentially hazardous materials/waste products. 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 and handling of invertebrates (e.g., clams, shrimps, and clams) in the Lower Duwamish Waterway (LDW). During site work, this HSP will be implemented by the Field Coordinator (FC), who is also the designated site Health and Safety Officer (HSO), in cooperation with the Corporate Health and Safety Manager (HSM) and the Project Manager.

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

A.2.1 SITE DESCRIPTION

The sampling 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 sampling program. The following section summarizes the types of work that will be performed during field activities.

A.2.2 SCOPE AND DURATION OF WORK

Specific tasks to be performed are as follows:

- Collection of crabs and shrimp via deployment of baited traps from a boat
- Collection of clams on intertidal beaches by hand digging with shovels

Sampling will commence as early as June 12, 2003 and will be completed by April 2004, as described in the QAPP.

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.

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.

Field Coordinator/Health and Safety Officer: Because of the limited scope and duration of fieldwork, the Field Coordinator (FC) and Health and Safety Officer (HSO) will be the same person. The FC/HSO will direct field sampling 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 FC/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 FC/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC/HSO or his designee shall be present during sampling and 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 FC/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, sampling 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.

A.4.1.2 Sampling equipment deployment

Baited pots will be used to collect crabs and shrimps subtidally. Each pot will be deployed from the bow of the boat via attached nylon line. Care will be taken to ensure that the line is not tangled with other gear onboard the boat or with body parts before deployment. No sampling equipment other than a shovel will be used in the clam survey. Before sampling activities begin, there will be a training session for all field personnel for the equipment that will be onboard the sampling vessel.

A.4.1.3 Falling overboard

Some of the sampling activities 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 from the boat.

A.4.1.4 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.4.1.5 Heat stress, hypothermia, or frostbite

Sampling operations and conditions that might result in the occurrence of heat stress, hypothermia, or frostbite are not anticipated. The sampling will occur during the time of year when extreme weather conditions are not expected to occur.

A.4.1.6 Weather

In general, field team members will be equipped for the normal range of weather conditions. The FC/HSO will be aware of current weather conditions, and of the potential for those conditions to pose a hazard to the field crew. 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 the sampling area. For the purposes of discussing potential exposure to substances in sediments, the chemicals of concern are metals, tributyltin (TBT), petroleum hydrocarbons, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls (PCBs).

A.4.2.1Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Exposure will be minimized by using safe work practices and by wearing the appropriate personal protective equipment (PPE). Further discussion of PPE requirements is presented in Section A.6.

Inhalation —Inhalation is not expected to be an important route of exposure.

Dermal exposure — Dermal exposure to hazardous substances associated with sediments, surface water, or equipment decontamination will be controlled by the use of PPE and by adherence to detailed sampling and decontamination procedures.

Ingestion — Ingestion is not considered a major route of exposure for this project. Accidental ingestion of surface water is possible. However, careful handling of equipment and containers aboard the boat should prevent the occurrence of water splashing or spilling during sample collection and handling activities.

A.4.2.2 Description of chemical hazards

Metals and tributyltin — Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is likely as an exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the metals into the body. Field procedures require immediate washing of sediments from exposed skin.

Petroleum hydrocarbons and PAHs — Exposure to petroleum hydrocarbons and PAHs may occur via ingestion or skin contact. The most important human health exposure pathway for this group of chemicals, inhalation, is not expected to occur at this site. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure, but these effects have not been seen in people. Some PAHs may reasonably be expected to be carcinogens. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the compounds into the body. Field procedures require immediate washing of sediments from exposed skin.

Polychlorinated biphenyls — Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic exposure can damage the liver, and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen. Skin absorption may substantially contribute to the uptake of PCBs. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the compounds into the body. Field procedures require immediate washing of sediments from exposed skin.

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 the following activities:

- Crab or shrimp deployment from boat
- Clam-digging at intertidal beaches

Table A-1. Activity hazard analysis

ACTIVITY	HAZARD	CONTROL
Sampling from a boat	Falling overboard	Use care in boarding/departing from vessel. Deploy and recover the crab and shrimp pots over the bow. Wear PFD.
	Skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	Back strain	Use appropriate lifting technique when deploying and retrieving pots, or seek help.
Clam digging in intertidal beaches	Skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	Back strain	Use appropriate lifting technique when digging in sediment with shovel.

A.5.0 Work Zones and Shipboard Access Control

During sampling and sample handling activities, work zones will be established to identify where sample collection and processing are actively occurring. The intent of the zone is to limit the migration of sample material out of the zone and to restrict access to active work areas by defining work zone boundaries.

A.5.1 WORK ZONE

The work zone onshore will encompass the area where sample collection and handling activities are performed. On the beach, the FC/HSO will delineate the work zone as a particular area. Only persons with appropriate training, PPE, and authorization from the FC/HSO will be allowed to enter the work zone while work is in progress.

A.5.2 DECONTAMINATION STATION

A decontamination station will be set up, and personnel will clean soiled boots or PPE prior to leaving the work zone. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zones. Plastic bags will be provided for expendable and disposable materials. If the location does not allow the establishment of a decontamination station, the FC/HSO will provide alternatives to prevent the spread of contamination.

A.5.3 ACCESS CONTROL

Security and control of access to the boat will be the responsibility of the FC/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

Following common sense rules will minimize the risk of exposure or accidents at a work site. These general safety rules will be followed on site:

- Do not climb over or under obstacles of questionable stability
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone
- Work only in well-lighted spaces
- Never enter a confined space without the proper training, permits, and equipment
- 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
- Use the established sampling and decontamination procedures
- Always use the buddy system
- Be alert to your own and other workers' physical condition
- Report all accidents, no matter how minor, to the FC/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. In addition, a PFD will be required when working aboard the boat. Prior to donning PPE, the field crew will inspect their PPE for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed below in Sections A.7.1 and A.7.2. Situations requiring PPE beyond modified Level D are not anticipated. Should the FC/HSO determine that PPE beyond modified Level D is necessary, the HSM will be notified and an alternative selected.

A.7.1 LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Workers performing general activities in which skin contact with contaminated materials is unlikely will wear Level D PPE. Level D PPE includes the following:

- Cotton overalls or lab coats

- Chemical-resistant steel-toed boots
- Chemical-resistant gloves
- Safety glasses

A.7.2 MODIFIED LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Workers performing activities where skin contact with contaminated materials is possible and in which inhalation risks are not expected will be required to wear an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Impermeable outer garb such as rain gear
- Chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

A.7.3 SAFETY EQUIPMENT

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
- Emergency eyewash

The FC/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

A monitoring program that addresses the potential site hazards will be maintained. For this project, air, dust, and noise monitoring will not be necessary. No volatile organic compounds have been identified among the expected contaminants, the sampled media will be wet and will not pose a dust hazard, and none of the equipment emits high-amplitude (>85 dBA) sound. 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

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following sections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Rinse buckets
- Long-handled scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- Alconox® or similar decontamination solution

A.9.1 MINIMIZATION OF CONTAMINATION

The first step in addressing contamination is to prevent or minimize exposure to existing contaminated materials and the spread of those materials. During field activities, the FC/HSO will enforce the following measures:

Personnel:

- Do not walk through areas of obvious or known contamination
- Do not handle, touch, or smell contaminated materials directly
- Make sure PPE has no cuts or tears prior to use
- Fasten all closures on outer clothing, covering with tape if necessary
- Protect and cover any skin injuries
- Stay upwind of airborne dusts and vapors
- Do not eat, drink, chew tobacco, or smoke in the work zones

Sampling equipment and boat:

- Place clean equipment on a plastic sheet or aluminum foil to avoid direct contact with contaminated media
- Keep contaminated equipment and tools separate from clean equipment and tools
- Clean boots before entering the boat

A.9.2 PERSONNEL DECONTAMINATION

The FC/HSO will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform decontamination procedures, as appropriate, before eating lunch, taking a break, or before leaving the work location. Following is a description of these procedures.

Decontamination procedure:

1. If outer suit is heavily soiled, rinse it off
2. Wash and rinse outer gloves and boots with in water
3. Remove outer gloves; inspect and discard if damaged
4. Wash hands if taking a break
5. Don necessary PPE before returning to work

Dispose of soiled, expendable PPE before leaving for the day

A.9.3 SAMPLING EQUIPMENT DECONTAMINATION

Before use at each sampling location, the crab and shrimp pots will be rinsed in river water to dislodge and remove any sediment and cleared of all debris before being deployed.

A.10.0 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE, decontamination fluids, and excess sample material. These contaminated materials will be disposed of as an integral part of the project.

A.10.1 PERSONAL PROTECTIVE EQUIPMENT

Gross surface contamination will be removed from PPE. All disposable sampling materials and PPE, such as disposable coveralls, gloves, and paper towels used in sample processing, will be placed in heavyweight garbage bags. Filled garbage bags will be placed in a normal refuse container for disposal as solid waste.

A.10.2 EXCESS SAMPLE MATERIALS

At each sampling location, all specimens collected will be returned to the water.

A.11.0 Training Requirements

Individuals performing work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. It is not anticipated that hazardous concentrations of contaminants will be encountered in sampled material, so training will consist of site-specific instruction for all personnel and oversight of inexperienced personnel by an experienced person for one working day. The following sections describe the training requirements for this fieldwork.

A.11.1 PROJECT-SPECIFIC TRAINING

In addition to HAZWOPER training, as described in Section 2.5 of the QAPP, field personnel will undergo training specifically for this project. All personnel must read this HSP and be familiar with its contents before beginning work. They shall acknowledge reading the HSP by signing the field team HSP review form contained in Attachment 1. The form will be kept in the project files.

The boat captain and FC/HSO or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers arrive. Field personnel will not be allowed to begin work until project-specific training is completed and documented by the FC/HSO. Training will address the HSP and all health and safety

issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards, and actions to control the hazard
- Ship access control and procedure
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment on the vessel
- Vessel safety practices
- Vessel evacuation and emergency procedures

A.11.2 DAILY SAFETY BRIEFINGS

The FC/HSO or a designee and the boat captain will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, address any specific concerns associated with the work location, and review emergency procedures and routes. The FC/HSO or designee will document safety briefings in the logbook.

A.11.3 FIRST AID AND CPR

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 FC/HSO.

The FC/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, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (spills). 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 sampling location to a hospital.

A.14.1 PRE-EMERGENCY PREPARATION

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

- Meeting with the FC/HSO and equipment handlers concerning the emergency procedures in the event that a person is injured.
- A training session given by the FC/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 FC/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 FC/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	
Tad Deshler	(206) 577-1285
Corporate Health and Safety Manager	
Tad Deshler	(206) 577-1285
Field Coordinator/ Field Health and Safety Officer	Site cellular telephone:
Mariah Meek (crab and shrimp surveys) Maryann Welsch (clam survey)	(206) 954-1780 (206) 954-1780

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 DECONTAMINATION

In the case of evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. If an injured individual is also heavily contaminated and must be transported by emergency vehicle, the emergency response team will be told of the type of contamination. To the extent possible, contaminated PPE will be removed, but only if doing so does not exacerbate the injury. Plastic sheeting will be used to reduce the potential for spreading contamination to the inside of the emergency vehicle.

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 FC/HSO or boat captain will call 911 and arrange to meet the Medic One unit at the nearest accessible dock. Otherwise, for emergency injuries which are not life-threatening (i.e., broken bones, 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

If an overt exposure to toxic materials occurs, the first responder to the victim will initiate actions to address the situation. The following actions should be taken, depending on the type of exposure.

A.14.8.1 Skin contact

- Wash/rinse the affected area thoroughly with copious amounts of soap and water
- If eye contact has occurred, eyes should be rinsed for at least 15 minutes using the eyewash that is part of the emergency equipment onboard
- After initial response actions have been taken, seek appropriate medical attention

A.14.8.2 Inhalation

- Move victim to fresh air
- Seek appropriate medical attention

A.14.8.3 Ingestion

- Seek appropriate medical attention

A.14.8.4 Puncture wound or laceration

- Seek appropriate medical attention

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

A.15.0 References

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Final Report. Prepared for the U.S. Environmental Protection Agency, Seattle, Washington, and the Puget Sound Water Quality Action Team, Olympia, WA.

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.

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