Attachment 11 Exposure Concentration Calculation Methods

1.0 INTRODUCTION 1
2.0 PROUCL CALCULATIONS 2
3.0 ROS METHODS 2
FIGURE 1. NORMAL QUANTILE PLOT FOR TBT CONCENTRATIONS IN CHINOOK SALMON WHOLE-BODY SAMPLES (WET WEIGHT) 3
4.0 REGRESSION-BASED CALCULATIONS 4
FIGURE 2. LINEAR REGRESSION RELATIONSHIP FOR TOTAL PCBS CONCENTRATIONS IN BENTHIC INVERTEBRATE TISSUES 4
FIGURE 3. REGRESSION RELATIONSHIP FOR ARSENIC CONCENTRATIONS IN BENTHIC INVERTEBRATE TISSUES 5
FIGURE 4. REGRESSION RELATIONSHIP FOR TBT CONCENTRATIONS IN BENTHIC INVERTEBRATE TISSUES 6
5.0 CALCULATION OF SWAC SEDIMENT CONCENTRATIONS 7
6.0 CALCULATION OF SWAC UCL 8
7.0 REFERENCES 9
TABLE 1. SUMMARY OF METHODS USED TO CALCULATE EXPOSURE CONCENTRATIONS 10
TABLE 2. EXPOSURE CONCENTRATIONS IN FISH, CRAB, CLAM, AND MUSSEL TISSUE ON A DRY-WEIGHT BASIS 13
TABLE 3. EXPOSURE CONCENTRATIONS IN SHINER SURFPERCH AND CRAB TISSUE FOR FOUR PACIFIC STAGHORN SCULPIN MODELING AREAS ON A DRY-WEIGHT BASIS 17
TABLE 4. EXPOSURE CONCENTRATIONS IN FISH AND CRAB TISSUE ON A WET WEIGHT BASIS FOR THE ENTIRE LDW 19
TABLE 5. EXPOSURE CONCENTRATIONS IN PACIFIC STAGHORN SCULPIN TISSUE ON A WET WEIGHT BASIS FOR FOUR PACIFIC STAGHORN SCULPIN MODELING AREAS 21
TABLE 6. EXPOSURE CONCENTRATIONS IN BENTHIC INVERTEBRATES CALCULATED FOR SIX EXPOSURE SCENARIOS FOR SPOTTED SANDPIPER ON A DRY WEIGHT BASIS 22
TABLE 7. EXPOSURE CONCENTRATIONS IN BENTHIC INVERTEBRATES CALCULATED FOR INTERTIDAL AREAS ON A DRY-WEIGHT BASIS 27
TABLE 8. EXPOSURE CONCENTRATIONS IN BENTHIC INVERTEBRATE TISSUE CALCULATED FOR FOUR PACIFIC STAGHORN SCULPIN MODELING AREAS ON A DRY-WEIGHT BASIS 28
TABLE 9. EXPOSURE CONCENTRATIONS IN BENTHIC INVERTEBRATES CALCULATED FOR THE ENTIRE LDW ON A DRY-WEIGHT BASIS 29
TABLE 10. EXPOSURE CONCENTRATIONS IN SEDIMENT CALCULATED FOR SIX EXPOSURE SCENARIOS FOR SANDPIPER ON A DRY-WEIGHT BASIS 30
TABLE 11. EXPOSURE CONCENTRATIONS IN SEDIMENT CALCULATED FOR INTERTIDAL AREAS ON A DRY-WEIGHT BASIS 34
TABLE 12. EXPOSURE CONCENTRATIONS IN SEDIMENT CALCULATED FOR FOUR PACIFIC STAGHORN SCULPIN MODELING AREAS ON A DRY-WEIGHT BASIS 35

TABLE 13. EXPOSURE CONCENTRATIONS FOR SEDIMENT CALCULATED FOR THE ENTIRE LDW ON A DRY-WEIGHT BASIS 36
TABLE 14. EXPOSURE CONCENTRATIONS IN WATER CALCULATED FOR THREE EXPOSURE AREAS FOR SPOTTED SANDPIPER 37
TABLE 15. EXPOSURE CONCENTRATIONS IN WATER CALCULATED FOR THE ENTIRE LDW 39

1.0 INTRODUCTION

Exposure concentrations were calculated throughout the ecological risk assessment (ERA) for all receptors and exposure pathways. The purpose of this attachment is to provide a summary of the methods used for the calculation of each exposure concentration. Upper confidence limits (UCLs) were calculated using three methods:

The method used most frequently was the calculation of UCLs using ProUCL software. ProUCL tests for normality, lognormality, and a gamma distribution of the dataset and computes a 95% UCL of the unknown population mean (EPA 2004) (Section 2.0). The tissue sample dataset for the ERA consists of composite tissue samples. The analysis of composite samples results in an increase in the number of individuals represented by the sample results. However, compositing samples results in the loss of information about the variance within a population of individuals and may therefore affect exposure estimates. If the variance of data based on individual samples is greater than the variance of composite samples, the difference between the 95% UCL and the sample mean would be greater for a dataset consisting of individual samples. This distinction is relevant to the risk assessment because the reasonable maximum exposure scenarios were derived based on the 95% UCL for each medium, the 95% UCL may be lower based on a dataset of composite samples compared to a dataset of individual samples because of the reduced variance around the mean.

However, there is no reason to assume that the mean of the composites would be equal to the mean of the individual samples, nor that the variance would be greater. The sample mean and variance of analogous data sets based on individual samples is simply unknown. If the mean of the individuals were sufficiently lower than the mean of the composites, it is possible that the 95% UCL on the mean of the individual samples would be less than the 95% UCL on the mean of the composite samples, even if the individual variance was greater.

If the non-detect frequency was less than or equal to 20%, ProUCL was used with half the reporting limit used as the value for non-detected results. The ProUCL User Guide (Singh et al, 2004) recommends careful attention to data sets with < 85% detection frequency. Therefore, different non-detect methods were used for datasets with greater than 20% and less than 85% frequency of non-detects. Robust regression on order statistic (ROS) methods were used to fill-in a set of concentrations for non-detects that would result in a better estimate of central tendency than substitution methods. The non-detected concentrations were assumed to follow a log-normal distribution with parameters estimated from the detected concentrations. The full dataset, including the filled-in concentrations, was then used to calculate the 95%UCL using ProUCL (Section 3.0).

If the non-detect frequency was greater than 80% then, no non-detect method should be used (Helsel 2005). In the instances where this was the case, the maximum detected concentration was used as the exposure point concentration.

Because of the limited dataset of benthic invertebrate tissue samples, the use of regression relationships between the invertebrate tissue concentrations and co-located sediment concentrations was explored to estimate the UCLs of the mean site-wide benthic invertebrate tissue concentrations as well as the UCLs of the mean for benthic invertebrate tissue concentrations within specific exposure areas (i.e., sandpiper exposure areas and intertidal exposure areas for fish and wildlife) (Section 4.0).

Spatially weighted average concentrations (SWACs) are available for sediment total PCB concentrations in the LDW (Section 5.0). For total PCBs, the area SWAC concentrations were used with the regression relationships to estimate the benthic invertebrate tissue concentrations. SWAC UCL values were calculated for the LDW as a whole as well as the intertidal areas to provide exposure point concentrations for the dietary consumption of sediment by wildlife receptors (Section 6.0).

A summary of the methods used for each receptor and chemical of potential concern (COPC) is presented in Table 1. Detailed descriptions of the specific statistic calculated for each exposure concentration as well as summary statistics on the dataset used in the calculation are presented in Tables 2–12.

2.0 PROUCL CALCULATIONS

UCL calculations and assessment of data distributions were performed using ProUCL software (EPA 2004). ProUCL software was developed by EPA to compute an appropriate 95% UCL of an unknown population mean. ProUCL tests for normality, lognormality, and a gamma distribution of the dataset, selects a conservative distribution, and computes a UCL of the unknown population mean.

For each chemical of potential concern (COPC) that was detected in more than 85% of the dataset being considered, the UCL recommended by ProUCL was used as the exposure concentration for the risk calculations. Summary statistics, distribution type, and UCL on the mean for chemical concentrations in tissue and sediment are presented in Tables 2–12.

ProUCL is not recommended for use in determining UCLs for datasets with a percentage of non-detects greater than 15% when a simple substitution method for non-detects has been employed (EPA 2004). In the baseline dataset, each non-detect value was replaced by one-half the reporting limit (RL) as a proxy value. When datasets contain a large number of proxy values, these values have the potential to skew the overall distribution of the data.

3.0 ROS METHODS

For COPCs that had detection frequencies less than 85% and greater than 20%, robust ROS methods were used to estimate a distribution of values for the non-detected results. These calculated values are referred to as "imputed data" and comprise the censored portion of the dataset. A robust ROS method that required an assumed

distribution for the censored portions of the datasets was selected based on Helsel (2005). Lognormal distributions were assumed for the censored data. This is an appropriate default distribution for environmental concentrations because it will not generate negative concentration values and is robust to differing amounts of skewness. A linear regression was computed from the normal probability plot of the natural logarithms of the detected concentrations versus their normal scores. Values for individual censored or nondetected observations were predicted from the linear regression. An example of the results of the imputation process for TBT concentrations in juvenile chinook is displayed graphically in Figure 1. In Figure 1, the natural-log transformed detected TBT concentrations are plotted versus their normal scores, and the least-squares linear regression line fit to these data points is displayed. The non detected concentrations are displayed as inverted triangles at their respective RLs, and as "x" marks at their imputed concentrations. Note that the regression lines displayed were the original regressions on detected concentrations only ("o" symbols). The final imputed values were converted back to original units to avoid transformation bias, and combined with the original detected concentrations in the calculation of the UCL using ProUCL.

The ROS method produces datasets containing both detected and imputed data. These datasets are then used to calculate UCLs, employing ProUCL as before.

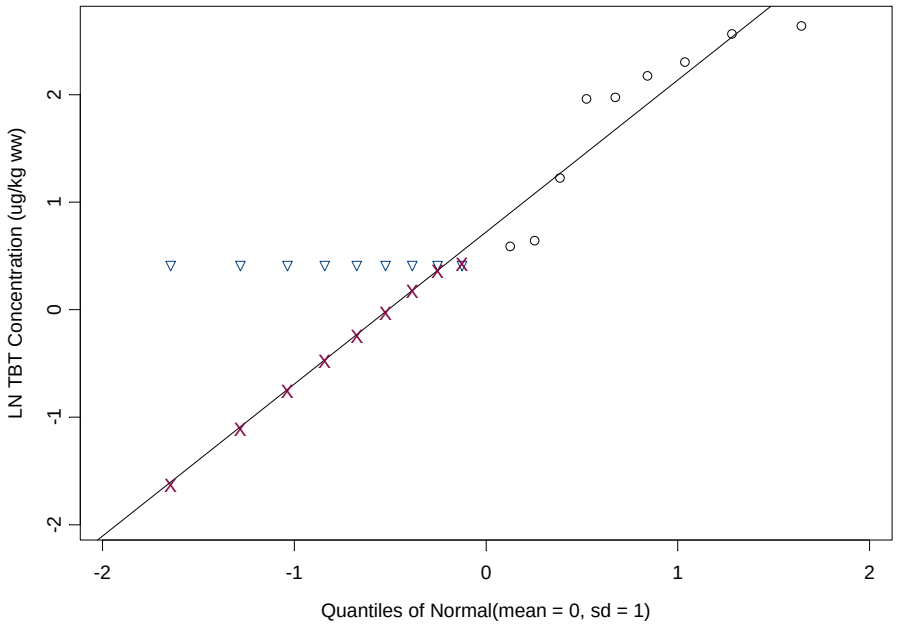

Figure 1. Normal quantile plot for TBT concentrations in chinook salmon whole-body samples (wet weight)

4.0 REGRESSION-BASED CALCULATIONS

Benthic invertebrate tissue samples were collected from 10 intertidal locations and 10 subtidal locations, with co-located sediment collected from each location (Windward 2005). The sample locations were selected to represent areas that covered the range of arsenic, lead, and polychlorinated biphenyl (PCB) concentrations measured throughout the Lower Duwamish Waterway (LDW) so that a relationship between PCB concentrations in sediment and benthic invertebrate tissue could be established (Windward 2004). The locations were not intended to be used to represent the average concentrations of chemicals for the entire site.

The relationships between COPC concentrations in benthic invertebrate tissue and co-located sediment for each COPC were examined to determine whether a significant linear regression existed. The term "significant" regression as used here means that there is sufficient statistical evidence to conclude that the slope of the true regression line is not zero. The significance of the linear regression was determined by calculating the probability (p-value) of obtaining an F-ratio greater than or equal to the observed F ratio if the true slope of the regression line was zero. The regression was deemed significant if the p-value was less than 0.05. Influential points with Cook's Distance greater than 1 were removed for this determination. Both linear and exponential regressions were evaluated, and the exponential model was used instead of the linear model if it provided a superior fit, as determined by the R^2 value. A linear model was selected for the PCBs (Figure 2), and exponential models were selected for arsenic and TBT (Figures 3 and 4).

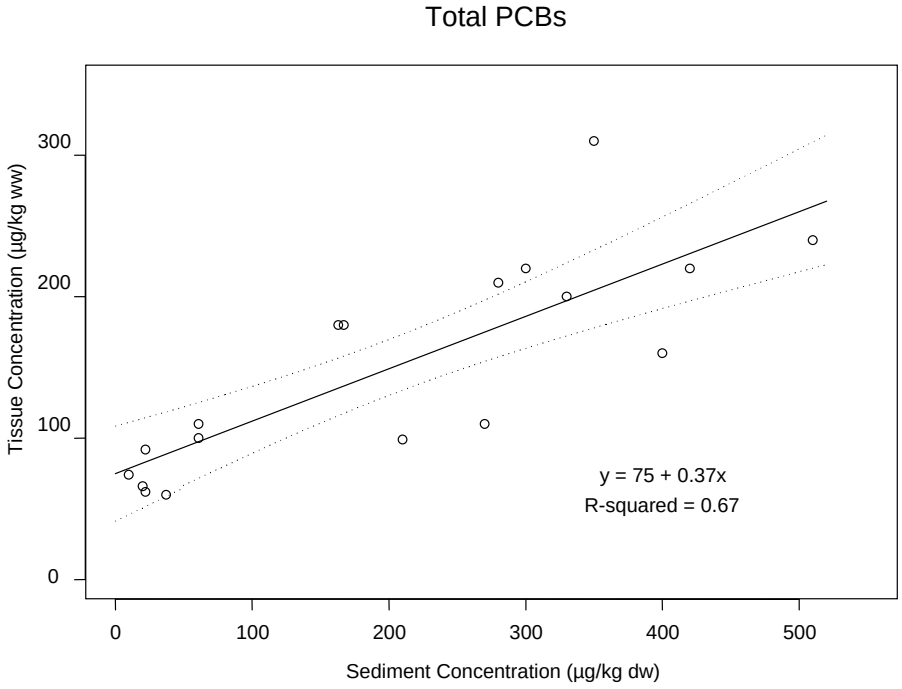

Figure 2. Linear regression relationship for total PCBs concentrations in benthic invertebrate tissues

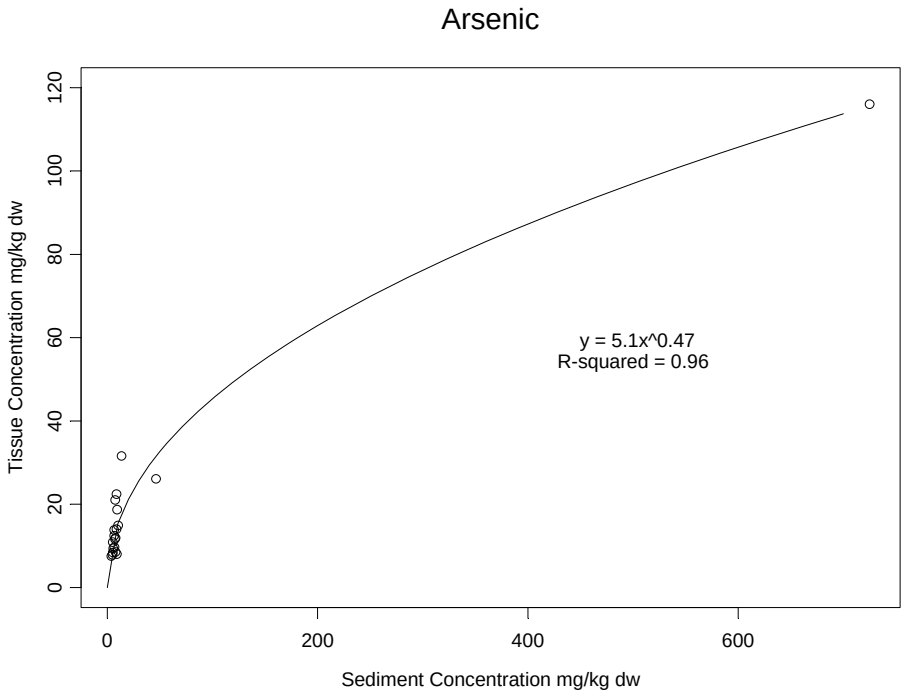

Figure 3. Regression relationship for arsenic concentrations in benthic invertebrate tissues

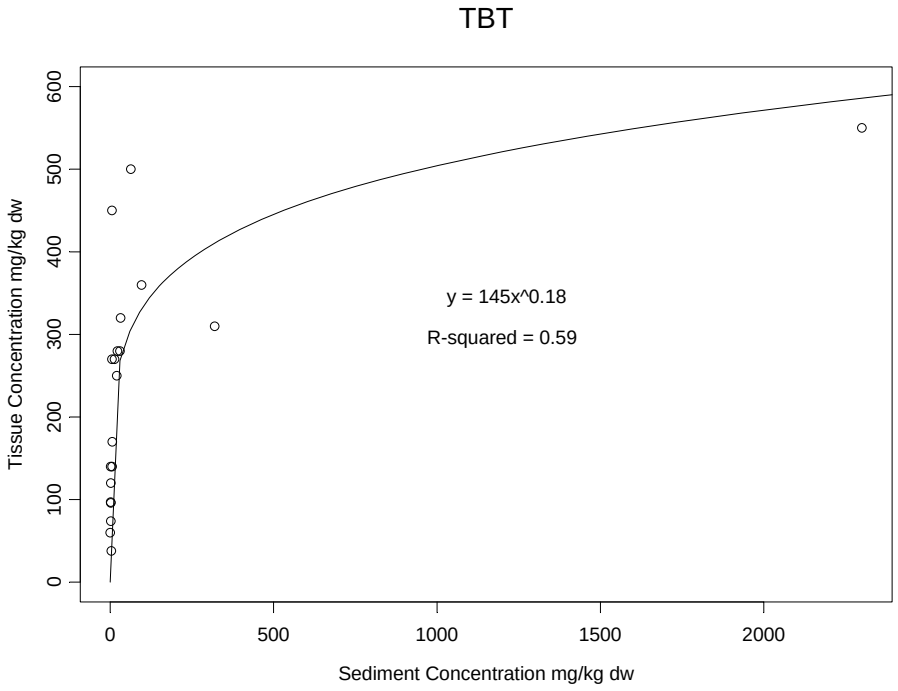

Figure 4. Regression relationship for TBT concentrations in benthic invertebrate tissues

The concentrations in sediment were often highly skewed, with the highest values identified as overly influential points using Cook's distance. The sediment spatially weighted average concentrations (SWACs) and mean concentrations were generally between the majority of the co-located sediment concentrations and the highly influential points. In these cases, the influential points were retained in the final regression models, presented in Table 3, in order to avoid extrapolation issues.

There is uncertainty in the selected exponential regressions for arsenic and TBT because of three data points that exerted undue influence on the regression relationship. The points were influential because the distribution of sediment concentrations was skewed, with few high concentrations. The removal of these points would result in a different regression relationship. However, the resulting relationship would not be appropriate for predicting tissue concentrations because extrapolation beyond the included sediment chemistry concentrations would be necessary. Also, because the existing data give some evidence that the relationship is exponential, excluding the high points in the distribution would likely result in a highly biased tissue prediction.

The regressions were used to estimate LDW-wide exposure concentrations to assess risk to benthic invertebrates from TBT exposure based on a tissue-residue approach as well as dietary exposure to arsenic for fish receptors. The PCB concentrations were used to assess risk to sandpiper in the various sandpiper exposure areas throughout

the LDW. For TBT and arsenic, site-wide arithmetic mean sediment concentrations were calculated and the TBT and arsenic regression models were used to predict the corresponding 95th UCL on the expected TBT and arsenic tissue concentrations. The 95th UCL on the TBT and arsenic tissue concentrations were used as the exposure point concentrations in the risk assessment.

5.0 CALCULATION OF SWAC SEDIMENT CONCENTRATIONS

An arithmetic mean of the sediment concentrations throughout a specified area is biased to overestimate exposure when more highly contaminated areas have been sampled more intensively than less-contaminated areas. In the LDW, this bias is most pronounced for total PCBs, which are the focus of several ongoing early action investigations in the LDW. Consequently, SWAC were calculated to estimate benthic tissue concentrations from the sediment-tissue regression model, and SWAC UCLs for total PCBs were used as exposure concentrations for the sediment component of the wildlife diets. The methods used to generate the UCL and SWAC are briefly described below. A more thorough description of the methods is provided in *Technical Memorandum: GIS Interpolation of Total PCBs in LDW Surface Sediment* (Windward 2006).

The SWAC was calculated from an inverse distance weighting (IDW) interpolation using the ESRI® ArcGIS extension Geostatistical Analyst. IDW is a technique in which interpolated estimates are made at the center of 10 x 10 ft grid cells covering the study area. Sample concentrations within a specified search radius of each grid cell are weighted by the inverse of their distance from the cell, with the effect of giving more influence to data points nearby than to those farther away. A variable weighting factor can be used to give more or less importance to distant points, relative to nearby points. The weighted mean is applied to each grid cell to create the IDW interpolation. The IDW technique creates a continuous surface of grid cells in which each cell is represented by a single estimated concentration.

The best fit of the search radius to the data can be evaluated by comparing root mean square errors (RMSEs) and mean errors of trial interpolations. These statistics are generated by removing one sample location from the dataset and using the specified search parameters and weighting factor to estimate the concentration at that location. The differences between the known concentrations and the interpolated concentrations are then used to calculate RMSEs and mean errors across the LDW.

Many interpolations were created systematically using different sets of input parameters, and the interpolation that optimized the error statistics was selected. The search shape that optimized these statistics for PCB interpolations was an ellipse angled in the direction of the river's flow. Because the LDW has three major angles, the LDW was divided into three reaches, and interpolation parameters were optimized for each reach separately. Once the interpolations were finalized for each of the three reaches, they were combined using tools available through the ESRI® ArcGIS

extension Spatial Analyst. Finally, the SWAC was calculated as the mean of all grid cell values in the LDW.

6.0 CALCULATION OF SWAC UCL

The IDW method does not include the necessary information that would permit the calculation of the UCL. Therefore, Microsoft® Visual Basic for Applications (VBA) was used to build a customizable program that generated the IDW grid as well as calculated various descriptive statistics for the IDW grid values. The interpolation parameters determined through systematic testing used in the VBA program to isolate the samples used to interpolate each cell value. Sample concentrations used to estimate the value of each grid cell were assumed to have a normal distribution because the sample size was often too low for normality testing (most cells were estimated using 4 to 16 samples). The program identified the samples within the search radius as defined by the interpolation parameters, retrieved the distance to each sample, and calculated weights based on the specified power value (p).

The UCLs and lower confidence limits (LCLs) for each grid cell are then calculated using the sample weights determined above. First, the weighted sample variance is calculated (Bing-Canar 2006):

$$\text{weighted sample variance} = \frac{\sum_{i=1}^{n} \text{adjusted sample weight}_i \left(\text{sample concentration}_i - \text{weighted mean}\right)^2}{\sum_{i=1}^{n} wt^2}$$

Equation 1

Where n is the number of sampling stations within the search area. The weighted standard deviation is calculated by taking the square root of the weighted sample variance.

The UCL per cell was then calculated as follows:

$$\text{UCL} = \text{weighted mean} + \left(t_{n-1,0.95}\right) \times \left(\frac{\text{weighted standard deviation}}{\sqrt{n}}\right) \qquad \textbf{Equation 2}$$

Where:

$t_{n-1,0.95}$ = the 95th percentile of the Student's t-distribution with n-1 degrees of freedom

Each cell UCL is then applied to the cells in a new output grid. The result is a surface that represents the UCL across all cells. The cell values in the UCL surface were averaged to calculate the UCL for the LDW.

The LDW-wide total PCB interpolation was clipped to create UCL-SWACs for the intertidal area (for dietary sediment exposure for great blue heron and osprey) as well

as for the spotted sandpiper exposure areas (for dietary sediment exposure for spotted sandpiper).

7.0 REFERENCES

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Windward. 2004. Lower Duwamish Waterway remedial investigation. Quality assurance project plan: Benthic invertebrate sampling of the Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2005. Lower Duwamish Waterway remedial investigation. Data report: Chemical analyses of benthic invertebrate and clam tissue samples and co-located sediment samples. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

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Table 1. Summary of methods used to calculate exposure concentrations

Receptor of Concern/Approach	Chemical of Potential Concern	Wet- or Dry-Weight Basis[a]	Media Type	Statistical Method	Table Presenting results
Benthic invertebrates/critical tissue residue	TBT	dry	benthic invertebrate tissue	regression	Table 9
Crab/critical tissue residue	zinc, methoxychlor, total DDTs, total PCBs	wet	whole-body crab tissue	UCL	Table 4
Juvenile chinook salmon/critical tissue residue	endrin	wet	juvenile chinook salmon	UCL	Table 4
English sole/critical tissue residue	alpha-endosulfan, beta-endosulfan, benzoic acid, BEHP, dimethyl-phthalate, di-n-butyl-phthalate, endrin, total PCBs, PCB TEQ	wet	whole-body English sole	UCL, maximum detected concentration, or maximum RL	Table 4
Pacific staghorn sculpin/critical tissue residue	alpha-endosulfan, beta-endosulfan, benzoic acid, BEHP, dimethyl-phthalate, di-n-butyl-phthalate, endrin, TBT, total PCBs	wet	whole-body Pacific staghorn sculpin	UCL, maximum detected concentration, or maximum RL	Tables 4, 5
Shiner surfperch/ critical tissue residue	total PCBs, TBT	wet	whole-body shiner surfperch	UCL	Table 4
Juvenile chinook salmon/dietary	arsenic, cadmium, chromium, copper, vanadium, total alkylated +non-alkylated PAH (benthic invertebrates only)	dry	benthic invertebrates	95% UCL of regression for arsenic, UCL for other COPCs	Table 7, 9
		dry	juvenile chinook salmon stomach contents	sample concentration	Table A.4-5 in Section A.4.1.2
Juvenile chinook salmon/sediment	total PAHs	dry	sediment	UCL	Table 13
English sole/dietary	arsenic, cadmium, chromium, copper, vanadium	dry	benthic invertebrates	95% UCL of regression for arsenic, UCL for other COPCs	Table 9
		dry	sediment	UCL	Table 13
English sole/sediment	total PAHs	dry	sediment	UCL	Table 13

Receptor of Concern/Approach	Chemical of Potential Concern	Wet- or Dry-Weight Basis[a]	Media Type	Statistical Method	Table Presenting results
Pacific staghorn sculpin/dietary	arsenic, cadmium, chromium, copper, vanadium	dry	benthic invertebrates	95% UCL of regression for arsenic, UCL for other COPCs	Tables 8, 9
		dry	shiner surfperch, crab	UCL	Tables 2, 3
		dry	sediment	UCL	Tables 12, 13
Pacific staghorn sculpin/sediment	total PAHs	dry	sediment	UCL	Table 13
Spotted sandpiper/dietary	arsenic, chromium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, vanadium, zinc, BEHP, total PCBs, PCB TEQs, total DDTs	dry	benthic invertebrates	95% UCL of regression for arsenic and PCBs; UCL, maximum detected concentration, or maximum RL for other COPCs	Table 6
			sediment	95% UCL of SWAC for PCBs, UCL for other COPCs	Table 10
		na	water	UCL or maximum detected concentration	Table 14
Great blue heron/dietary	chromium, lead, mercury, total PCBs, PCB TEQs	dry	shiner surfperch, English sole, juvenile chinook salmon, Pacific staghorn sculpin, whole-body crab	UCL	Table 2
		dry	sediment	95% UCL of SWAC for PCBs; UCL for other COPCs	Table 11
		na	water	UCL	Table 15
Osprey/dietary	chromium, lead, mercury, total PCBs, PCB TEQs	dry	shiner surfperch, English sole, juvenile chinook salmon	UCL	Table 2
		dry	sediment	95% UCL of SWAC for PCBs; UCL for other COPCs	Table 11
		na	water	UCL or maximum detected concentration	Table 15

Receptor of Concern/Approach	Chemical of Potential Concern	Wet- or Dry-Weight Basis[a]	Media Type	Statistical Method	Table Presenting results
River otter/dietary	arsenic, cobalt, mercury, selenium, total PCBs, PCB TEQs	dry	shiner surfperch, English sole, juvenile chinook salmon, Pacific staghorn sculpin, whole-body crab, clams, mussels	UCL	Table 2
		dry	sediment	95% UCL of SWAC for PCBs; UCL for other COPCs	Table 13
		na	water	UCL or maximum detected concentration	Table 15
Harbor seal/dietary	mercury, total PCBs, PCB TEQs	dry	shiner surfperch, English sole, juvenile chinook salmon, Pacific staghorn sculpin	UCL	Table 2
		dry	sediment	95% UCL of SWAC for PCBs; UCL for other COPCs	Table 13
		na	water	UCL or maximum detected concentration	Table 15

[a] Tissue concentrations in Tables 2 through 9 are presented on a wet or dry weight basis depending on how those data were used in risk calculations.

BEHP – bis(2-ethylhexyl)phthalate
COPC – chemical of potential concern
na – not applicable
PCB – polychlorinated biphenyl
SWAC – spatially weighted average concentration
TBT – tributyltin
TEQ – toxic equivalency quotient
UCL – upper confidence limit

Table 2. Exposure concentrations in fish, crab, clam, and mussel tissue on a dry-weight basis

Receptor and COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
			Min	Max	Mean			
Shiner surfperch								
Arsenic	27	100%	2.97	5.4	4.0	gamma (0.05)	approximate gamma	4.2
Cadmium	27	100%	0.038	0.0972	0.061	normal (0.05)	Student's-t UCL	0.066
Chromium	27	96%	0.26	1.8	0.70	gamma distribution (0.05)	approximate gamma UCL	0.82
Cobalt	24	100%	0.110	0.222	0.17	normal (0.05)	Student's-t UCL	0.18
Copper	27	100%	2.260	8.902	6.4	normal (0.05)	Student's-t UCL	7.0
Total DDTs	24	100%	0.14	3.8	0.75	lognormal (0.05)	95% H-UCL	1.0
Lead	27	100%	0.176	1.061	0.47	lognormal (0.05)	Student's-t UCL	0.53
Mercury	27	100%	0.071	0.34	0.13	nonparametric (0.05)	Student's-t UCL	0.15
Total PCBs	49	100%	1.3	69	6.9	nonparametric (0.05)	95% Chebyshev UCL	14
PCB TEQ (mammal)	9	100%	3.04×10^{-5}	2.74×10^{-4}	9.3×10^{-5}	gamma distribution (0.05)	approximate gamma UCL	1.6×10^{-4}
PCB TEQ (bird)	9	100%	1.67×10^{-4}	1.48×10^{-3}	4.5×10^{-4}	gamma distribution (0.05)	approximate gamma UCL	7.2×10^{-4}
Selenium	24	100%	0.448	0.866	0.72	gamma distribution (0.05)	approximate gamma UCL	0.77
Silver	27	89%	0.009	0.0437	0.019	gamma distribution (0.05)	approximate gamma UCL	0.021
Vanadium	24	92%	0.49	4.62	1.6	lognormal (0.05)	95% H-UCL	2.0
English sole								
Arsenic	24	100%	3.51	19.67	12	nonparametric (0.05)	Student's-t UCL	13
Chromium	24	88%	0.25	16.3	1.5	nonparametric (0.05)	95% Chebyshev UCL	4.4
Cobalt	24	100%	0.102	1	0.24	nonparametric (0.05)	95% Chebyshev UCL	0.41
Total DDTs	24	100%	0.22	1.1	0.68	data are normal (0.05)	Student's-t UCL	0.76
Lead	24	100%	0.15	3.64	1.4	normal (0.05)	Student's-t UCL	1.7
Mercury	24	100%	0.02	0.12	0.058	gamma distribution (0.05)	approximate gamma UCL	0.070
PCBs	45	100%	2.0	18	8.8	gamma distribution (0.05)	approximate gamma UCL	10
PCB TEQ (mammal)	8	100%	1.86×10^{-5}	1.02×10^{-4}	6.4×10^{-5}	data are normal (0.05)	Student's-t UCL	8.2×10^{-5}
PCB TEQ (bird)	8	100%	8.38×10^{-5}	6.03×10^{-4}	3.2×10^{-4}	normal (0.05)	Student's-t UCL	4.2×10^{-4}

Table 2, cont. Exposure concentrations in fish, crab, clam, and mussel tissue on a dry-weight basis

Receptor and COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
			Min	Max	Mean			
Selenium	24	100%	0.4	1.24	0.76	gamma distribution (0.05)	approximate gamma UCL	0.82
Juvenile chinook salmon								
Arsenic	nd	nd	nd	nd	nd	nd	nd	nd
Chromium	nd	nd	nd	nd	nd	nd	nd	nd
Cobalt	nd	nd	nd	nd	nd	nd	nd	nd
Total DDTs	18	100%	0.0067	0.44	0.13	gamma distribution (0.05)	approximate gamma UCL	0.21
Lead	nd	nd	nd	nd	nd	nd	nd	nd
Mercury	6	100%	0.1	0.15	0.12	normal (0.05)	Student's-t UCL	0.14
PCBs	24	100%	0.031	6	0.71	nonparametric (0.05)	99% Chebyshev UCL	3.4
PCB TEQ (mammal)	nd	nd	nd	nd	nd	nd	nd	nd
PCB TEQ (bird)	nd	nd	nd	nd	nd	nd	nd	nd
Selenium	nd	nd	nd	nd	nd	nd	nd	nd
Pacific staghorn sculpin								
Arsenic	24	100%	1.78	6.59	3.5	normal (0.05)	Student's-t UCL	4.0
Chromium	24	25%	0.24	0.5	0.30	nonparametric (0.05)	Student's-t UCL	0.40[a]
Cobalt	24	100%	0.0854	0.193	0.12	gamma distribution (0.05)	approximate gamma UCL	0.13
Total DDTs	24	100%	0.15	1.1	0.40	lognormal (0.05)	95% H-UCL	0.50
Lead	24	100%	0.059	0.525	0.25	normal (0.05)	Student's-t UCL	0.30
Mercury	24	100%	0.088	0.18	0.14	normal (0.05)	Student's-t UCL	0.15
PCBs	28	100%	2.1	13	4.3	nonparametric (0.05)	Student's-t UCL	5.0
PCB TEQ (mammal)	8	100%	1.84×10^{-5}	4.88×10^{-5}	3.1×10^{-5}	normal (0.05)	Student's-t UCL	3.8×10^{-5}
PCB TEQ (bird)	8	100%	3.90×10^{-5}	1.59×10^{-4}	9.4×10^{-5}	normal (0.05)	Student's-t UCL	1.2×10^{-4}
Selenium	24	100%	0.66	1.1	0.83	normal (0.05)	Student's-t UCL	0.87
Clam								
Arsenic	14	100%	9.487	43.16	21	normal (0.05)	Student's-t UCL	25
Chromium	14	100%	2.5	8.15	4.5	normal (0.05)	Student's-t UCL	5.2

Table 2, cont. Exposure concentrations in fish, crab, clam, and mussel tissue on a dry-weight basis

Receptor and COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
			Min	Max	Mean			
Cobalt	14	100%	1.122	5.19	2.3	nonparametric (0.05)	Student's-t UCL	2.9
Total DDTs	14	100%	0.028	0.2	0.077	gamma distribution (0.05)	approximate gamma UCL	0.10
Lead	14	100%	2.45	39.32	13	gamma distribution (0.05)	approximate gamma UCL	19
Mercury	14	100%	0.06	0.15	0.11	normal (0.05)	Student's-t UCL	0.12
PCBs	14	100%	0.18	3.6	0.97	nonparametric (0.05)	99% Chebyshev UCL	4.0
PCB TEQ (mammal)	8	100%	$3.13x\ 10^{-6}$	3.49×10^{-5}	9.6×10^{-6}	nonparametric (0.05)	95% Chebyshev UCL	2.7×10^{-5}
PCB TEQ (bird)	8	100%	3.15×10^{-5}	1.90×10^{-4}	6.2×10^{-5}	nonparametric (0.05)	95% Chebyshev UCL	1.5×10^{-4}
Selenium	14	100%	1.41	2.39	1.9	normal (0.05)	Student's-t UCL	2.0
Crab whole body (estimated)								
Arsenic	21	100%	13.95 M	55 M	21	nonparametric (0.05)	Student's-t UCL	25
Cadmium	21	100%	0.19 M	1.778 M	0.95	normal (0.05)	Student's-t UCL	1.1
Chromium	21	29%	0.1 M	0.64 M	0.25	nonparametric (0.05)	95% Chebyshev UCL	0.30[a]
Copper	21	100%	47.1 M	121 M	80	gamma distribution (0.05)	approximate gamma UCL	90
Cobalt	19	100%	0.146 JM	0.6855 JM	0.31	gamma distribution (0.05)	approximate gamma UCL	0.39
Total DDTs	19	100%	0..298 M	0.92 M	0.52	nonparametric (0.05)	Student's-t UCL	0.61
Lead	21	100%	0.1 M	1.1 JM	0.38	lognormal (0.05)	95% H-UCL	0.53
Mercury	21	100%	0.17 M	0.49 M	0.26	gamma distribution (0.05)	approximate gamma UCL	0.29
PCBs	25	100%	1.4 M	9.2 M	5.1	gamma distribution (0.05)	approximate gamma UCL	6.0
PCB TEQ (mammal)	6	100%	3.18×10^{-5} M	5.93×10^{-5} M	4.2×10^{-5}	normal (0.05)	Student's-t UCL	5.0×10^{-5}
PCB TEQ (bird)	6	100%	2.28×10^{-4} M	3.71×10^{-4} M	3.2×10^{-4}	normal (0.05)	Student's-t UCL	3.6×10^{-4}
Selenium	19	100%	0.81 M	1.45 M	1.1	normal (0.05)	Student's-t UCL	1.2
Vanadium	19	62%	0.25 M	1.0 M	0.73	nonparametric (0.05)	95% Chebyshev UCL	1.1
Zinc	21	100%	130 M	216 M	180	nonparametric (0.05)	Student's-t UCL	190
Mussels								
Arsenic	22	100%	2.3	7.4	5.4	normal (0.05)	Student's-t UCL	5.9
Chromium	22	95%	0.17	2.3	1.1	normal (0.05)	Student's-t UCL	1.2

Table 2, cont. Exposure concentrations in fish, crab, clam, and mussel tissue on a dry-weight basis

Receptor and COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
			Min	Max	Mean			
Cobalt	11	100%	0.2	0.47	0.37	normal (0.05)	Student's-t UCL	0.41
Total DDTs	11	0%	0.0087	0.0087	0.0087	all non-detects	maximum RL	0.0087
Lead	22	100%	0.87	4.8	2.8	gamma distribution (0.05)	approximate gamma UCL	3.3
Mercury	21	100%	0.059	0.15	0.087	gamma distribution (0.05)	approximate gamma UCL	0.094
PCBs	22	82%	0.078	0.4	0.23	normal (0.05)	Student's-t UCL	0.27[a]
PCB TEQ (mammal)	nd	nd	nd	nd	nd	nd	nd	nd
PCB TEQ (bird)	nd	nd	nd	nd	nd	nd	nd	nd
Selenium	nd	nd	nd	nd	nd	nd	nd	nd

[a] Calculated with ROS method because detection frequency was <85%.

[b] Detection frequency was below 20%. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

COPC – chemical of potential concern

dw – dry weight

JM – estimated calculated value

M – calculated value

N – number of samples

nd – no data

PCB – polychlorinated biphenyl

RL – reporting limit

ROS – regression on order statistic

TEQ – toxic equivalency quotient

UCL – upper confidence limit

Table 3. Exposure concentrations in shiner surfperch and crab tissue for four Pacific staghorn sculpin modeling areas on a dry-weight basis

Receptor and COPC	Area	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Crab									
Arsenic	M1	8	100%	16.24 M	55 M	28	normal (0.05)	Student's-t	36
	M2	6	100%	14.68 M	17.05 M	16	normal (0.05)	Student's-t	17
	M3	6	100%	13.95 M	18.75 M	15	non-parametric (0.05)	Student's-t	17
	M4	1	100%	26.98 M	26.98 M	27	n=1	reported conc.	27
Cadmium	M1	8	100%	0.19 M	1.778 M	1.2	non-parametric (0.05)	95% Chebyshev (Mean, Sd) UCL	2.2
	M2	6	100%	0.7916 M	0.9669 M	0.89	normal (0.05)	Student's-t	0.95
	M3	6	100%	0.4871 M	0.8336 M	0.61	normal (0.05)	Student's-t	0.71
	M4	1	100%	1.197 M	1.197 M	1.2	n=1	reported conc.	1.2
Copper	M1	8	100%	93.8 M	121 M	110	normal (0.05)	Student's-t	110
	M2	6	100%	65 M	79.5 M	70	normal (0.05)	Student's-t	75
	M3	6	100%	47.1 M	65.1 M	57	normal (0.05)	Student's-t	63
	M4	1	100%	52 M	52 M	52	n=1	reported conc.	52
Vanadium	M1	6	50%	0.3 M	1 JM	0.65	gamma	approximate Gamma UCL	1.1
	M2	6	50%	0.25 M	1 M	0.63	non-parametric (0.05)	95% Chebyshev (Mean, Sd) UCL	1.3
	M3	6	100%	1 JM	1M	1.0	data all equal	not calc'd	1.0
	M4	1	0%	0.5 M	0.5 M	0.5	n=1	maximum RL	0.5
Shiner surfperch									
Arsenic	M1	9	100%	3.2	5.4	4.2	normal (0.05)	Student's-t UCL	4.7
	M2	6	100%	3.84	5.227	4.5	normal (0.05)	Student's-t UCL	5.0
	M3	6	100%	3.26	3.82	3.6	normal (0.05)	Student's-t UCL	3.7
	M4	6	100%	2.97	4.886	3.5	normal (0.05)	Student's-t UCL	4.1

Receptor and COPC	Area	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Cadmium	M1	9	100%	0.046	0.0972	0.070	normal (0.05)	Student's-t UCL	0.079
	M2	6	100%	0.0527	0.075	0.064	normal (0.05)	Student's-t UCL	0.071
	M3	6	100%	0.0435	0.0749	0.059	normal (0.05)	Student's-t UCL	0.068
	M4	6	100%	0.038	0.0675	0.048	normal (0.05)	Student's-t UCL	0.056
Copper	M1	9	100%	3.7	8.4	6.6	normal (0.05)	Student's-t UCL	7.6
	M2	6	100%	5.354	8.672	6.5	normal (0.05)	Student's-t UCL	7.5
	M3	6	100%	6.067	8.902	7.6	normal (0.05)	Student's-t UCL	8.3
	M4	6	100%	2.26	6.667	4.9	normal (0.05)	Student's-t UCL	6.4
Vanadium	M1	6	66%	0.49	3.6	1.2	lognormal (0.05)	H-UCL	3.6
	M2	6	100%	1.1	4.62	2.5	normal (0.05)	Student's-t UCL	3.7
	M3	6	100%	1.3	2.1	1.7	normal (0.05)	Student's-t UCL	2.0
	M4	6	100%	0.87 J	1.2	1.1	normal (0.05)	Student's-t UCL	1.2

COPC – chemical of potential concern

dw – dry weight

JM – estimated calculated value

M – calculated value

N – number of samples

UCL – upper confidence limit

Table 4. Exposure concentrations in fish and crab tissue on a wet weight basis for the entire LDW

Receptor and COPC	N	Detection Frequency	Concentration (µg/kg ww)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (µg/kg ww)
			Minimum	Maximum	Mean			
Juvenile chinook salmon								
Endrin	18	49%	0.09	6.5	0.76	nonparametric (0.05)	99% Chebyshev UCL	4.3[a]
Crab whole body								
Zinc	21	100%	24.6	37.3	31	normal (0.05)	Student's-t UCL	32
Methoxychlor	19	16%	0.4	90.2	6.9	nonparametric (0.05)	95% Chebyshev UCL	54
Total DDTs	19	100%	110	150	90	nonparametric (0.05)	Student's-t UCL	48
Total PCBs	25	100%	250	1,900	890	lognormal (0.05)	95% H-UCL	1,100
English sole[a]								
alpha-Endosulfan	24[b]	54%	2.1	6.6	3.7	gamma distribution (0.05)	approximate gamma UCL	4.2[a]
beta-Endosulfan	24[b]	17%	3.6	18	5.4	low detection frequency	maximum detected conc.	18[c]
Benzoic acid	24[b]	71%	1,900	6,500	4,400	nonparametric (0.05)	Student's-t UCL	5,100[a]
BEHP	24[b]	0%	66	3,600	1,300	all non-detects	maximum RL	3,600[c]
Dimethyl phthalate	24[b]	0%	290	580	440	all non-detects	maximum RL	580[c]
Di-n-butyl phthalate	24[b]	0%	290	1200	770	all non-detects	maximum RL	1,200[c]
Endrin	24[b]	17%	0.85	14	4.4	nonparametric (0.05)	95% Chebyshev UCL	14[c]
Total PCBs	45[b]	100%	450	4,700	2,200	gamma distribution (0.05)	approximate gamma UCL	2,600
PCB TEQ (fish)	7	100%	0.00103	0.00218	0.00154	normal (0.05)	Student's-t UCL	0.00188
Pacific staghorn sculpin								
alpha-endosulfan	24	46%	0.50	5.0	1.2	gamma distribution (0.05)	approximate gamma UCL	1.4[a]
beta-endosulfan	24	21%	0.55	6.5	2.6	nonparametric (0.05)	95% Chebyshev UCL	4.1[a]
Benzoic acid	24	96%	400	6,800	4,600	nonparametric (0.05)	95% Chebyshev UCL	7,000
BEHP	24	0%	490	5,000	3,500	all non-detects	maximum RL	5,000 [c]
Dimethyl phthalate	24	0%	40	400	140	all non-detects	maximum RL	400[c]
Di-n-butyl phthalate	24	4%	100	1,300	490	low detection frequency	maximum detected conc.	1,300[c]

Receptor and COPC	N	Detection Frequency	Concentration (µg/kg ww)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (µg/kg ww)
			Minimum	Maximum	Mean			
Endrin	24	4%	0.5	36	2.3	low detection frequency	maximum detected conc.	36[c]
TBT	24	100%	23	80	32	nonparametric (0.05)	Student's-t UCL	36
Total PCBs	28	100%	430	2,800	900	nonparametric (0.05)	Student's-t UCL	1,100
Shiner surfperch								
Total PCBs	49	100%	350	18,400	1,800	nonparametric (0.05)	95% Chebyshev UCL	3,500
TBT	27	100%	33	180	58	nonparametric (0.05)	Student's-t UCL	69

[a] Calculated with ROS method because detection frequency was <85%.

[b] Includes 3 starry flounder whole-body/composite samples; starry flounder were used as a surrogate for English sole because insufficient numbers of English sole were collected in Area T4 during Phase 2 sampling (see Map A.2-3).

[c] Detection frequency was below 20% or in less than 4 samples. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

COPC – chemical of potential concern

N – number of samples

PCB – polychlorinated biphenyl

RL – reporting limit

ROS – regression on order statistic

TBT – tributyltin

UCL – upper confidence limit

ww – wet weight

Table 5. Exposure concentrations in Pacific staghorn sculpin tissue on a wet weight basis for four Pacific staghorn sculpin modeling areas

COPC	Area	N	Detection Frequency	Concentration (µg/kg ww)			Distribution Type	UCL Type	Concentration Used in Risk Estimation (µg/kg ww)
				Minimum	Maximum	Mean			
TBT	M1	6	100%	27	40	33	normal (0.05)	student's-t UCL	37
	M2	6	100%	26	39	32	normal (0.05)	student's-t UCL	36
	M3	6	100%	25	29	27	normal (0.05)	student's-t UCL	28
	M4	6	100%	23	80	35	non-parametric (0.05)	student's-t UCL	53
PCBs	M1	7	100%	580	860	720	normal (0.05)	student's-t UCL	800
	M2	7	100%	620	1,260	750	non-parametric (0.05)	student's-t UCL	920
	M3	7	100%	590	2,800	1,400	normal (0.05)	student's-t UCL	2,000
	M4	7	100%	430	1,330	730	normal (0.05)	student's-t UCL	940

COPC – chemical of potential concern

N – number of samples

PCB – polychlorinated biphenyl

RL – reporting limit

ROS – regression on order statistic

TBT – tributyltin

UCL – upper confidence limit

ww – wet weight

Table 6. Exposure concentrations in benthic invertebrates calculated for six exposure scenarios for spotted sandpiper on a dry weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Arsenic	Area 1 – high	8	100%	5.3	26.09	11	nonlinear regression	95% UCL of regression	23
	Area 1 – high/poor	8	100%	5.3	26.09	11	nonlinear regression	95% UCL of regression	21
	Area 2 – high	3	100%	10.89	26.09	16	nonlinear regression	95% UCL of regression	25
	Area 2 – high/poor	4	100%	10.89	26.09	16	nonlinear regression	95% UCL of regression	21
	Area 3 – high	6	100%	7.88	21.01	13	nonlinear regression	95% UCL of regression	18
	Area 3 – high/poor	6	100%	7.88	21.01	13	nonlinear regression	95% UCL of regression	26
Bis(2-ethylhexyl) phthalate	Area 1 – high Area 1 – high/poor	8	25%	0.065	15	7.4	not enough samples to calculate UCL	maximum detected conc.	2.9[a]
	Area 2 – high	3	33%	8	14	12	not enough samples to calculate UCL	maximum detected conc.	14[a]
	Area 2 – high/poor	4	25%	8	19	14	not enough samples to calculate UCL	maximum detected conc.	14[a]
	Area 3 – high Area 3 – high/poor	6	0%	23	61	34	all non-detects	maximum RL	61[a]
Cadmium	Area 1 – high Area 1 – high/poor	8	100%	0.094	0.83	0.38	normal (0.05)	Student's-t UCL	0.56
	Area 2 – high	3	100%	0.193	0.401	0.32	not enough samples to calculate UCL	maximum detected conc.	0.40
	Area 2 – high/poor	4	100%	0.193	0.46	0.35	normal (0.05)	Student's-t UCL	0.49
	Area 3 – high Area 3 – high/poor	6	100%	0.261	0.831	0.46	normal (0.05)	Student's-t UCL	0.64

Table 6, cont. Exposure concentrations in benthic invertebrates calculated for six exposure scenarios for spotted sandpiper on a dry weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Chromium	Area 1 – high Area 1 – high/poor	8	100%	1.0	3.1	2.0	normal (0.05)	Student's-t UCL	3.0
	Area 2 – high	3	100%	1.9	18.4	7.6	not enough samples to calculate UCL	maximum detected conc.	18
	Area 2 – high/poor	4	100%	1.9	58.2	20	normal (0.05)	Student's-t UCL	51
	Area 3 – high Area 3 – high/poor	6	100%	2.3	6.2	3.8	normal (0.05)	Student's-t UCL	5.0
Cobalt	Area 1 – high Area 1 – high/poor	4	100%	0.62	1.552	1.3	normal (0.05)	Student's-t UCL	1.8
	Area 2 – high	3	100%	1.459	2.02	1.8	not enough samples to calculate UCL	maximum detected conc.	2.0
	Area 2 – high/poor	4	100%	1.459	2.149	1.9	normal (0.05)	Student's-t UCL	2.2
	Area 3 – high Area 3 – high/poor	6	100%	1.059	2.408	1.8	normal (0.05)	Student's-t UCL	2.2
Copper	Area 1 – high Area 1 – high/poor	8	100%	31.24	170	86	normal (0.05)	Student's-t UCL	120
	Area 2 – high	3	100%	24.52	143	89	not enough samples to calculate UCL	maximum detected conc.	140
	Area 2 – high/poor	4	100%	24.52	143	80	normal (0.05)	Student's-t UCL	140
	Area 3 – high Area 3 – high/poor	6	100%	34.12	84.58	56	normal (0.05)	Student's-t UCL	70
DDTs	Area 1 – high Area 1 – high/poor	4	100%	0.077	0.31	0.17	normal (0.05)	Student's-t UCL	0.29
	Area 2 – high	3	100%	0.077	1.1	0.43	not enough samples to calculate UCL	maximum detected conc.	1.1
	Area 2 – high/poor	4	100%	0.077	1.1	0.40	normal (0.05)	Student's T-UCL	0.96
	Area 3 – high Area 3 – high/poor	6	100%	0.023	1.9	0.48	gamma distribution	gamma UCL	1.8

Table 6, cont. Exposure concentrations in benthic invertebrates calculated for six exposure scenarios for spotted sandpiper on a dry weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Lead	Area 1 – high Area 1 – high/poor	8	100%	1.836	41	13	lognormal (0.05)	95% Chebyshev UCL	31
	Area 2 – high	3	100%	5.527	14.87	10	not enough samples to calculate UCL	maximum detected conc.	15
	Area 2 – high/poor	4	100%	5.527	217.9	62	gamma distribution (0.05)	approximate gamma UCL	660
	Area 3 – high Area 3 – high/poor	6	100%	1.888	8.048	3.7	normal (0.05)	Student's-t UCL	5.6
Mercury	Area 1 – high Area 1 – high/poor	8	88%	0.02	0.19	0.073	gamma distribution (0.05)	approximate gamma UCL	0.10
	Area 2 – high	3	100%	0.03	0.066	0.054	not enough samples to calculate UCL	maximum detected conc.	0.066
	Area 2 – high/poor	4	100%	0.03	0.066	0.054	normal (0.05)	Student's-t UCL	0.070
	Area 3 – high Area 3 – high/poor	6	100%	0.03	0.44	0.17	gamma distribution (0.05)	approximate gamma UCL	0.50
Nickel	Area 1 – high Area 1 – high/poor	8	100%	1.1	4.3	2.8	normal (0.05)	Student's-t UCL	3.5
	Area 2 – high	3	100%	1.96	5.84	3.3	not enough samples to calculate UCL	maximum detected conc.	5.8
	Area 2 – high/poor	4	100%	1.96	5.84	3.1	normal (0.05)	Student's-t UCL	5.3
	Area 3 – high Area 3 – high/poor	6	100%	2.33	9.907	5.0	gamma distribution (0.05)	approximate gamma UCL	7.4
Total PCBs	Area 1 – high	8	88%	0.59	2.3	1.2	linear regression	95% UCL of regression	1.5
	Area 1 – high/poor	8	88%	0.59	2.3	1.2	linear regression	95% UCL of regression	1.5
	Area 2 – high	3	67%	1.1	9.1	3.9	linear regression	95% UCL of regression	5.9
	Area 2 – high/poor	4	75%	1.1	9.1	3.3	linear regression	95% UCL of regression	3.8
	Area 3 – high	6	100%	0.61	21	4.5	linear regression	95% UCL of regression	2.7
	Area 3 – high/poor	6	100%	0.61	21	4.5	linear regression	95% UCL of regression	3.4

Table 6, cont. Exposure concentrations in benthic invertebrates calculated for six exposure scenarios for spotted sandpiper on a dry weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
PCB TEQ (bird)	Area 1 – high	1	100%	1.62×10^{-4}	1.62×10^{-4}	1.6×10^{-4}	not enough samples to calculate UCL	maximum detected conc.	1.6×10^{-4}
	Area 2 – high	1	100%	5.63×10^{-4}	5.63×10^{-4}	5.6×10^{-4}	not enough samples to calculate UCL	maximum detected conc.	5.6×10^{-4}
	Area 2 – high/poor	1	100%	5.63×10^{-4}	5.63×10^{-4}	5.6×10^{-4}	not enough samples to calculate UCL	maximum detected conc.	5.6×10^{-4}
	Area 3 – high Area 3 – high/poor	3	100%	2.21×10^{-5}	3.90×10^{-4}	1.7×10^{-4}	not enough samples to calculate UCL	maximum detected conc.	3.9×10^{-4}
Selenium	Area 1 – high Area 1 – high/poor	4	100%	1.0	1.84	1.5	normal (0.05)	Student's-t UCL	1.9
	Area 2 – high	3	100%	1.13	1.6	1.4	not enough samples to calculate UCL	maximum detected conc.	1.6
	Area 2 – high/poor	4	100%	1.13	1.79	1.5	normal (0.05)	Student's-t UCL	1.8
	Area 3 – high Area 3 – high/poor	6	100%	0.80	1.62	1.2	normal (0.05)	Student's-t UCL	1.4
Vanadium	Area 1 – high Area 1 – high/poor	4	100%	3.1	5.9	4.9	normal (0.05)	Student's-t UCL	6.4
	Area 2 – high	3	100%	5.1	10.2	7.5	not enough samples to calculate UCL	maximum detected conc.	10
	Area 2 – high/poor	4	100%	5.1	10.2	7.2	normal (0.05)	Student's-t UCL	9.8
	Area 3 – high Area 3 – high/poor	6	100%	4.6	9.8	7.9	normal (0.05)	Student's-t UCL	9.6
Zinc	Area 1 – high Area 1 – high/poor	8	100%	44	295	130	normal (0.05)	Student's-t UCL	190
	Area 2 – high	3	100%	208	295	260	not enough samples to calculate UCL	maximum detected conc.	300
	Area 2 – high/poor	4	100%	208	384	290	normal (0.05)	Student's-t UCL	380
	Area 3 – high Area 3 – high/poor	6	100%	102	346	190	normal (0.05)	Student's-t UCL	270

Table 6, cont. Exposure concentrations in benthic invertebrates calculated for six exposure scenarios for spotted sandpiper on a dry weight basis

[a] Six exposure scenarios were evaluated; in each of three exposure areas, foraging in high-quality habitat only and foraging in both high- and poor-quality habitat were evaluated. These exposure scenarios are described in detail in Section A.5.1.3.1.

[b] Detection frequency was below 20% or in less than 4 samples. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

COPC – chemical of potential concern

dw – dry weight

N – number of samples

PCB – polychlorinated biphenyl

TEQ – toxic equivalent

UCL – upper confidence limit

Table 7. Exposure concentrations in benthic invertebrates calculated for intertidal areas on a dry-weight basis

COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
			Minimum	Maximum	Mean			
Arsenic	17	100%	5.3	26.09	12	nonlinear regression	95% UCL of regression	22
						gamma distribution (0.05)	approximate gamma UCL	14
Cadmium	17	100%	0.094	0.831	0.40	normal (0.05)	Student's-t UCL	0.50
Chromium	17	100%	1.0	58.2	7.0	nonparametric (0.05)	95% Chebyshev UCL	20
Copper	17	100%	24.52	170	73	gamma distribution (0.05)	approximate gamma UCL	93
Vanadium	13	100%	3.1	10.2	7.0	normal (0.05)	Student's-t UCL	8.1

COPC – chemical of potential concern

dw – dry weight

N – number of samples

UCL – upper confidence limit

Table 8. Exposure concentrations in benthic invertebrate tissue calculated for four Pacific staghorn sculpin modeling areas on a dry-weight basis

COPC	Area	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Arsenic	M1	10	100%	5.3	116	19	nonlinear regression	95% UCL of regression	23
	M2	6	100%	9.655	31.56	17	nonlinear regression	95% UCL of regression	25
	M3	4	100%	11.9	22.41	16	nonlinear regression	95% UCL of regression	23
	M4	4	100%	7.88	21.01	12	nonlinear regression	95% UCL of regression	18
Cadmium	M1	10	100%	0.094	1.3 J	0.57	normal (0.05)	Student's-t UCL	0.81
	M2	6	100%	0.193 J	0.57 J	0.38	normal (0.05)	Student's-t UCL	0.48
	M3	4	100%	0.309	0.831	0.51	normal (0.05)	Student's-t UCL	0.77
	M4	4	100%	0.261	0.560	0.38	normal (0.05)	Student's-t UCL	0.54
Copper	M1	10	100%	31.24 J	170	90	normal (0.05)	Student's-t UCL	110
	M2	6	100%	24.52 J	151	90	normal (0.05)	Student's-t UCL	130
	M3	4	100%	37.23 J	66.11 J	51	normal (0.05)	Student's-t UCL	65
	M4	4	100%	34.12 J	84.58 J	55	normal (0.05)	Student's-t UCL	81
Vanadium	M1	6	100%	3.10	16.5	8.3	normal (0.05)	Student's-t UCL	12
	M2	6	100%	5.10	21.3	12	normal (0.05)	Student's-t UCL	18
	M3	4	100%	6.30	22.2	12	normal (0.05)	Student's-t UCL	20
	M4	4	100%	4.60	9.80	7.4	normal (0.05)	Student's-t UCL	10

COPC – chemical of potential concern

dw – dry weight

J – estimated concentration

N – number of samples

UCL – upper confidence limit

Table 9. Exposure concentrations in benthic invertebrates calculated for the entire LDW on a dry-weight basis

COPC	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
			Minimum	Maximum	Mean			
Arsenic	24	100%	5.3	116	17	nonlinear regression	95th UCL of regression	24
						non-parametric (0.05)	95% Chebyshev (Mean, SD) UCL	37
Cadmium	24	100%	0.094	1.3 J	0.48	gamma distribution (0.05)	approximate gamma UCL	0.60
Chromium	24	100%	1.0	58.2	8.2	lognormal (0.05)	95% H-UCL	12
Copper	24	100%	24.52 J	170	78	normal (0.05)	Student's-t UCL	92
Lead	24	100%	1.836	217.9	19	data are lognormal (0.05)	95% Chebyshev (MVUE) UCL	31
total alkylated + non-alkylated PAHs	24	88%	0.18	36.1 J	6.8	gamma distribution (0.05)	approximate gamma UCL	11
Total PCBs	24	96%	0.59	21	2.5	linear regression	95% UCL of regression	2.3
Selenium	20	100%	0.80	3.63	1.8	normal (0.05)	Student's-t UCL	2.1
Silver	24	100%	0.156	2.496	0.48	gamma distribution (0.05)	approximate gamma UCL	0.62
Vanadium	20	100%	3.1	22.2	10	gamma distribution (0.05)	approximate gamma UCL	12
TBT	20	95%	0.03	0.55	0.24	nonlinear regression	95% UCL of regression	0.38

[a] Total PAHs included: indeno (1,2,3-cd)perylene, benz(a)anthracene, benzo(a)pyrene, benzo(k)fluoranthene, fluoranthene, benzo(g,h,i)perylene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, pyrene.

COPC – chemical of potential concern

dw – dry weight

N – number of samples

UCL – upper confidence limit

Table 10. Exposure concentrations in sediment calculated for six exposure scenarios for sandpiper on a dry-weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Arsenic	Area 1 – high	39	95%	3.13	161	17	nonparametric (0.05)	95% Chebyshev UCL	36
	Area 1 – high/poor	55	95%	1.2	161	15	lognormal	95% H-UCL	18
	Area 2 – high	25	92%	4.0	161	22	nonparametric (0.05)	95% Chebyshev UCL	49
	Area 2 – high/poor	49	96%	1.2	161	15	lognormal	95% H-UCL	18
	Area 3 – high	87	92%	2.5	79.4	10	nonparametric (0.05)	95% Chebyshev UCL	20
	Area 3 – high/poor	150	93%	2.5	1,100	20	nonparametric (0.05)	95% Chebyshev UCL	60
Bis(2-ethylhexyl) phthalate	Area 1 – high	39	85%	0.0054	0.65	0.089	gamma distribution (0.05)	approximate gamma UCL	0.12
	Area 1 – high/poor	55	87%	0.0054	14	0.63	nonparametric (0.05)	97.5% Chebyshev UCL	2.5
	Area 2 – high	25	96%	0.02	5.1	0.94	lognormal (0.05)	95% Chebyshev UCL	2.7
	Area 2 – high/poor	49	94%	0.01	5.1	0.54	nonparametric (0.05)	99% Chebyshev UCL	2.1
	Area 3 – high	92	78%	0.014	8.6	0.40	lognormal (0.05)	95% H-UCL	0.41[b]
	Area 3 – high/poor	145	85%	0.014	8.6	0.40	lognormal (0.05)	95% H-UCL	0.41
Cadmium	Area 1 – high	39	77%	0.050	1.0	0.36	gamma distribution (0.05)	approximate gamma UCL	0.45[b]
	Area 1 – high/poor	55	78%	0.03	2	0.51	gamma distribution (0.05)	approximate gamma UCL	0.65[b]
	Area 2 – high	25	96%	0.070	2.7	0.84	gamma distribution (0.05)	approximate gamma UCL	1.0
	Area 2 – high/poor	49	78%	0.030 J	2.7	0.52	data are lognormal (0.05)	95% H-UCL	0.93[b]
	Area 3 – high	80	61%	0.068	5.2	0.52	data are lognormal (0.05)	95% H-UCL	0.62[b]
	Area 3 – high/poor	143	69%	0.068	92	2.5	nonparametric (0.05)	97.5% Chebyshev UCL	7.8[b]
Chromium	Area 1 – high	39	100%	9.84	60.5	28	data are normal (0.05)	Student's-t UCL	32
	Area 1 – high/poor	55	100%	4.8	60.5	27	data are normal (0.05)	Student's-t UCL	30
	Area 2 – high	25	100%	9.0	122 J	35	gamma distribution (0.05)	approximate gamma UCL	43
	Area 2 – high/poor	49	100%	4.8	122 J	28	gamma distribution (0.05)	approximate gamma UCL	32
	Area 3 – high	87	100%	9.19	76 J	29	nonparametric (0.05)	Student's-t UCL	31
	Area 3 – high/poor	150	100%	9.19	1,100	67	nonparametric (0.05)	95% Chebyshev UCL	120

Table 10, cont. Exposure concentrations in sediment calculated for six exposure scenarios for sandpiper on a dry-weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Cobalt	Area 1 – high	25	100%	2.82	18.7	7.4	gamma distribution (0.05)	approximate gamma UCL	9.0
	Area 1 – high/poor	28	100%	2.82	18.7	7.1	gamma distribution (0.05)	approximate gamma UCL	8.0
	Area 2 – high	22	100%	3.0	18.7	8.2	data are normal (0.05)	Student's-t UCL	9.5
	Area 2 – high/poor	38	100%	3.0	18.7	7.3	gamma distribution (0.05)	approximate gamma UCL	8.0
	Area 3 – high	70	100%	3.48	12	7.7	gamma distribution (0.05)	approximate gamma UCL	8.0
	Area 3 – high/poor	106	100%	3.48	37	9.2	nonparametric (0.05)	Student's-t UCL	10
Copper	Area 1 – high	39	100%	7.90	365	74	gamma distribution (0.05)	approximate gamma UCL	94
	Area 1 – high/poor	55	100%	7.90	365	65	gamma distribution (0.05)	approximate gamma UCL	80
	Area 2 – high	25	100%	16	365	87	gamma distribution (0.05)	approximate gamma UCL	120
	Area 2 – high/poor	49	100%	11.5	365	64	lognormal (0.05)	95% H-UCL	79
	Area 3 – high	87	100%	17.2	290	45	nonparametric (0.05)	95% Chebyshev UCL	63
	Area 3 – high/poor	150	100%	17.2	12,000	200	nonparametric (0.05)	97.5% Chebyshev UCL	730
Total DDTs	Area 1 – high	20	50%	7.2×10^{-4}	0.0216	0.0050	nonparametric (0.05)	99% Chebyshev UCL	0.017
	Area 1 – high/poor	24	54%	7.2×10^{-4}	0.0216	0.0055	nonparametric (0.05)	99% Chebyshev UCL	0.018
	Area 2 – high	13	69%	9.5×10^{-4}	2.9	0.28	lognormal (0.05)	99% Chebyshev (MVUE) UCL	1.0
	Area 2 – high/poor	19	63%	9.5×10^{-4}	2.9	0.19	lognormal (0.05)	99% Chebyshev (MVUE) UCL	0.52
	Area 3 – high	15	53%	9.5×10^{-4}	0.047	0.012	gamma distribution (0.05)	approximate gamma UCL	0.024
	Area 3 – high/poor	18	56%	9.5×10^{-4}	0.047	0.012	gamma distribution (0.05)	approximate gamma UCL	0.020
Lead	Area 1 – high	39	100%	7.94 J	400	70	gamma distribution (0.05)	approximate gamma UCL	90
	Area 1 – high/poor	55	100%	7.94 J	400	70	gamma distribution (0.05)	approximate gamma UCL	90
	Area 2 – high	25	100%	8.2	615	110	gamma distribution (0.05)	approximate gamma UCL	160
	Area 2 – high/poor	49	100%	8.2	615	70	lognormal (0.05)	95% H-UCL	96
	Area 3 – high	87	100%	6.3	533	50	nonparametric (0.05)	95% Chebyshev UCL	90
	Area 3 – high/poor	150	100%	6.3	23,000	300	nonparametric (0.05)	97.5% Chebyshev UCL	1,000

Table 10, cont. Exposure concentrations in sediment calculated for six exposure scenarios for sandpiper on a dry-weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Mercury	Area 1 – high	39	87%	0.015	0.63	0.13	gamma distribution (0.05)	approximate gamma UCL	0.17
	Area 1 – high/poor	47	85%	0.01	0.63	0.13	gamma distribution (0.05)	approximate gamma UCL	0.16
	Area 2 – high	32	91%	0.025	2.46	0.30	gamma distribution (0.05)	approximate gamma UCL	0.43
	Area 2 – high/poor	49	84%	0.021	2.46	0.22	lognormal (0.05)	95% H-UCL	0.29
	Area 3 – high	87	82%	0.025	4.6 J	0.20	nonparametric (0.05)	97.5% Chebyshev UCL	0.60[b]
	Area 3 – high/poor	149	83%	0.025	4.6 J	0.20	nonparametric (0.05)	95% Chebyshev UCL	0.40[b]
Nickel	Area 1 – high	39	100%	6	37	19	data are normal (0.05)	Student's-t UCL	21
	Area 1 – high/poor	48	98%	6	37	20	nonparametric (0.05)	95% Chebyshev UCL	30
	Area 2 – high	25	100%	8.9	39	19	data are normal (0.05)	Student's-t UCL	22
	Area 2 – high/poor	42	98%	8.9	39	17	gamma distribution (0.05)	approximate gamma UCL	20
	Area 3 – high	85	100%	7.66	52	20	gamma distribution (0.05)	approximate gamma UCL	22
	Area 3 – high/poor	141	100%	7.66	910	50	nonparametric (0.05)	95% Chebyshev UCL	90
Total PCBs	Area 1 – high	56	93%	0.0026	0.81	0.15	SWAC	95% UCL	0.34
	Area 1 – high/poor	81	91%	0.0022	0.81	0.14	SWAC	95% UCL	0.33
	Area 2 – high	50	98%	0.02	25	2.8	SWAC	95% UCL	2.5
	Area 2 – high/poor	88	95%	0.0047	25	1.6	SWAC	95% UCL	1.5
	Area 3 – high	129	91%	0.0061	15	1.3	SWAC	95% UCL	0.72
	Area 3 – high/poor	228	95%	0.0061	110	3.3	SWAC	95% UCL	1.1
PCB TEQ (bird)	Area 1 – high	8	100%	6.46×10^{-7}	5.61×10^{-5}	2.3×10^{-5}	normal (0.05)	Student's-t UCL	3.7×10^{-5}
	Area 1 – high/poor	9	100%	6.46×10^{-7}	5.61×10^{-5}	2.1×10^{-5}	normal (0.05)	Student's-t UCL	3.4×10^{-5}
	Area 2 – high	7	100%	6.22×10^{-6}	2.64×10^{-3}	4.6×10^{-4}	gamma distribution (0.05)	Adjusted gamma UCL	4.3×10^{-3}
	Area 2 – high/poor	10	100%	1.61×10^{-6}	2.64×10^{-3}	3.2×10^{-4}	gamma distribution (0.05)	Adjusted gamma UCL	1.8×10^{-3}
	Area 3 – high	8	100%	2.53×10^{-6}	1.33×10^{-4}	3.6×10^{-5}	gamma distribution (0.05)	approximate gamma UCL	9.6×10^{-5}
	Area 3 – high/poor	11	100%	2.53×10^{-6}	6.21×10^{-3}	6.6×10^{-4}	lognormal (0.05)	99% Chebyshev UCL	3.0×10^{-3}

Table 10, cont. Exposure concentrations in sediment calculated for six exposure scenarios for sandpiper on a dry-weight basis

COPC	Exposure Scenario[a]	N	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Selenium	Area 1 – high	28	43%	0.2	10	2.5	normal (0.05)	Student's-t UCL	0.59[b]
	Area 1 – high/poor	36	36%	0.2	10	2.5	gamma distribution (0.05)	approximate gamma UCL	0.56[b]
	Area 2 – high	22	55%	0.3	9	3.2	nonparametric (0.05)	99% Chebyshev UCL	7.2[b]
	Area 2 – high/poor	38	42%	0.3	10	3.3	nonparametric (0.05)	95% Chebyshev UCL	3.0[b]
	Area 3 – high	60	37%	0.5	13	5.5	nonparametric (0.05)	97.5% Chebyshev UCL	7.0[b]
	Area 3 – high/poor	96	33%	0.5	20	5.9	nonparametric (0.05)	97.5% Chebyshev UCL	6.6[b]
Vanadium	Area 1 – high	25	100%	34.8	72.6	50	lognormal (0.05)	Student's-t UCL	53
	Area 1 – high/poor	28	100%	34.8	72.6	49	nonparametric (0.05)	Student's-t UCL	52
	Area 2 – high	22	100%	15	72.6	53	normal (0.05)	Student's-t UCL	58
	Area 2 – high/poor	38	100%	15	72.6	52	normal (0.05)	Student's-t UCL	55
	Area 3 – high	70	100%	27.9	83	55	normal (0.05)	Student's-t UCL	57
	Area 3 – high/poor	106	100%	27.9	87	57	normal (0.05)	Student's-t UCL	59
Zinc	Area 1 – high	39	100%	31	607	150	gamma distribution (0.05)	approximate gamma UCL	180
	Area 1 – high/poor	55	98%	19.2	607	140	gamma distribution (0.05)	approximate gamma UCL	170
	Area 2 – high	25	100%	28	607	190	gamma distribution (0.05)	approximate gamma UCL	240
	Area 2 – high/poor	49	98%	19.2	607	140	lognormal (0.05)	95% H-UCL	180
	Area 3 – high	87	100%	35.6	343	110	nonparametric (0.05)	95% Chebyshev UCL	150
	Area 3 – high/poor	150	100%	35.6	6,400	320	nonparametric (0.05)	97.5% Chebyshev UCL	710

[a] Six exposure scenarios were evaluated; in each of three exposure areas, foraging in high-quality habitat only and foraging in both high- and poor-quality habitat were evaluated. These exposure scenarios are described in detail in Section A.5.1.3.1.

[b] Calculated with ROS method because detection frequency was < 85%

[c] Detection frequency was below 20% or in less than 4 samples. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

COPC – chemical of potential concern

dw – dry weight

N – number of samples

na – not available

PCB – polychlorinated biphenyl

ROS – regression on order statistic

SWAC – spatially weighted average concentration

UCL – upper confidence limit

Table 11. Exposure concentrations in sediment calculated for intertidal areas on a dry-weight basis

COPC	N[a]	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
			Minimum	Maximum	Mean			
Arsenic	357	86%	1.2	1,100 J	16	nonparametric (0.05)	95% Chebyshev UCL	30
Cadmium	348	63%	0.0131	120	1.7	nonparametric (0.05)	97.5% Chebyshev UCL	4.7[b]
Chromium	357	100%	4.8	1,100	50	nonparametric (0.05)	95% Chebyshev UCL	70
Cobalt	232	100%	2.82	140	9.0	nonparametric (0.05)	Student's-t UCL	10
Copper	357	100%	5	12,000	150	nonparametric (0.05)	95% Chebyshev UCL	400
Total DDTs	75	45%	5.7×10^{-5}	2.9	0.049	nonparametric (0.05)	97.5% Chebyshev UCL	0.29[b]
Lead	357	100%	2	23,000	190	nonparametric (0.05)	97.5% Chebyshev UCL	600
Mercury	356	78%	0.009	5.6	0.17	nonparametric (0.05)	97.5% Chebyshev UCL	0.40[b]
Total PCBs	552	92%	0.0022 J	220	2.3	SWAC	95 %UCL	0.98
PCB TEQ (mammal)	34	100%	9.08×10^{-8}	1.38×10^{-3}	6.1×10^{-5}	lognormal (0.05)	97.5% Chebyshev UCL	1.5×10^{-4}
PCB TEQ (bird)	34	100%	6.5×10^{-7}	0.0062	3.5×10^{-4}	lognormal (0.05)	97.5% Chebyshev UCL	9.2×10^{-4}
Selenium	249	29%	0.0958	20	2.5	nonparametric (0.05)	97.5% Chebyshev UCL	3.9[b]
Silver	345	50%	0.020	270	1.6	nonparametric (0.05)	97.5% Chebyshev UCL	6.8[b]
Total PAHs	345	97%	0.0095	128	4.0	nonparametric (0.05)	97.5% Chebyshev UCL	7.0
Vanadium	232	100%	15	150	55	gamma distribution (0.05)	approximate gamma UCL	57

[a] Number of intertidal sediment samples in the baseline surface sediment dataset as of June 26, 2006, prior to an update to the baseline dataset.

[b] Calculated with ROS method because detection frequency was <85%.

COPC – chemical of potential concern

dw – dry weight

N – number of samples

na – not available

PCB – polychlorinated biphenyl

ROS – regression on order statistic

SWAC – spatially weighted average concentration

UCL – upper confidence limit

Table 12. Exposure concentrations in sediment calculated for four Pacific staghorn sculpin modeling areas on a dry-weight basis

COPC	Modeling Area	N[a]	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
				Minimum	Maximum	Mean			
Arsenic	M1	222	98%	1.55	725	19	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	34
	M2	152	98%	1.2	807	22	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	46
	M3	239	81%	2.5	1,100	18	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	40
	M4	186	95%	1.5	51	11	gamma	approximate gamma UCL	11
Cadmium	M1	217	88%	0.050	11.7	0.78	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	1.1
	M2	152	84%	0.030	3	0.44	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	0.55
	M3	239	75%	0.060	120	2.3	non-parametric (0.05)	97.5% Chebyshev (Mean, Sd) UCL	6.8
	M4	177	37%	0.030	1	0.26	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	0.33
Copper	M1	222	100%	7.9	495	84	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	97
	M2	152	100%	10	1,420	100	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	170
	M3	239	100%	14	12,000	200	non-parametric (0.05)	95% Chebyshev (mean, sd) UCL	510
	M4	186	100%	5	89.9	38	gamma	Approximate Gamma UCL	41
Vanadium	M1	128	100%	27.7	100	61	normal (0.05)	Student's-t UCL	63
	M2	132	100%	15	86	59	normal (0.05)	Student's-t UCL	60
	M3	182	100%	30	150	58	gamma	approximate gamma UCL	60
	M4	100	100%	27.9	89.6	58	normal (0.05)	Student's-t UCL	60

[a] Number of intertidal sediment samples in the baseline surface sediment dataset as of June 26, 2006, prior to an update to the baseline dataset.

[b] Calculated with ROS method because detection frequency was <85%.

COPC – chemical of potential concern
dw – dry weight
N – number of samples
na – not available
PCB – polychlorinated biphenyl
ROS – regression on order statistic
SWAC – spatially weighted average concentration
UCL – upper confidence limit

Table 13. Exposure concentrations for sediment calculated for the entire LDW on a dry-weight basis

COPC	N[a]	Detection Frequency	Concentration (mg/kg dw)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/kg dw)
			Minimum	Maximum	Mean			
Arsenic	814	93%	1.2	1,100	20	nonparametric (0.05)	95% Chebyshev UCL	30
Cadmium	797	71%	0.02	120	1.0	nonparametric (0.05)	97.5% Chebyshev UCL	2.4[b]
Chromium	811	100%	4.8	1,100 J	40	nonparametric (0.05)	95% Chebyshev UCL	50
Cobalt	556	100%	2.82	140	9.5	nonparametric (0.05)	Student's-t UCL	10
Copper	814	100%	5	12,000 J	110	nonparametric (0.05)	95% Chebyshev UCL	200
Total DDTs	197	40%	1.3×10^{-5}	2.9	0.025	nonparametric (0.05)	97.5% Chebyshev UCL	0.12[b]
Lead	814	100%	2	23,000	110	nonparametric (0.05)	97.5% Chebyshev UCL	300
Mercury	831	86%	0.01	4.6 J	0.21	nonparametric (0.05)	95% Chebyshev UCL	0.30
Total PCBs	1288	93%	2.8×10^{-4}	220	1.0	SWAC	95% UCL	0.72
PCB TEQ (mammal)	48	100%	9.08×10^{-8}	1.38×10^{-3}	4.6×10^{-5}	lognormal (0.05)	95% Chebyshev UCL	7.2×10^{-5}
PCB TEQ (bird)	48	100%	6.46×10^{-7}	0.00621	2.9×10^{-4}	lognormal (0.05)	95% Chebyshev UCL	5.4×10^{-4}
Selenium	629	44%	0.1	28	4.3	nonparametric (0.05)	97.5% Chebyshev UCL	5.0[b]
Silver	782	62%	0.02	270	1.0	nonparametric (0.05)	97.5% Chebyshev UCL	3.4[b]
Total PAHs	790	97%	0.0095	128	4.5	nonparametric (0.05)	97.5% Chebyshev UCL	6.0
Vanadium	556	100%	15	150	59	nonparametric (0.05)	Student's-t UCL	60

[a] Number of sediment samples in the baseline surface sediment dataset as of June 26, 2006, prior to an update to two locations at the Norfolk site.

[b] Calculated with ROS method because detection frequency was <85%.

COPC – chemical of potential concern
dw – dry weight
J – estimated value
N – number of samples
na – not available
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
ROS – regression on order statistic
SWAC – spatially weighted average concentration
TEQ – toxic equivalent
UCL – upper confidence limit

Table 14. Exposure concentrations in water calculated for three exposure areas for spotted sandpiper

COPC[a]	Exposure Area[b]	N	Detection Frequency	Concentration (mg/L)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/L)
				Minimum	Maximum	Mean			
Arsenic (total)	1	167	100%	2.92×10^{-4}	0.00153	9.3×10^{-4}	nonparametric (0.05)	Student's-t UCL	9.7×10^{-4}
	2	167	100%	2.82×10^{-4}	0.00157	8.8×10^{-4}	nonparametric (0.05)	Student's-t UCL	9.3×10^{-4}
	3	56	100%	1.83×10^{-4}	8.68×10^{-4}	4.9×10^{-4}	normal (0.05)	Student's-t UCL	5.3×10^{-4}
BEHP	1	39	18%	7.0×10^{-5}	0.00351	4.3×10^{-4}	low detection frequency	maximum detected conc.	0.0035[c]
	2	42	19%	7.0×10^{-5}	0.0238	8.6×10^{-4}	low detection frequency	maximum detected conc.	0.024[c]
	3	13	31%	1.4×10^{-4}	2.5×10^{-4}	1.7×10^{-4}	normal (0.05)	Student's-t UCL	1.8×10^{-4} [b]
Cadmium (total)	1	173	100%	8.8×10^{-6}	7.8×10^{-5}	4.7×10^{-5}	nonparametric (0.05)	95% Chebyshev UCL	5.4×10^{-5}
	2	173	99%	3.35×10^{-6}	3.91×10^{-4}	4.3×10^{-5}	nonparametric (0.05)	95% Chebyshev UCL	5.5×10^{-5}
	3	56	88%	3.4×10^{-6}	3.2×10^{-5}	1.5×10^{-5}	normal (0.05)	Student's-t UCL	1.6×10^{-5}
Chromium (total)	1	165	100%	2.4×10^{-4}	0.00174	5.7×10^{-4}	lognormal (0.05)	Student's-t UCL	6.1×10^{-4}
	2	157	100%	2.77×10^{-4}	0.00232	6.8×10^{-4}	nonparametric (0.05)	Student's-t UCL	7.3×10^{-4}
	3	58	100%	2.56×10^{-4}	0.00237	9.8×10^{-4}	gamma (0.05)	approximate gamma UCL	0.0011
Cobalt (total)	1	155	100%	3.34×10^{-5}	5.75×10^{-4}	1.8×10^{-4}	nonparametric (0.05)	95% Chebyshev UCL	2.2×10^{-4}
	2	155	100%	3.11×10^{-5}	7.72×10^{-4}	2.3×10^{-4}	gamma (0.05)	approximate gamma UCL	2.5×10^{-4}
	3	49	100%	1.23×10^{-4}	0.00133	4.0×10^{-4}	gamma (0.05)	approximate gamma UCL	4.6×10^{-4}
Copper (total)	1	166	100%	5.36×10^{-4}	0.00583	0.0014	nonparametric (0.05)	Student's-t UCL	0.0015
	2	167	99%	3.215×10^{-4}	0.00403	0.0015	gamma (0.05)	approximate gamma UCL	0.0016
	3	58	100%	7.28×10^{-4}	0.00424	0.0021	normal (0.05)	Student's-t UCL	0.0023
DDTs	1	nd	nd	nd	nd	nd	nd	nd	nd
	2	nd	nd	nd	nd	nd	nd	nd	nd
	3	nd	nd	nd	nd	nd	nd	nd	nd
Lead (total)	1	171	100%	4.59×10^{-5}	0.00145	3.5×10^{-4}	lognormal (0.05)	95% H-UCL	3.8×10^{-4}
	2	167	100%	5.7×10^{-5}	0.00157	4.0×10^{-4}	nonparametric (0.05)	95% Chebyshev UCL	4.9×10^{-4}
	3	58	100%	1.43×10^{-4}	0.00281	7.8×10^{-4}	gamma (0.05)	approximate gamma UCL	8.9×10^{-4}

COPC[a]	Exposure Area[b]	N	Detection Frequency	Concentration (mg/L)			Distribution Type	Statistic Used	Concentration Used in Risk Estimation (mg/L)
				Minimum	Maximum	Mean			
Mercury (total)	1	15	60%	5.6×10^{-7}	3.4×10^{-6}	1.5×10^{-6}	gamma (0.05)	approximate gamma UCL	2.0×10^{-6} [b]
	2	6	0%	1.0×10^{-4}	2.0×10^{-4}	1.0×10^{-4}	all non-detects	maximum RL	2.0×10^{-4} [c]
	3	8	75%	1.04×10^{-6}	6.9×10^{-6}	3.0×10^{-6}	normal (0.05)	Student's-t UCL	4.3×10^{-6} [b]
Nickel (total)	1	147	99%	1.74×10^{-4}	0.00211	6.7×10^{-4}	nonparametric (0.05)	Student's-t UCL	7.1×10^{-4}
	2	143	96%	1.455×10^{-4}	0.00288	7.6×10^{-4}	nonparametric (0.05)	Student's-t UCL	8.2×10^{-4}
	3	55	100%	4.34×10^{-4}	0.00291	0.0011	lognormal (0.05)	95% H-UCL	0.0013
Selenium (total)	1	151	2%	6.5×10^{-5}	2.7×10^{-4}	7.7×10^{-5}	low detection frequency	maximum detected conc.	2.7×10^{-4} [c]
	2	155	0%	6.5×10^{-5}	8.0×10^{-5}	7.4×10^{-5}	all non-detects	maximum RL	1.6×10^{-4} [c]
	3	54	0%	7.0×10^{-5}	8.0×10^{-5}	7.5×10^{-5}	all non-detects	maximum RL	1.6×10^{-4} [c]
PCBs	1	7	100%	2.0×10^{-7}	2.0×10^{-6}	1.1×10^{-6}	normal (0.05)	Student's-t UCL	1.7×10^{-6}
	2	8	100%	1.1×10^{-7}	3.1×10^{-6}	1.3×10^{-6}	normal (0.05)	Student's-t UCL	1.9×10^{-6}
	3	8	100%	1.1×10^{-7}	3.1×10^{-6}	1.3×10^{-6}	normal (0.05)	Student's-t UCL	1.9×10^{-6}
PCB TEQ (bird)	1	nd	nd	nd	nd	nd	nd	nd	nd
	2	nd	nd	nd	nd	nd	nd	nd	nd
	3	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium (Total)	1	133	100%	2.67×10^{-4}	0.00296	0.0014	normal (0.05)	Student's-t UCL	0.0014
	2	125	100%	2.2×10^{-4}	0.00399	0.0014	gamma (0.05)	approximate gamma UCL	0.0015
	3	46	100%	3.15×10^{-4}	0.00357	0.0015	lognormal (0.05)	95% H-UCL	0.0019
Zinc (total)	1	173	100%	7.0×10^{-4}	0.00834	0.0028	lognormal (0.05)	Student's-t UCL	0.0030
	2	173	100%	0.00108	0.00662	0.0028	nonparametric (0.05)	Student's-t UCL	0.0030
	3	56	100%	9.79×10^{-4}	0.00904	0.0042	normal (0.05)	Student's-t UCL	0.0046

[a] Metals were analyzed as total concentrations in water.

[b] The thee exposure areas are described in Section A.5.1.3.1 and shown on Figure 5-1.

[c] Detection frequency was below 20% or in less than 4 samples. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

[d] Calculated with ROS method because detection frequency was <85%.

COPC – chemical of potential concern
N – number of samples
nd – no data
PCB – polychlorinated biphenyl
ROS – regression on order statistic
TEQ – toxic equivalent
UCL – upper confidence limit

Table 15. Exposure concentrations in water calculated for the entire LDW

COPC[a]	N	Detection Frequency	Concentration (mg/L)			Distribution Type	Statistic Used	Concentration used in Risk Estimation (mg/L)
			Minimum	Maximum	Mean			
Arsenic (total)	390	100%	1.83×10^{-4}	0.00157	8.5×10^{-4}	nonparametric (0.05)	Student's-t UCL	8.8×10^{-4}
Bis(2-ethylhexyl) phthalate	94	20%	9.9×10^{-7}	0.0238	4.6×10^{-4}	nonparametric (0.05)	97.5% Chebyshev UCL	0.0021[b]
Cadmium (total)	402	98%	3.35×10^{-6}	3.91×10^{-4}	4.1×10^{-5}	nonparametric (0.05)	95% Chebyshev UCL	4.7×10^{-5}
Total chromium	380	100%	2.4×10^{-4}	0.00237	6.8×10^{-4}	nonparametric (0.05)	Student's-t UCL	7.1×10^{-4}
Cobalt (total)	359	100%	3.11×10^{-5}	0.00133	2.3×10^{-4}	nonparametric (0.05)	95% Chebyshev UCL	2.7×10^{-4}
Copper (total)	391	100%	3.215×10^{-4}	0.00583	0.0016	lognormal (0.05)	Student's-t UCL	0.0016
DDTs	nd	nd	nd	nd	nd	nd	nd	nd
Lead (total)	396	100%	4.59×10^{-5}	0.00281	4.3×10^{-4}	nonparametric (0.05)	95% Chebyshev UCL	5.0×10^{-4}
Mercury (total)	29	52%	5.0×10^{-7}	6.9×10^{-6}	2.1×10^{-6}	gamma distribution (0.05)	approximate gamma UCL	2.7×10^{-6} [b]
Nickel (total)	345	98%	1.455×10^{-4}	0.00291	7.8×10^{-4}	nonparametric (0.05)	Student's-t UCL	8.2×10^{-4}
Total PCBs	15	100%	1.1×10^{-7}	3.1×10^{-6}	1.2×10^{-6}	normal (0.05)	Student's-t UCL	1.6×10^{-6}
PCB TEQ (bird)	nd	nd	nd	nd	nd	nd	nd	nd
PCB TEQ (mammal)	nd	nd	nd	nd	nd	nd	nd	nd
Selenium (total)	360	1%	6.5×10^{-5}	2.7×10^{-4}	7.6×10^{-5}	low detection frequency	maximum detected conc.	2.7×10^{-4} [c]
Vanadium (total)	304	100%	2.2×10^{-4}	0.00399	0.0014	nonparametric (0.05)	Student's-t UCL	0.0014
Zinc (total)	402	100%	7.0×10^{-4}	0.00904	0.0030	nonparametric (0.05)	Student's-t UCL	0.0032

[a] Metals were analyzed as total concentrations in water

[b] Calculated with ROS method because detection frequency was <85%

[c] Detection frequency was below 20% or in less than 4 samples. If detected, the maximum detected concentration was used. If not detected the maximum RL was used.

COPC – chemical of potential concern

N – number of samples

nd – no data

PCB – polychlorinated biphenyl

ROS – regression on order statistic

TEQ – toxic equivalent