Lower Duwamish Waterway Group

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

Appendix B – Background and Site-Related Risk Estimates

Draft Feasibility Study

Lower Duwamish Waterway
Seattle, Washington

For submittal to

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

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

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B.1 Introduction

This appendix presents an evaluation of background and site-related risk estimates for the Lower Duwamish Waterway (LDW). Site-related risk is defined as the difference between risk estimates for anthropogenic background and risk estimates for the LDW that were presented in the human health risk assessment (HHRA) (Windward 2007b) and in the ecological risk assessment (ERA) (Windward 2007a). This assessment was done, where possible, for the risk-driver chemicals for human health, which include polychlorinated biphenyls (PCBs), arsenic, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and dioxins and furans, and for PCBs and river otter (Table 1).

Table 1 Types of Risk Estimates Included in this Evaluation

Type of Risk Estimate	PCBs	Arsenic	cPAHs	Dioxins and Furans
Background excess cancer and non-cancer risks for seafood ingestion scenarios	X	X		
Background excess cancer risk for direct sediment contact scenarios	X	X	X	X
Background risk for river otter	X			
Site-related excess cancer and non-cancer risks for seafood ingestion scenarios	X	X		
Site-related excess cancer risks for direct sediment contact scenarios	X	X	X	X
Site-related risk for river otter	X			

PCB – polychlorinated biphenyl
cPAH – carcinogenic polycyclic aromatic hydrocarbon

Background and site-related risks for seafood ingestion scenarios were not evaluated for cPAHs because few tissue samples from background areas in Puget Sound have been analyzed for cPAHs. In addition, the excess cancer risk from cPAHs contributed only 2% of the combined excess cancer risk from PCBs, arsenic, and cPAHs for the adult tribal reasonable maximum exposure (RME) seafood ingestion scenario, 3% for the adult Asian and Pacific Islander (API) RME seafood ingestion scenario, and 12% for the child tribal RME seafood ingestion scenario.

Human health (seafood ingestion scenarios)[1] and ecological risks were not evaluated for dioxins and furans in the risk assessments because tissue data were not available for dioxins and furans when the risk assessments were finalized. However, a memorandum was submitted to the US Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) (LDWG 2008), following the

[1] Direct sediment contact risks were estimated for dioxins and furans in the HHRA.

approval of the HHRA and ERA, that presented simplified risk estimates for dioxins and furans using tissue data for English sole collected from Kellogg Island in 2007. As presented in the memorandum, seafood ingestion risk from dioxin and furan toxic equivalents (TEQs) was 6×10^{-5} for the adult tribal RME scenario, which was 6% of the risk calculated for dioxin-like toxicity from PCBs (expressed as TEQs) in the HHRA. The lowest-observed-adverse-effect level (LOAEL)-based hazard quotient (HQ) for dioxins and furans (TEQ) was 0.09 for river otter based on the Kellogg Island data, which was approximately 16% of the risk calculated for PCBs (TEQ) in the ERA. Based on this assessment, using the small dioxin and furan tissue dataset, risk from exposure to dioxins and furans appears to be low relative to that from dioxin-like PCBs. Thus, background and site-related risks from dioxins and furans, based on seafood ingestion, were not evaluated in this appendix.

B.2 Human Health Seafood Ingestion Scenarios

This section presents estimated background and site-related risks for the human health RME seafood ingestion scenarios for PCBs and arsenic.

B.2.1 PCBs

In the HHRA (Windward 2007b), human seafood ingestion was represented by specified proportions of different seafood species for which tissue concentration data were available from the LDW. However, data are not available for all of these seafood species from background locations. Consequently, total PCB concentrations in various seafood species were estimated using the food web model (FWM) based on total PCB concentrations in background sediment and water. The FWM was discussed in detail in Appendix D of the Remedial Investigation (RI) (Windward 2008). The total PCB concentrations in tissue estimated from the FWM were used to calculate risks for human seafood ingestion using the same methods and exposure parameters as in the HHRA (see Sections B.3 and B.5 in Windward 2007b).

The total PCB concentrations in background sediment used in the FWM were the lower and higher end of anthropogenic background concentrations (50 and 100 µg/kg dw, respectively), as discussed in Section 4 of the FS. The total PCB concentration in background water was 0.6 ng/L, based on the assumption for water corresponding to total PCB concentrations of 0 – 100 µg/kg dw in sediment (see Appendix D of the RI, Section D.8). There is uncertainty in this assumption; the sensitivity of risk estimates to this assumption is discussed below.

Total PCB concentrations in various tissue types estimated using these background assumptions ranged from 23 to 715 µg/kg ww (Table 2).

Table 2 Food Web Model-predicted Total PCB Concentrations in Tissue

FWM Inputs		FWM-Estimated Total PCB Concentration (µg/kg ww)							
Sediment (µg/kg dw)	Water (ng/L)	Clams	Juvenile Fish	Crabs[a]		Sculpin	Shiner Surfperch	English Sole[a]	
				Whole Body	Edible Meat			Whole Body	Fillet
50	0.6	23	108	121 (slender) 277 (Dungeness)	36 (slender) 38 (Dungeness)	232	295	423	223
100	0.6	36	154	201 (slender) 391 (Dungeness)	59 (slender) 54 (Dungeness)	348	467	715	376

[a] The FWM estimated total PCB concentrations in whole-body crab and fish. Conversion factors were used to calculate the fillet and edible-meat concentrations from whole-body concentrations (0.526 for English sole, 0.295 for slender crab, and 0.139 for Dungeness crab).

dw – dry weight; FWM – food web model; PCB – polychlorinated biphenyl; ww – wet weight

Background risk estimates were calculated using the FWM-estimated total PCB concentrations in tissues corresponding to background conditions. Site-related seafood ingestion risks were calculated by subtracting the background risk estimate from the HHRA risk estimate for the LDW for each of the three RME scenarios for both excess cancer risks and non-cancer risks. The site-related risks associated with PCBs from seafood ingestion accounted for a high portion of the total PCB risks presented in the HHRA, ranging from 80 to 90% for the three RME scenarios for both excess cancer risks and non-cancer risks (Tables 3 and 4).

Table 3 HHRA, Background, and Site-related Seafood Ingestion Excess Cancer Risks for Total PCBs

Type of Estimate	Site-Related Seafood Ingestion Excess Cancer Risk for Total PCBs (% of Risk that is Site-Related)		
	Adult Tribal RME (Tulalip data)	Child Tribal RME (Tulalip data)	Adult API RME
HHRA[a]			
LDW risk estimate from the HHRA	2×10^{-3}	3×10^{-4}	5×10^{-4}
Background			
Low end (50 µg/kg dw in sediment and 0.6 ng/L in water)	2×10^{-4}	4×10^{-5}	6×10^{-5}
High end (100 µg/kg dw in sediment and 0.6 ng/L in water)	3×10^{-4}	6×10^{-5}	9×10^{-5}

Table 3 HHRA, Background, and Site-related Seafood Ingestion Excess Cancer Risks for Total PCBs

Type of Estimate	Site-Related Seafood Ingestion Excess Cancer Risk for Total PCBs (% of Risk that is Site-Related)		
	Adult Tribal RME (Tulalip data)	Child Tribal RME (Tulalip data)	Adult API RME
Site-related			
Low end (HHRA risk estimate minus lower end background risk estimate)	1.8×10^{-3} (90%)	2.6×10^{-4} (87%)	4.4×10^{-4} (88%)
High end (HHRA risk estimate minus lower end background risk estimate)	1.7×10^{-3} (85%)	2.4×10^{-4} (80%)	4.1×10^{-4} (82%)

Note: Additional significant figures are shown for site-related risks as appropriate based on significant figure conventions.

[a] LDW risk estimate in the HHRA represents a combination of site-related risk and background risk.

API – Asian and Pacific Islander; HHRA – human health risk assessment; LDW – Lower Duwamish Waterway; PCB – polychlorinated biphenyl; RME – reasonable maximum exposure

Table 4 HHRA, Background, and Site-related Seafood Ingestion Non-cancer HQs for Total PCBs

Type of Estimate	Site-Related Seafood Ingestion Non-cancer HQs for Total PCBs (% of Risk that is Site-Related)		
	Adult Tribal RME (Tulalip data)	Child Tribal RME (Tulalip data)	Adult API RME
HHRA[a]			
LDW risk estimate from the HHRA	40	86	29
Background			
Low end (50 µg/kg dw in sediment and 0.6 ng/L in water)	5	11	3
High end (100 µg/kg dw in sediment and 0.6 ng/L in water)	8	17	5
Site-related			
Low end (HHRA risk estimate minus lower end background risk estimate)	35 (88%)	75 (87%)	26 (90%)
High end (HHRA risk estimate minus lower end background risk estimate)	32 (80%)	69 (80%)	24 (81%)

[a] LDW risk estimate in the HHRA represents a combination of site-related risk and background risk.

API – Asian and Pacific Islander; HHRA – human health risk assessment; LDW – Lower Duwamish Waterway; PCB – polychlorinated biphenyl; RME – reasonable maximum exposure

As noted above, there is uncertainty in the average total PCB concentration in water corresponding to background conditions. Therefore, the sensitivity of background risk estimates was evaluated over a range of total PCB concentrations in water (0.3 to 0.9 ng/L, including the default assumption of 0.6 ng/L) (Table 5). As a point of reference, total PCB concentrations in upstream water ranged from 0.038 ng/L to 2.441 ng/L,

with a mean of 0.366 ng/L, in the 21 samples analyzed in 2005 to 2008 (see Section 7 of the RI). Surface water grab samples collected from the LDW in 2005 had total PCB concentrations that ranged from 0.132 to 3.211 ng/L with an overall mean concentration of 1.277 ng/L.

Table 5 Background Seafood Ingestion Excess Cancer Risks as a Function of Total PCB Concentration in Water

Background Assumptions	Adult Tribal RME (Tulalip Data)		Child Tribal RME (Tulalip Data)		Adult API RME	
	Excess Cancer Risk	Non-Cancer HQ	Excess Cancer Risk	Non-Cancer HQ	Excess Cancer Risk	Non-Cancer HQ
50 µg/kg dw in sediment and 0.3 ng/L in water	2×10^{-4}	4	3×10^{-5}	9	5×10^{-5}	3
50 µg/kg dw in sediment and 0.6 ng/L in water	2×10^{-4}	5	4×10^{-5}	11	6×10^{-5}	3
50 µg/kg dw in sediment and 0.9 ng/L in water	2×10^{-4}	6	4×10^{-5}	13	7×10^{-5}	4

API – Asian and Pacific Islander
PCB – polychlorinated biphenyl
RME – reasonable maximum exposure

B.2.2 Arsenic

In the HHRA, inorganic arsenic data were used to evaluate human health risks because arsenic is most toxic in its inorganic form. Inorganic arsenic concentrations in clams contributed 96% of the total excess cancer risk for adult tribal and child tribal RME seafood ingestion scenarios and 98% of the total excess cancer risk for the adult API RME seafood ingestion scenario. Background excess cancer risks and non-cancer risks for arsenic were calculated using background tissue data collected in 2004 as part of the RI (Table 6). Background tissue data were collected from areas considered influenced by Asarco smelter emissions, as well as from areas considered outside of the influence of the Asarco smelter.

B.3 References

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