APPENDIX E

HUMAN HEALTH RISK-BASED CONCENTRATIONS FOR SURFACE WATER, FISH TISSUE AND SEDIMENT IN SUPPORT OF SAMPLING AND ANALYSIS PLAN DEVELOPMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

May 1, 2008

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

Reply To: ECL-112

Marko E. Adzic
Teck Cominco American Incorporated
501 North Riverpoint Boulevard
Spokane, Washington 99202

Re: Upper Columbia River (UCR) Remedial Investigation and Feasibility Study

Dear Mr. Adzic:

The purpose of this letter is two-fold: (1) to provide Teck Cominco the human health risk-based concentrations (RBCs) for surface water to support development of the sampling and analysis plan (SAP) for surface water at the Upper Columbia River site (the Site), and (2) to require the submittal by Teck Cominco of a draft surface water sampling and analysis plan.

The EPA, through its contractor, Syracuse Research Corporation, has generated the enclosed April 23, 2008 memorandum on Human Health Risk-Based Concentrations for Surface Water, Fish Tissue and Sediment in Support of Sampling and Analysis Plan Development. It is important to note that the RBCs provided in the enclosed April 23 memorandum are not intended to represent clean-up levels or remediation goals. They have been derived solely for the purposes of establishing target analytical methods in the development of site SAPs in support of the human health risk assessment.

Surface Water RBCs

The surface water RBCs will be used to select appropriate analytical methods to ensure that method detection limits for surface water are adequate to calculate meaningful risk estimates for human health pertinent to the risk assessment for the Site.

Table 1 of the enclosed memorandum presents the RBCs for ingestion of chemicals of interest (COIs) in water based on a drinking water scenario. This table also includes the EPA Maximum Contaminant Levels (MCLs) for drinking water. Details of the calculation of the HIF for drinking water (i.e., body weight, exposure frequency, exposure duration, ingestion rates) are presented in Appendix A of the enclosed memorandum. For mercury, the water quality criterion is protective of fish tissue ingestion (EPA 2006 Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, U.S. Environmental Protection Agency, Office of Science and Technology, EPA 823/B-04/001). Details of the calculation of the mercury RBC for

water are presented in Appendix B of the enclosed memorandum. For chemicals identified as having a mutagenic mode of action for carcinogenesis, drinking water RBCs were calculated in accordance with EPA 2005 Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-03/003F as shown in Appendix C of the enclosed memorandum.

Table 2 of the enclosed April 23 memorandum presents the RBCs for inhalation of COIs in water during sweat lodge use. As noted in the table, in the case of most metals and perchlorocyclopentadiene, the RBC based on inhalation exposures during sweat lodge use is lower than the RBC based on drinking water ingestion exposures. For these COIs, the Surface Water SAP should establish analytical goals based on the lower RBC (i.e., sweat lodge RBC). Details of the calculation of the HIF for sweat lodge exposures are presented in Appendix D of the April 23 memorandum. For chemicals identified as having a mutagenic mode of action for carcinogenesis, water RBCs for sweat lodge use were calculated in accordance with EPA 2005 Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-03/003F as shown in Appendix E of the enclosed memorandum.

Sampling and Analysis Plan

EPA is hereby requiring Teck Cominco to submit a draft sampling and analysis plan for surface water at the Site pursuant to the Settlement Agreement. Teck Cominco must submit a draft sampling and analysis plan by June 2, 2008 to EPA.

If you have any questions, please feel free to contact me at (206) 553-2106.

Sincerely,

Kevin Rochlin
Project Manager

Enclosures

cc: w/ Enclosures
Dan Audet, U. S. Department of the Interior
John Roland, WA Department of Ecology
Patti Bailey, Colville Confederated Tribes
Randy Connolly, Spokane Tribe

Syracuse Research Corporation
999 18th Street, Suite 1975
Denver, CO 80202
(303) 292-4760 phone
(303) 292-4755 fax

MEMORANDUM

To: Monica Tonel, Marc Stifelman (EPA, Region 10)
From: Lynn Woodbury (SRC)
Task: FD052.CF999.842
Date: April 23, 2008
Re: Human Health Risk-Based Concentrations for Surface Water, Fish Tissue and Sediment in Support of Sampling and Analysis Plan Development

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Per your email request on March 28, 2008, SRC has calculated risk-based concentrations (RBCs) for surface water, fish tissue, and sediment to support development of the sampling and analysis plans (SAPs) for these media at the Upper Columbia River (UCR) Site. This memorandum has been revised, as appropriate, based on comments from the Confederated Tribes of the Colville Reservation, the Spokane Tribe of Indians, and the Washington State Department of Ecology.

RBCs were calculated based on the maximally exposed receptor population (i.e., traditional subsistence scenario) from the draft Human Health Risk Assessment (HHRA) Workplan (EPA 2008). RBCs were back-calculated based on target hazard quotient (HQ) of 0.1 for non-cancer and a target cancer risk of 1E-06. When calculating RBCs, the human intake factor (HIF) was based on the child for non-cancer and the time-weighted average (TWA) for cancer.

It is important to note that the RBCs provided in this memorandum are not intended to represent clean-up levels or remediation goals. They have been derived solely for the purposes of establishing target analytical detection limits and selecting appropriate analytical methods in the development of site SAPs in support of the human health risk assessment.

These RBCs should be utilized to ensure that method detection limits for each medium are adequate to calculate meaningful risk estimates for human health. For example, if the RBC for some chemical in sediment was 1 mg/kg, and all of the analytical results were obtained using a method with a detection limit of 5 mg/kg, then it would not be certain that risks from that chemical are below a level of concern even if all of the results were non-detect.

Detection limit adequacy is most important for chemicals with high censoring (i.e., low detection frequency). If a chemical has a high detection frequency, it is possible to calculate meaningful risk estimates, even if the detection limit exceeds the RBC. For example, if the sediment RBC were 1 mg/kg, the detection limit were 5 mg/kg, and the detected results ranged from 10 to 100 mg/kg, the data would be adequate for estimating exposure and risk.

It is recognized that, in some instances, it may not be possible for current analytical methods to achieve method detection limits that are lower than the specified RBCs. As appropriate, samples will be analyzed using the best available techniques and data limitations related to detection limit adequacy will be noted in the uncertainties section of the human health risk assessment.

Surface Water RBCs

Table 1 presents the RBCs for ingestion of chemicals of interest (COIs) in water based on a drinking water ingestion scenario. This table also includes the EPA Maximum Contaminant Levels (MCLs) for drinking water. Details of the calculation of the HIF for drinking water (i.e., body weight, exposure frequency, exposure duration, ingestion rates) are presented in Appendix A. For mercury, the water quality criterion is protective of fish tissue ingestion (EPA 2006). Details of the calculation of the mercury RBC for water are presented in Appendix B. For chemicals identified as having a mutagenic mode of action for carcinogenesis, drinking water RBCs were calculated in accordance with EPA (2005) as shown in Appendix C.

Table 2 presents the RBCs for inhalation of COIs in water during sweat lodge use. As noted in the table, in the case of most metals and perchlorocyclopentadiene, the RBC based on inhalation exposures during sweat lodge use is lower than the RBC based on drinking water ingestion exposures. For these COIs, the Surface Water SAP should establish analytical goals based on the lower RBC (i.e., sweat lodge RBC). Details of the calculation of the HIF for sweat lodge exposures are presented in Appendix D. For chemicals identified as having a mutagenic mode of action for carcinogenesis, water RBCs for sweat lodge use were calculated in accordance with EPA (2005) as shown in Appendix E.

Fish Tissue RBCs

Table 3 presents the RBCs for ingestion of COIs in fish tissue. For arsenic, the fish tissue RBC was calculated based on an assumption that 10% of arsenic in tissue is in a biologically available form. As noted above, the fish tissue residue criterion (TRC) for mercury was calculated in accordance with draft guidance provided in EPA (2006). Details of the calculation of the methylmercury TRC is presented in Appendix B. Details of the calculation of the HIF for fish ingestion exposures are presented in Appendix F. For chemicals identified as having a mutagenic mode of action for carcinogenesis, fish tissue RBCs were calculated in accordance with EPA (2005) as shown in Appendix G.

Sediment RBCs

Although sediment RBCs had been calculated previously in support of the Sediment DQO and Strawman SAP memorandum (SRC 2008), values were derived using a target cancer risk of 1E-05 and the adult HIF. **Table 4** presents revised sediment RBCs for metals based on a target cancer risk of 1E-06 and the TWA HIF for the purposes of maintaining consistency with the surface water and fish tissue RBCs. Details of the calculation of the HIF for incidental ingestion of sediment are presented in Appendix H.

References cited:

Syracuse Research Corporation (SRC). 2008. Memorandum: Proposed Beach Surface Sediment Data Quality Objectives and Sampling Design Recommendations. Provided by: Lynn Woodbury and Bill Brattin (SRC). Provided to: Monica Tonel and Marc Stifelman (EPA, Region 10). March 21, 2008.

U.S. Environmental Protection Agency (EPA). 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. U.S. Environmental Protection Agency, Washington, DC. EPA/630/R-03/003F.

_____. 2006. Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. U.S. Environmental Protection Agency, Office of Science and Technology. EPA 823/B-04/001.

_____. 2008. Workplan for the Human Health Risk Assessment for the Upper Columbia River Site Remedial Investigation and Feasibility Study. U.S. Environmental Protection Agency, Region 10. Prepared by Syracuse Research Corporation. Draft – February 22, 2008.

Attached Tables:

Table 1	Risk-Based Concentrations (RBCs) and Maximum Contaminant Levels (MCLs) for Ingestion of Chemicals of Interest (COIs) in Drinking Water
Table 2	Risk-Based Concentrations (RBCs) for Inhalation of Chemicals of Interest (COIs) in Water During Sweat Lodge Use
Table 3	Risk-Based Concentrations (RBCs) and for Ingestion of Chemicals of Interest (COIs) in Fish Tissue
Table 4	Risk-Based Concentrations (RBCs) and for Incidental Ingestion of Metals in Surface Sediment

Attached Appendices:

Appendix A	Human Intake Factor for Drinking Water (HIF_{dw})
Appendix B	Calculation of Fish Tissue Residue Criterion for Mercury
Appendix C	Calculation of RBCs for Ingestion of Drinking Water for Chemicals with a Mutagenic Mode of Action
Appendix D	Human Intake Factor for Sweat Lodge Use
Appendix E	Calculation of RBC for Inhalation of Benzo(a)pyrene in Water During Sweat Lodge Use
Appendix F	Human Intake Factor for Ingestion of Fish (HIF_{fish})
Appendix G	Calculation of RBCs for Ingestion of Fish Tissue for Chemicals with a Mutagenic Mode of Action
Appendix H	Human Intake Factor for Incidental Ingestion of Surface Sediment (HIF_{sed})

TABLE 1
RISK-BASED CONCENTRATIONS (RBCs) AND MAXIMUM CONTAMINANT LEVELS (MCLs)
FOR INGESTION OF CHEMICALS OF INTEREST (COIs) IN DRINKING WATER

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			EPA Drinking Water MCL (mg/L) [1]	Lowest Water Value (mg/L)	Notes
		Target HQ:		0.1	Target Risk:		1E-06			
		HIF_{dw} (L/kg-d):		1.2E-01	HIF_{TWAdw} (L/kg-d):		5.2E-02			
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
METALS AND METALLOIDS										
Aluminum	7429905	1.0E+00	P	8.6E-01	--		--	--	8.6E-01	
Antimony	7440360	4.0E-04	I	3.4E-04	--		--	6.0E-03	3.4E-04	
Arsenic	7440382	3.0E-04	I	2.6E-04	1.5E+00	I	1.3E-05	1.0E-02	1.3E-05	
Barium	7440393	2.0E-01	I	1.7E-01	--		--	2.0E+00	1.7E-01	
Beryllium	7440417	2.0E-03	I	1.7E-03	--		--	4.0E-03	1.7E-03	
Boron	7440428	2.0E-01	I	1.7E-01	--		--	--	1.7E-01	
Cadmium	7440439	5.0E-04	I	4.3E-04	--		--	5.0E-03	4.3E-04	(a)
Calcium	7440702	--		--	--		--	--	--	
Chromium	7440473	1.5E+00	I	1.3E+00	--		--	1.0E-01	1.0E-01	(b)
Cobalt	7440484	2.0E-02	P	1.7E-02	--		--	--	1.7E-02	
Copper	7440508	4.0E-02	H	3.4E-02	--		--	1.3E+00	3.4E-02	
Fluoride	16984488	6.0E-02	I	5.2E-02	--		--	4.0E+00	5.2E-02	(c)
Iron	7439896	7.0E-01	P	6.0E-01	--		--	--	6.0E-01	
Lead	7439921	--		--	--		--	1.5E-02	1.5E-02	(d)
Magnesium	7439954	--		--	--		--	--	--	
Manganese	7439965	4.7E-02	I	4.0E-02	--		--	--	4.0E-02	(e)
Mercury	7439976	see Appendix B		8.9E-11	--		--	2.0E-03	8.9E-11	(f)
Molybdenum	7439987	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
Nickel	7440020	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
Potassium	7440097	--		--	--		--	--	--	
Selenium	7782492	5.0E-03	I	4.3E-03	--		--	5.0E-02	4.3E-03	
Silica	7631869	--		--	--		--	--	--	
Silver	7440224	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
Sodium	7440235	--		--	--		--	--	--	
Thallium	7440280	7.0E-05	O	6.0E-05	--		--	2.0E-03	6.0E-05	
Tin	7440315	6.0E-01	H	5.2E-01	--		--	--	5.2E-01	
Uranium	7440611	3.0E-03	I	2.6E-03	--		--	3.0E-02	2.6E-03	(g)
Vanadium	7440622	1.0E-03	E	8.6E-04	--		--	--	8.6E-04	
Zinc	7440666	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
OTHER TRACE ELEMENTS										
Bismuth	7440699	--		--	--		--	--	--	
Cerium	7440451	--		--	--		--	--	--	
Cesium	7440462	--		--	--		--	--	--	
Gallium	7440553	--		--	--		--	--	--	
Lanthanum	7439910	--		--	--		--	--	--	
Lithium	7439932	2.0E-02	E	1.7E-02	--		--	--	1.7E-02	
Niobium	7440031	--		--	--		--	--	--	
Rubidium	7440177	--		--	--		--	--	--	
Scandium	7440202	--		--	--		--	--	--	
Strontium	7440246	6.0E-01	I	5.2E-01	--		--	--	5.2E-01	
Thorium	7440291	--		--	--		--	--	--	
Titanium	7440326	--		--	--		--	--	--	
Ytterbium	7440644	--		--	--		--	--	--	
Zirconium	7440677	--		--	--		--	--	--	
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)										
2-Methylnaphthalene	91576	4.0E-03	I	3.4E-03	--		--	--	3.4E-03	
Acenaphthene	83329	6.0E-02	I	5.2E-02	--		--	--	5.2E-02	
Acenaphthylene	208968	--		--	--		--	--	--	
Anthracene	120127	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
Benzo(a)anthracene	56553	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Benzo(a)pyrene	50328	--		--	see Appendix C		1.3E-06	2.0E-04	1.3E-06	MMOA
Benzo(b)fluoranthene	205992	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Benzo(ghi)perylene	191242	--		--	--		--	--	--	
Benzo(k)fluoranthene	207089	--		--	see Appendix C		1.3E-04	--	1.3E-04	MMOA
Chrysene	218019	--		--	see Appendix C		1.3E-03	--	1.3E-03	MMOA
Dibenz(a,h)anthracene	53703	--		--	see Appendix C		1.3E-06	--	1.3E-06	MMOA
Fluoranthene	206440	4.0E-02	I	3.4E-02	--		--	--	3.4E-02	
Fluorene	86737	4.0E-02	I	3.4E-02	--		--	--	3.4E-02	
Indeno(1,2,3-cd)pyrene	193395	--		--	see Appendix C		1.3E-05	--	1.3E-05	MMOA
Naphthalene	91203	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
Phenanthrene	85018	--		--	--		--	--	--	
Pyrene	129000	3.0E-02	I	2.6E-02	--		--	--	2.6E-02	

TABLE 1
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		HIF_{dw} (L/kg-d):		1.2E-01	HIF_{TWAdw} (L/kg-d):		5.2E-02			
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
PESTICIDES										
2,4'-DDD	53190	--		--	2.4E-01	I	8.0E-05	--	8.0E-05	(h)
4,4'-DDD	72548	--		--	2.4E-01	I	8.0E-05	--	8.0E-05	
2,4'-DDE	3424826	--		--	3.4E-01	I	5.6E-05	--	5.6E-05	(i)
4,4'-DDE	72559	--		--	3.4E-01	I	5.6E-05	--	5.6E-05	
2,4'-DDT	789026	5.0E-04	I	4.3E-04	3.4E-01	I	5.6E-05	--	5.6E-05	(j)
4,4'-DDT	50293	5.0E-04	I	4.3E-04	3.4E-01	I	5.6E-05	--	5.6E-05	
Aldrin	309002	3.0E-05	I	2.6E-05	1.7E+01	I	1.1E-06	--	1.1E-06	
Atrazine	1912249	3.5E-02	I	3.0E-02	2.2E-01	H	8.7E-05	3.0E-03	8.7E-05	
alpha-BHC	319846	--		--	6.3E+00	I	3.0E-06	--	3.0E-06	
beta-BHC	319857	--		--	1.8E+00	I	1.1E-05	--	1.1E-05	
delta-BHC	319868	--		--	--		--	--	--	
gamma-BHC	58899	3.0E-04	I	2.6E-04	1.3E+00	H	1.5E-05	--	1.5E-05	
alpha-Chlordane	5103719	5.0E-04	I	4.3E-04	3.5E-01	I	5.5E-05	--	5.5E-05	(k)
gamma-Chlordane	5566347	5.0E-04	I	4.3E-04	3.5E-01	I	5.5E-05	--	5.5E-05	(k)
Dieldrin	60571	5.0E-05	I	4.3E-05	1.6E+01	I	1.2E-06	--	1.2E-06	
Endosulfan I	959988	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endosulfan II	33213659	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endosulfan sulfate	1031078	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	(l)
Endrin	72208	3.0E-04	I	2.6E-04	--		--	2.0E-03	2.6E-04	
Endrin aldehyde	7421934	--		--	--		--	--	--	
Endrin ketone	53494705	--		--	--		--	--	--	
Heptachlor	76448	5.0E-04	I	4.3E-04	4.5E+00	I	4.3E-06	4.0E-04	4.3E-06	
Heptachlor epoxide	1024573	1.3E-05	I	1.1E-05	9.1E+00	I	2.1E-06	2.0E-04	2.1E-06	
Hexachlorobenzene	118741	8.0E-04	I	6.9E-04	1.6E+00	I	1.2E-05	1.0E-04	1.2E-05	
Hexachlorobutadiene	87683	1.0E-03	P	8.6E-04	7.8E-02	I	2.5E-04	--	2.5E-04	
Methoxychlor	72435	5.0E-03	I	4.3E-03	--		--	4.0E-02	4.3E-03	
cis-Nonachlor	5103731	--		--	--		--	--	--	
trans-Nonachlor	39765805	--		--	--		--	--	--	
Oxychlordane	27304138	--		--	--		--	--	--	
Toxaphene	8001352	--		--	1.1E+00	I	1.7E-05	3.0E-03	1.7E-05	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)										
1,1'-Biphenyl	92524	5.0E-02	I	4.3E-02	--		--	--	4.3E-02	
1,2,4-Trichlorobenzene	120821	1.0E-02	I	8.6E-03	--		--	7.0E-02	8.6E-03	
1,2-Dichlorobenzene	95501	9.0E-02	I	7.7E-02	--		--	--	7.7E-02	
1,3-Dichlorobenzene	541731	3.0E-03	E	2.6E-03	--		--	--	2.6E-03	
1,4-Dichlorobenzene	106467	3.0E-02	E	2.6E-02	2.4E-02	H	8.0E-04	--	8.0E-04	
2,2'-oxybis(1-chloropropane)	108601	4.0E-02	I	3.4E-02	7.0E-02	H	2.7E-04	--	2.7E-04	
2,4,5-Trichlorophenol	95954	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
2,4,6-Trichlorophenol	88062	1.0E-03	P	8.6E-04	1.1E-02	I	1.7E-03	--	8.6E-04	
2,4-Dichlorophenol	120832	3.0E-03	I	2.6E-03	--		--	--	2.6E-03	
2,4-Dimethylphenol	105679	2.0E-02	I	1.7E-02	--		--	--	1.7E-02	
2,4-Dinitrophenol	51285	2.0E-03	I	1.7E-03	--		--	--	1.7E-03	
2,4-Dinitrotoluene	121142	2.0E-03	I	1.7E-03	--		--	--	1.7E-03	
2,6-Dinitrotoluene	606202	1.0E-03	P	8.6E-04	--		--	--	8.6E-04	
2-Chloronaphthalene	91587	8.0E-02	I	6.9E-02	--		--	--	6.9E-02	
2-Chlorophenol	95578	5.0E-03	I	4.3E-03	--		--	--	4.3E-03	
2-Methylphenol	95487	5.0E-02	I	4.3E-02	--		--	--	4.3E-02	
2-Nitroaniline	88744	--		--	--		--	--	--	
2-Nitrophenol	88755	--		--	--		--	--	--	
3,3'-Dichlorobenzidine	91941	--		--	4.5E-01	I	4.3E-05	--	4.3E-05	
3-Nitroaniline	99092	--		--	--		--	--	--	
4,6-Dinitro-2-methylphenol	534521	--		--	--		--	--	--	
4-Bromophenyl-phenylether	101553	--		--	--		--	--	--	
4-Chloro-3-methylphenol	59507	--		--	--		--	--	--	
4-Chloroaniline	106478	4.0E-03	I	3.4E-03	--		--	--	3.4E-03	
4-Chlorophenylphenyl ether	7005723	--		--	--		--	--	--	
4-Methylphenol	106445	5.0E-03	H	4.3E-03	--		--	--	4.3E-03	
4-Nitroaniline	100016	--		--	--		--	--	--	
4-Nitrophenol	100027	--		--	--		--	--	--	
Acetophenone	98862	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Benzaldehyde	100527	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Benzoic acid	65850	4.0E+00	I	3.4E+00	--		--	--	3.4E+00	

TABLE 1
RISK-BASED CONCENTRATIONS (RBCs) AND MAXIMUM CONTAMINANT LEVELS (MCLs)
FOR INGESTION OF CHEMICALS OF INTEREST (COIs) IN DRINKING WATER

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			EPA Drinking Water MCL (mg/L) [1]	Lowest Water Value (mg/L)	Notes
		Target HQ: 0.1			Target Risk: 1E-06					
		HIF_{dw} (L/kg-d): 1.2E-01			HIF_{TWAdw} (L/kg-d): 5.2E-02					
		oRfD (mg/kg-d)	oRfD Source	RBC (mg/L)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	RBC (mg/L)			
Benzyl alcohol	100516	5.0E-01	P	4.3E-01	--		--	--	4.3E-01	
bis(2-Chloroethoxy)methane	111911	--		--	--		--	--	--	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	1.7E-05	--	1.7E-05	
Bis(2-ethylhexyl)phthalate	117817	2.0E-02	I	1.7E-02	1.4E-02	I	1.4E-03	--	1.4E-03	
Butyl benzyl phthalate	85687	2.0E-01	I	1.7E-01	--		--	--	1.7E-01	
Caprolactam	105602	5.0E-01	I	4.3E-01	--		--	--	4.3E-01	
Carbazole	86748	--		--	2.0E-02	H	9.6E-04	--	9.6E-04	
Dibenzofuran	132649	1.0E-03	P	8.6E-04	--		--	--	8.6E-04	
Diethylphthalate	84662	8.0E-01	I	6.9E-01	--		--	--	6.9E-01	
Dimethylphthalate	131113	--		--	--		--	--	--	
Di-n-butylphthalate	84742	1.0E-01	I	8.6E-02	--		--	--	8.6E-02	
Di-n-octylphthalate	117840	--		--	--		--	--	--	
Hexachloroethane	67721	1.0E-03	I	8.6E-04	1.4E-02	I	1.4E-03	--	8.6E-04	
Isophorone	78591	2.0E-01	I	1.7E-01	9.5E-04	I	2.0E-02	--	2.0E-02	
Nitrobenzene	98953	5.0E-04	I	4.3E-04	--		--	--	4.3E-04	
N-Nitrosodi-n-propylamine	621647	--		--	7.0E+00	I	2.7E-06	--	2.7E-06	
N-Nitrosodiphenylamine	86306	--		--	4.9E-03	I	3.9E-03	--	3.9E-03	
Pentachlorophenol	87865	3.0E-02	I	2.6E-02	1.2E-01	I	1.6E-04	1.0E-03	1.6E-04	
Perchlorocyclopentadiene	77474	6.0E-03	I	5.2E-03	--		--	--	5.2E-03	
Phenol	108952	3.0E-01	I	2.6E-01	--		--	--	2.6E-01	
POLYBROMINATED DIPHENYLETHERS (PBDEs)										
multiple congeners	--	--		--	--		--	--	--	
POLYCHLORINATED BIPHENYLS (PCBs)										
as Aroclor	--	2.0E-05	I	1.7E-05	2.0E+00	I	9.6E-06	--	9.6E-06	(m)
DIOXIN-LIKE CONGENERS										
as TEQ	--	--		--	1.5E+05	H	1.3E-10	--	1.3E-10	(n)

RBC = risk-based concentration HIF = Human Intake Factor -- = no data MMOA = mutagenic mode of action

[1] Maximum Contaminant Levels (MCLs) for drinking water from http://www.epa.gov/safewater/contaminants/index.html

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Based on toxicity values for water.
(b) Based on toxicity values for Chromium III.
(c) Based on IRIS values for fluorine (CASRN 7782-41-4).
(d) Risk calculations for lead not based on oRfD or oSF approach, RBC not calculated.
(e) Based on toxicity values for non-food.
(f) Criterion is based on fish ingestion scenario, see Appendix B.
(g) Based on toxicity values from IRIS.
(h) Based on toxicity values for 4-4'-DDE.
(i) Based on toxicity values for 4-4'-DDD.
(j) Based on toxicity values for 4-4'-DDT.
(k) Based on toxicity values for Chlordane.
(l) Based on toxicity values for Endosulfan.
(m) Based on toxicity values for Aroclor 1254.
(n) Based on toxicity values for TCDD.

See Appendix A for details on the derivation of the Human Intake Factor (HIF_{dw}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{oSF_{water} * IR_{TWAdw} * EF * ED}$$

IR_{TWAdw} = (IRchild * EDchild + IRadult * EDadult) / EDtotal
= (2 L/d * 4 yrs + 4 L/d * 64 yrs) / 68 yrs
= 3.9 L/d

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Water Ingestion Slope Factor (risk/pCi) [1]	**Drinking Water RBC (pCi/L)**
Radium (88)	Ra-226+D	3.86E-10	**2.7E-02**
Uranium (92)	U-238+D	8.71E-11	**1.2E-01**

[1] http://www.epa.gov/radiation/heast/

See Appendix A for details on the exposure parameters.

TABLE 2
RISK-BASED CONCENTRATIONS (RBCs) FOR INHALATION OF CHEMICALS OF INTEREST (COIs) IN WATER DURING SWEAT LODGE USE

Chemical of Interest (COI)	CASRN	Non-Cancer			Cancer			Lowest Water RBC (mg/L)	Lower than drinking water RBC?	Notes
		Target HQ: 0.1			Target Risk: 1E-06					
		HIF (L/kg-d): 4.3E-03			HIF_{TWA} (L/kg-d): 4.0E-03					
		iRfD (mg/kg-d)	iRfD Source	RBC (mg/L)	iSF $(mg/kg\text{-}d)^{-1}$	iSF Source	RBC (mg/L)			
METALS AND METALLOIDS										
Aluminum	7429905	1.0E-03	P	2.3E-02	--		--	2.3E-02	yes	
Arsenic	7440382	--		--	1.5E+01	I	1.6E-05	1.6E-05	no	
Barium	7440393	1.4E-04	A	3.3E-03	--		--	3.3E-03	yes	
Beryllium	7440417	5.7E-06	I	1.3E-04	8.4E+00	I	2.9E-05	2.9E-05	yes	
Boron	7440428	5.7E-03	H	1.3E-01	--		--	1.3E-01	yes	
Cadmium	7440439	5.7E-05	E	1.3E-03	6.3E+00	I	3.9E-05	3.9E-05	yes	
Cobalt	7440484	5.7E-06	P	1.3E-04	9.8E+00	P	2.5E-05	2.5E-05	yes	
Manganese	7439965	1.4E-05	I	3.3E-04	--		--	3.3E-04	yes	
Uranium	7440611	8.6E-05	M	2.0E-03	--		--	2.0E-03	yes	(a)
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)										
Benzo(a)pyrene	50328	--		--	see Appendix E		5.5E-05	5.5E-05	no	MMOA
Naphthalene	91203	9.0E-04	I	2.1E-02	--		--	2.1E-02	no	
PESTICIDES										
2,4'-DDT	789026	--		--	3.4E-01	I	7.3E-04	7.3E-04	no	(b)
4,4'-DDT	50293	--		--	3.4E-01	I	7.3E-04	7.3E-04	no	
Aldrin	309002	--		--	1.7E+01	I	1.5E-05	1.5E-05	no	
alpha-BHC	319846	--		--	6.3E+00	I	3.9E-05	3.9E-05	no	
beta-BHC	319857	--		--	1.8E+00	I	1.4E-04	1.4E-04	no	
alpha-Chlordane	5103719	2.0E-04	I	4.7E-03	3.5E-01	I	7.1E-04	7.1E-04	no	(c)
gamma-Chlordane	5566347	2.0E-04	I	4.7E-03	3.5E-01	I	7.1E-04	7.1E-04	no	(c)
Dieldrin	60571	--		--	1.6E+01	I	1.5E-05	1.5E-05	no	
Heptachlor	76448	--		--	4.5E+00	I	5.5E-05	5.5E-05	no	
Heptachlor epoxide	1024573	--		--	9.1E+00	I	2.7E-05	2.7E-05	no	
Hexachlorobenzene	118741	--		--	1.6E+00	I	1.5E-04	1.5E-04	no	
Hexachlorobutadiene	87683	--		--	7.8E-02	I	3.2E-03	3.2E-03	no	
Toxaphene	8001352	--		--	1.1E+00	I	2.2E-04	2.2E-04	no	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)										
1,2-Dichlorobenzene	95501	4.0E-02	H	9.3E-01	--		--	9.3E-01	no	
1,4-Dichlorobenzene	106467	2.3E-01	I	5.3E+00	4.0E-02	O	6.2E-03	6.2E-03	no	
2,2'-oxybis(1-chloropropane)	108601	--		--	3.5E-02	H	7.1E-03	7.1E-03	no	
2,4,6-Trichlorophenol	88062	--		--	1.0E-02	I	2.5E-02	2.5E-02	no	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	2.2E-04	2.2E-04	no	
Hexachloroethane	67721	--		--	1.4E-02	I	1.8E-02	1.8E-02	no	
Nitrobenzene	98953	6.0E-04	A	1.4E-02	--		--	1.4E-02	no	
Perchlorocyclopentadiene	77474	5.7E-05	I	1.3E-03	--		--	1.3E-03	yes	
POLYCHLORINATED BIPHENYLS (PCBs)										
as Aroclor	--	--		--	2.0E+00	I	1.2E-04	1.2E-04	no	(d)
DIOXIN-LIKE CONGENERS										
as TEQ	--	--		--	1.5E+05	H	1.6E-09	1.6E-09	no	(e)

RBC = risk-based concentration HIF = Human Intake Factor -- = no data MMOA = mutagenic mode of action

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Based on toxicity values from IRIS.
(b) Based on toxicity values for 4-4'-DDT.
(c) Based on toxicity values for Chlordane.
(d) Based on toxicity values for Aroclor 1254.
(e) Based on toxicity values for TCDD.

See Appendix D for details on the derivation of the Human Intake Factor (HIF) for sweat lodge use.

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{iSF * IR_{TWAdw} * TF_{water>>air} * EF * ED}$$

$$BR_{TWAdw} = (BRchild * EDchild + BRadult * EDadult) / EDtotal$$
$$= (1\ m^3/d * 4\ yrs + 1\ m^3/d * 64\ yrs) / 68\ yrs$$
$$= 1\ m^3/d$$

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Inhalation Slope Factor (risk/pCi) [1]	**Water RBC (pCi/L)**	Lower than drinking water RBC?
Radium (88)	Ra-226+D	3.86E-10	**7.0E-01**	no
Uranium (92)	U-238+D	8.71E-11	**3.1E+00**	no

[1] http://www.epa.gov/radiation/heast/

See Appendix D for details on the exposure parameters.

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ:		0.1	Target Risk:		1E-06		
		HIF_{fish} (kg ww/kg-d):		3.1E-02	$HIF_{TWAfish}$ (kg ww/kg-d):		1.4E-02		
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
METALS AND METALLOIDS									
Aluminum	7429905	1.0E+00	P	3.2E+00	--		--	3.2E+00	
Antimony	7440360	4.0E-04	I	1.3E-03	--		--	1.3E-03	
Arsenic	7440382	3.0E-04	I	9.7E-03	1.5E+00	I	4.8E-04	4.8E-04	(a)
Barium	7440393	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Beryllium	7440417	2.0E-03	I	6.5E-03	--		--	6.5E-03	
Boron	7440428	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Cadmium	7440439	1.0E-03	I	3.2E-03	--		--	3.2E-03	(b)
Calcium	7440702	--		--	--		--	--	
Chromium	7440473	1.5E+00	I	4.9E+00	--		--	4.9E+00	(c)
Cobalt	7440484	2.0E-02	P	6.5E-02	--		--	6.5E-02	
Copper	7440508	4.0E-02	H	1.3E-01	--		--	1.3E-01	
Fluoride	16984488	6.0E-02	I	1.9E-01	--		--	1.9E-01	(d)
Iron	7439896	7.0E-01	P	2.3E+00	--		--	2.3E+00	
Lead	7439921	--		--	--		--	--	(e)
Magnesium	7439954	--		--	--		--	--	
Manganese	7439965	1.4E-01	I	4.5E-01	--		--	4.5E-01	(f)
Mercury	7439976	see Appendix B		2.4E-04	--		--	2.4E-04	(g)
Molybdenum	7439987	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Nickel	7440020	2.0E-02	I	6.5E-02	--		--	6.5E-02	
Potassium	7440097	--		--	--		--	--	
Selenium	7782492	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Silica	7631869	--		--	--		--	--	
Silver	7440224	5.0E-03	I	1.6E-02	--		--	1.6E-02	
Sodium	7440235	--		--	--		--	--	
Thallium	7440280	7.0E-05	O	2.3E-04	--		--	2.3E-04	
Tin	7440315	6.0E-01	H	1.9E+00	--		--	1.9E+00	
Uranium	7440611	3.0E-03	I	9.7E-03	--		--	9.7E-03	(h)
Vanadium	7440622	1.0E-03	E	3.2E-03	--		--	3.2E-03	
Zinc	7440666	3.0E-01	I	9.7E-01	--		--	9.7E-01	
OTHER TRACE ELEMENTS									
Bismuth	7440699	--		--	--		--	--	
Cerium	7440451	--		--	--		--	--	
Cesium	7440462	--		--	--		--	--	
Gallium	7440553	--		--	--		--	--	
Lanthanum	7439910	--		--	--		--	--	
Lithium	7439932	2.0E-02	E	6.5E-02	--		--	6.5E-02	
Niobium	7440031	--		--	--		--	--	
Rubidium	7440177	--		--	--		--	--	
Scandium	7440202	--		--	--		--	--	
Strontium	7440246	6.0E-01	I	1.9E+00	--		--	1.9E+00	
Thorium	7440291	--		--	--		--	--	
Titanium	7440326	--		--	--		--	--	
Ytterbium	7440644	--		--	--		--	--	
Zirconium	7440677	--		--	--		--	--	
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)									
2-Methylnaphthalene	91576	4.0E-03	I	1.3E-02	--		--	1.3E-02	
Acenaphthene	83329	6.0E-02	I	1.9E-01	--		--	1.9E-01	
Acenaphthylene	208968	--		--	--		--	--	
Anthracene	120127	3.0E-01	I	9.7E-01	--		--	9.7E-01	
Benzo(a)anthracene	56553	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Benzo(a)pyrene	50328	--		--	see Appendix G		5.0E-06	5.0E-06	MMOA
Benzo(b)fluoranthene	205992	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Benzo(ghi)perylene	191242	--		--	--		--	--	
Benzo(k)fluoranthene	207089	--		--	see Appendix G		5.0E-04	5.0E-04	MMOA
Chrysene	218019	--		--	see Appendix G		5.0E-03	5.0E-03	MMOA
Dibenz(a,h)anthracene	53703	--		--	see Appendix G		5.0E-06	5.0E-06	MMOA
Fluoranthene	206440	4.0E-02	I	1.3E-01	--		--	1.3E-01	
Fluorene	86737	4.0E-02	I	1.3E-01	--		--	1.3E-01	
Indeno(1,2,3-cd)pyrene	193395	--		--	see Appendix G		5.0E-05	5.0E-05	MMOA
Naphthalene	91203	2.0E-02	I	6.5E-02	--		--	6.5E-02	
Phenanthrene	85018	--		--	--		--	--	
Pyrene	129000	3.0E-02	I	9.7E-02	--		--	9.7E-02	

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ:		0.1	Target Risk:		1E-06		
		HIF_{fish} (kg ww/kg-d):		3.1E-02	$HIF_{TWAfish}$ (kg ww/kg-d):		1.4E-02		
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
PESTICIDES									
2,4'-DDD	53190	--		--	2.4E-01	I	3.0E-04	3.0E-04	(i)
4,4'-DDD	72548	--		--	2.4E-01	I	3.0E-04	3.0E-04	
2,4'-DDE	3424826	--		--	3.4E-01	I	2.1E-04	2.1E-04	(j)
4,4'-DDE	72559	--		--	3.4E-01	I	2.1E-04	2.1E-04	
2,4'-DDT	789026	5.0E-04	I	1.6E-03	3.4E-01	I	2.1E-04	2.1E-04	(k)
4,4'-DDT	50293	5.0E-04	I	1.6E-03	3.4E-01	I	2.1E-04	2.1E-04	
Aldrin	309002	3.0E-05	I	9.7E-05	1.7E+01	I	4.2E-06	4.2E-06	
Atrazine	1912249	3.5E-02	I	1.1E-01	2.2E-01	H	3.3E-04	3.3E-04	
alpha-BHC	319846	--		--	6.3E+00	I	1.1E-05	1.1E-05	
beta-BHC	319857	--		--	1.8E+00	I	4.0E-05	4.0E-05	
delta-BHC	319868	--		--	--		--	--	
gamma-BHC	58899	3.0E-04	I	9.7E-04	1.3E+00	H	5.6E-05	5.6E-05	
alpha-Chlordane	5103719	5.0E-04	I	1.6E-03	3.5E-01	I	2.1E-04	2.1E-04	(l)
gamma-Chlordane	5566347	5.0E-04	I	1.6E-03	3.5E-01	I	2.1E-04	2.1E-04	(l)
Dieldrin	60571	5.0E-05	I	1.6E-04	1.6E+01	I	4.5E-06	4.5E-06	
Endosulfan I	959988	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endosulfan II	33213659	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endosulfan sulfate	1031078	6.0E-03	I	1.9E-02	--		--	1.9E-02	(m)
Endrin	72208	3.0E-04	I	9.7E-04	--		--	9.7E-04	
Endrin aldehyde	7421934	--		--	--		--	--	
Endrin ketone	53494705	--		--	--		--	--	
Heptachlor	76448	5.0E-04	I	1.6E-03	4.5E+00	I	1.6E-05	1.6E-05	
Heptachlor epoxide	1024573	1.3E-05	I	4.2E-05	9.1E+00	I	7.9E-06	7.9E-06	
Hexachlorobenzene	118741	8.0E-04	I	2.6E-03	1.6E+00	I	4.5E-05	4.5E-05	
Hexachlorobutadiene	87683	1.0E-03	P	3.2E-03	7.8E-02	I	9.3E-04	9.3E-04	
Methoxychlor	72435	5.0E-03	I	1.6E-02	--		--	1.6E-02	
cis-Nonachlor	5103731	--		--	--		--	--	
trans-Nonachlor	39765805	--		--	--		--	--	
Oxychlordane	27304138	--		--	--		--	--	
Toxaphene	8001352	--		--	1.1E+00	I	6.6E-05	6.6E-05	
SEMI-VOLATILE ORGANIC CHEMICALS (SVOCs)									
1,1'-Biphenyl	92524	5.0E-02	I	1.6E-01	--		--	1.6E-01	
1,2,4-Trichlorobenzene	120821	1.0E-02	I	3.2E-02	--		--	3.2E-02	
1,2-Dichlorobenzene	95501	9.0E-02	I	2.9E-01	--		--	2.9E-01	
1,3-Dichlorobenzene	541731	3.0E-03	E	9.7E-03	--		--	9.7E-03	
1,4-Dichlorobenzene	106467	3.0E-02	E	9.7E-02	2.4E-02	H	3.0E-03	3.0E-03	
2,2'-oxybis(1-chloropropane)	108601	4.0E-02	I	1.3E-01	7.0E-02	H	1.0E-03	1.0E-03	
2,4,5-Trichlorophenol	95954	1.0E-01	I	3.2E-01	--		--	3.2E-01	
2,4,6-Trichlorophenol	88062	1.0E-03	P	3.2E-03	1.1E-02	I	6.6E-03	3.2E-03	
2,4-Dichlorophenol	120832	3.0E-03	I	9.7E-03	--		--	9.7E-03	
2,4-Dimethylphenol	105679	2.0E-02	I	6.5E-02	--		--	6.5E-02	
2,4-Dinitrophenol	51285	2.0E-03	I	6.5E-03	--		--	6.5E-03	
2,4-Dinitrotoluene	121142	2.0E-03	I	6.5E-03	--		--	6.5E-03	
2,6-Dinitrotoluene	606202	1.0E-03	P	3.2E-03	--		--	3.2E-03	
2-Chloronaphthalene	91587	8.0E-02	I	2.6E-01	--		--	2.6E-01	
2-Chlorophenol	95578	5.0E-03	I	1.6E-02	--		--	1.6E-02	
2-Methylphenol	95487	5.0E-02	I	1.6E-01	--		--	1.6E-01	
2-Nitroaniline	88744	--		--	--		--	--	
2-Nitrophenol	88755	--		--	--		--	--	
3,3'-Dichlorobenzidine	91941	--		--	4.5E-01	I	1.6E-04	1.6E-04	
3-Nitroaniline	99092	--		--	--		--	--	
4,6-Dinitro-2-methylphenol	534521	--		--	--		--	--	
4-Bromophenyl-phenylether	101553	--		--	--		--	--	
4-Chloro-3-methylphenol	59507	--		--	--		--	--	
4-Chloroaniline	106478	4.0E-03	I	1.3E-02	--		--	1.3E-02	
4-Chlorophenylphenyl ether	7005723	--		--	--		--	--	
4-Methylphenol	106445	5.0E-03	H	1.6E-02	--		--	1.6E-02	
4-Nitroaniline	100016	--		--	--		--	--	
4-Nitrophenol	100027	--		--	--		--	--	
Acetophenone	98862	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Benzaldehyde	100527	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Benzoic acid	65850	4.0E+00	I	1.3E+01	--		--	1.3E+01	
Benzyl alcohol	100516	5.0E-01	P	1.6E+00	--		--	1.6E+00	
bis(2-Chloroethoxy)methane	111911	--		--	--		--	--	
Bis(2-chloroethyl)ether	111444	--		--	1.1E+00	I	6.6E-05	6.6E-05	

TABLE 3
RISK-BASED CONCENTRATIONS (RBCs) FOR INGESTION OF COIs IN FISH TISSUE

COI	CASRN	Non-Cancer			Cancer			Lowest Fish RBC (mg/kg ww)	Notes
		Target HQ: 0.1			Target Risk: 1E-06				
		HIF_{fish} (kg ww/kg-d): 3.1E-02			$HIF_{TWAfish}$ (kg ww/kg-d): 1.4E-02				
		oRfD (mg/kg-d)	oRfD Source	Fish RBC (mg/kg ww)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Fish RBC (mg/kg ww)		
Bis(2-ethylhexyl)phthalate	117817	2.0E-02	I	6.5E-02	1.4E-02	I	5.2E-03	5.2E-03	
Butyl benzyl phthalate	85687	2.0E-01	I	6.5E-01	--		--	6.5E-01	
Caprolactam	105602	5.0E-01	I	1.6E+00	--		--	1.6E+00	
Carbazole	86748	--		--	2.0E-02	H	3.6E-03	3.6E-03	
Dibenzofuran	132649	1.0E-03	P	3.2E-03	--		--	3.2E-03	
Diethylphthalate	84662	8.0E-01	I	2.6E+00	--		--	2.6E+00	
Dimethylphthalate	131113	--		--	--		--	--	
Di-n-butylphthalate	84742	1.0E-01	I	3.2E-01	--		--	3.2E-01	
Di-n-octylphthalate	117840	--		--	--		--	--	
Hexachloroethane	67721	1.0E-03	I	3.2E-03	1.4E-02	I	5.2E-03	3.2E-03	
Isophorone	78591	2.0E-01	I	6.5E-01	9.5E-04	I	7.6E-02	7.6E-02	
Nitrobenzene	98953	5.0E-04	I	1.6E-03	--		--	1.6E-03	
N-Nitrosodi-n-propylamine	621647	--		--	7.0E+00	I	1.0E-05	1.0E-05	
N-Nitrosodiphenylamine	86306	--		--	4.9E-03	I	1.5E-02	1.5E-02	
Pentachlorophenol	87865	3.0E-02	I	9.7E-02	1.2E-01	I	6.0E-04	6.0E-04	
Perchlorocyclopentadiene	77474	6.0E-03	I	1.9E-02	--		--	1.9E-02	
Phenol	108952	3.0E-01	I	9.7E-01	--		--	9.7E-01	
POLYBROMINATED DIPHENYLETHERS (PBDEs)									
multiple congeners	--	--		--	--		--	--	
POLYCHLORINATED BIPHENYLS (PCBs)									
as Aroclor	--	2.0E-05	I	6.5E-05	2.0E+00	I	3.6E-05	3.6E-05	(n)
DIOXIN-LIKE CONGENERS									
as TEQ	--	--		--	1.5E+05	H	4.8E-10	4.8E-10	(o)

RBC = risk-based concentration HIF = Human Intake Factor -- = no toxicity data MMOA = mutagenic mode of action

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Assumes 10% of arsenic in tissue is in a biologically available form.
(b) Based on toxicity values for food.
(c) Based on toxicity values for Chromium III.
(d) Based on IRIS values for fluorine (CASRN 7782-41-4).
(e) Risk calculations for lead not based on oRfD or oSF approach, RBC not calculated.
(f) Based on toxicity values for food.
(g) Tissue residue criterion calculated in Appendix B.
(h) Based on toxicity values from IRIS.
(i) Based on toxicity values for 4-4'-DDE.
(j) Based on toxicity values for 4-4'-DDD.
(k) Based on toxicity values for 4-4'-DDT.
(l) Based on toxicity values for Chlordane.
(m) Based on toxicity values for Endosulfan.
(n) Based on toxicity values for Aroclor 1254.
(o) Based on toxicity values for TCDD.

See Appendix F for details on the derivation of the Human Intake Factor (HIF_{fish}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{oSF_{food} * IR_{TWAfish} * EF * ED}$$

$$IR_{TWAfish} = (IRchild * EDchild + IRadult * EDadult) / EDtotal$$
$$= (530\ g/d * 4\ yrs + 1060\ g/d * 64\ yrs) / 68\ yrs$$
$$= 1029\ g/d$$

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Food Ingestion Slope Factor (risk/pCi) [1]	**Fish Tissue RBC (pCi/g)**
Radium (88)	Ra-226+D	5.15E-10	**7.6E-05**
Uranium (92)	U-238+D	1.21E-10	**3.2E-04**

[1] http://www.epa.gov/radiation/heast/

See Appendix F for details on the exposure parameters.

TABLE 4

RISK-BASED CONCENTRATIONS (RBCs) FOR INCIDENTAL INGESTION OF METALS AND RADIONUCLIDES IN SURFACE SEDIMENT

Analyte Name	Non-Cancer			Cancer			Lowest Sediment RBC (mg/kg)	Notes	Sediment Reference Concentration Range (mg/kg) [1]
	Target HQ: 0.1			Target Risk: 1E-06					
	HIF_{sed} (kg/kg-d): 1.7E-05			HIF_{TWAsed} (kg/kg-d): 4.9E-06					
	oRfD (mg/kg-d)	oRfD Source	Sediment RBC (mg/kg)	oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	Sediment RBC (mg/kg)			
Aluminum	1.0E+00	P	5,733	--		--	5,733		
Antimony	4.0E-04	I	2.3	--		--	2.3		0.1 - 1.4
Arsenic	2.4E-04	I	1.38	1.9E+00	I	0.11	0.11	(a)	1 - 10
Barium	2.0E-01	I	1,147	--		--	1,147		
Beryllium	2.0E-03	I	11	--		--	11		
Cadmium	1.0E-03	I	5.7	--		--	5.7	(b)	
Calcium	--		--	--		--	--		
Chromium	1.5E+00	I	8,600	--		--	8,600	(c)	
Cobalt	2.0E-02	P	115	--		--	115		
Copper	4.0E-02	H	229	--		--	229		10 - 25
Iron	7.0E-01	P	4,013	--		--	4,013		5,100 - 34,000
Lead							400	(d)	8 - 47
Lithium	2.0E-02	E	115	--		--	115		
Magnesium	--		--	--		--	--		
Manganese	4.7E-02	I	268	--		--	268	(e)	129 - 1,000
Mercury	3.0E-04	I	1.7	--		--	1.7	(f)	
Molybdenum	5.0E-03	I	29	--		--	29		
Nickel	2.0E-02	I	115	--		--	115		
Potassium	--		--	--		--	--		
Selenium	5.0E-03	I	29	--		--	29		
Silver	5.0E-03	I	29	--		--	29		
Sodium	--		--	--		--	--		
Strontium	6.0E-01	I	3,440	--		--	3,440		
Thallium	7.0E-05	O	0.40	--		--	0.40		
Tin	6.0E-01	H	3,440	--		--	3,440		
Titanium	--		--	--		--	--		
Uranium	3.0E-03	I	17	--		--	17	(g)	0.5
Vanadium	1.0E-03	E	5.7	--		--	5.7		
Zinc	3.0E-01	I	1,720	--		--	1,720		

RBC = risk-based concentration HIF = Human Intake Factor -- = no toxicity data

Toxicity Data Sources: I = IRIS H = HEAST A = HEAST Alternate M = ATSDR MRL (chronic)
E = EPA-NCEA provisional value O = other P = EPA provisional peer-reviewed value

(a) Oral toxicity values adjusted based on RBA of 0.80.
(b) Based on toxicity values for food.
(c) Based on toxicity values for Chromium III.
(d) Based on residential exposure scenario.
(e) Based on toxicity values for non-food. oRfd adjusted by a modifying factor of 3, in accord with IRIS recommendations.
(f) Assumes chemical form of mercury is mercuric chloride.
(g) Based on toxicity values from IRIS.

[1] As presented in Table 2-2 of the Beach Screening Level Risk Assessment. Values based on sediment reference samples collected by EPA in 2005, the USGS in 1995 and 1990, and Ecology's Natural Background Soil Metals Concentrations in Washington State.

See Appendix H for details on the derivation of the Human Intake Factor (HIF_{sed}).

RISK-BASED CONCENTRATIONS FOR RADIONUCLIDES:

Equations:

$$RBC = \frac{\text{Target Risk [1E-06]}}{[oSF_{soil} * IR_{TWAsed} * EF * ED] + [SF_{ext} * ACF * EF/365 * ED * ET]}$$

IR_{TWAsed} = (IRchild * EDchild + IRadult * EDadult) / EDtotal
= (300 mg/d * 4 yrs + 300 mg/d * 64 yrs) / 68 yrs
= 300 mg/d >> 0.3 g/d

ACF = area correction factor (default = 0.9) [1]

Risk-Based Concentrations:

Element (Atomic No.)	Isotope	Slope Factor [2]		**Sediment RBC (pCi/g)**
		Soil Ingestion (risk/pCi)	External Exposure (risk/y per pCi/g)	
Radium (88)	Ra-226+D	7.30E-10	8.49E-06	**4.3E-04**
Uranium (92)	U-238+D	2.10E-10	1.14E-07	**3.1E-02**

[1] http://epa-prgs.ornl.gov/radionuclides/acf.shtml
[2] http://www.epa.gov/radiation/heast/

See Appendix H for details on the exposure parameters.

APPENDIX A
Human Intake Factor for Drinking Water (HIF_{dw})
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of drinking water from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Ingestion rate of drinking water	L/day	4	Harper et al. 2002, Harris & Harper 1997 [1]	2	USEPA 2005 [1]
HIF (non-cancer)	**L/kg-d**	**5.71E-02**		**1.16E-01**	
HIF (cancer)	**L/kg-d**	**5.22E-02**		**6.64E-03**	
HIF_{TWA} (cancer)	**L/kg-d**	**5.89E-02**			

Harris and Harper 1997. Umatilla Tribe Exposure Scenarios.
Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Includes extra 1 L/day associated with sweat lodge use

APPENDIX B
CALCULATION OF FISH TISSUE RESIDUE CRITERION FOR MERCURY

Basic Equation --

$TRC = [BW * (oRfD - RSC)] / FI_{total}$

where:

TRC	Fish tissue residue criterion (mg/kg)
BW	Body weight (kg)
RSC	Relative Source Contribution (ug/kg-d)
oRfD	Oral Reference Dose for MeHg (ug/kg-d)
FI_{total}	Fish intake (g ww/d)

See Section 3.1.2.2 of "Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion" EPA 823/B-04/001

Note: Assumes a Target Hazard Quotient (HQ) of 1.0.

Traditional Subsistence Scenario Exposure Parameters

	Adult	Child
BW (kg):	70	17.2
FI_{total} (g ww/day):	1060	530

Toxicity Values

MeHg oRfD (ug/kg-d):	0.1
RSC [1] (ug/kg-d):	0.027
Adj. MeHg oRfD (ug/kg-d):	0.073

[1] Relative source contribution (subtracted from the oRfD to account for MeHg in marine fish).

Tissue Residue Criterion

	Adult	Child
TRC (mg/kg ww) =	4.8E-03	2.4E-03
adjusted to a Target HQ of 0.1	4.8E-04	2.4E-04

TRANSLATING TISSUE RESIDUE CRITERION TO A WATER CONCENTRATION

Basic Equation --

Cw = TRC / BAF

where:

Cw	Water concentration (mg/L)
BAF	Bioaccumulation Factor (L water/kg fish)
TRC	Fish tissue residue criterion (mg/kg)

Bioaccumulation Factors

	Trophic Level		
	2	3	4
Geomean BAF (L/kg):	117,000	680,000	2,670,000

See Section 3.1.3.1.3, Table 1 for draft national BAFs

Risk Based Concentrations in Surface Water

	Trophic Level		
	2	3	4
Cw, Adult (mg/L):	4.1E-09	7.1E-10	1.8E-10
Cw, Child (mg/L):	2.0E-09	3.5E-10	8.9E-11

APPENDIX C
CALCULATION OF RBCs FOR INGESTION OF DRINKING WATER FOR CHEMICALS WITH A MUTAGENIC MODE OF ACTION

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Estimated Order of Potency (EOP)	Toxicity Values		Child				Adult				Target Risk: 1E-06
					HIF_{dw} (L/kg-d): 0.00664				HIF_{dw} (L/kg-d): 0.05224				
					0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/L)
			oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	
Benzo(a)anthracene	56553	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05
Benzo(a)pyrene	50328	1	7.3	I		73		21.9		21.9		7.3	1.3E-06
Benzo(b)fluoranthene	205992	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05
Benzo(k)fluoranthene	207089	0.01	0.073	O	0.00221	0.73	0.00443	0.219	0.00816	0.219	0.04408	0.073	1.3E-04
Chrysene	218019	0.001	0.0073	O		0.073		0.0219		0.0219		0.0073	1.3E-03
Dibenz(a,h)anthracene	53703	1	7.3	O		73		21.9		21.9		7.3	1.3E-06
Indeno(1,2,3-cd)pyrene	193395	0.1	0.73	O		7.3		2.19		2.19		0.73	1.3E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX D
Human Intake Factor for Sweat Lodge Use
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Time	hrs/event	2	USEPA 2005	0.25	USEPA 2005 [1]
Exposure Frequency	events/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of water from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Breathing rate in sweat lodge	m^3/hr	1.0	USEPA 1997 [2]	1.0	USEPA 1997 [2]
Bulk transport factor for water to air	L/m^3	0.15			USEPA 2005 [3]
HIF (non-cancer)	**L/kg-d**	**4.29E-03**		**2.18E-03**	
HIF (cancer)	**L/kg-d**	**3.92E-03**		**1.25E-04**	
HIF_{TWA} (cancer)	**L/kg-d**	**4.04E-03**			

Harris and Harper 1997. Umatilla Tribe Exposure Scenarios.
Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] child value based on heat stress recommendations from American Academy of Pediatrics (2000)
[2] Table 5-23. Mean breathing rate for light activities.
[3] water vapor saturation at 150 degrees F (sweat lodge temperature)

APPENDIX E
CALCULATION OF RBC FOR INHALATION OF BENZO(A)PYRENE IN WATER DURING SWEAT LODGE USE

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Toxicity Values		Child				Adult				Target Risk: 1E-06
				HIF (L/kg-d): 1.2E-04				HIF (L/kg-d): 3.9E-03				
				0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/L)
		iSF $(mg/kg\text{-}d)^{-1}$	iSF Source	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	HIF Adj.	iSF Adj.	
Benzo(a)pyrene	50328	3.1	E	4E-05	31	8E-05	9.3	6.1E-04	9.3	3.3E-03	3.1	5.5E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX F
Human Intake Factor for Ingestion of Fish (HIF_{fish})
Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Fraction of meals from UCR	unitless	1	Prof. judgement	1	Prof. judgement
Ingestion rate of fish	g ww/day	1060	USEPA 2005 [1]	530	Prof. judgment [1]
Conversion factor	*kg/g*	*1E-03*		*1E-03*	
HIF (non-cancer)	**kg ww/kg-d**	**1.51E-02**		**3.08E-02**	
HIF (cancer)	**kg ww/kg-d**	**1.38E-02**		**1.76E-03**	
HIF_{TWA} (cancer)	**kg ww/kg-d**	**1.56E-02**			

Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Adult: Table I, high fish diet -- 885 g/d fish and 175 g/d shellfish
Child: assumed to be 1/2 the adult

APPENDIX G
CALCULATION OF RBCs FOR INGESTION OF FISH TISSUE FOR CHEMICALS WITH A MUTAGENIC MODE OF ACTION

Age-specific adjustment factors

Receptor: Traditional Subsistence

Receptor Type	HIF [1]		oSF ADAF	
	0-<2 yrs	2-6 yrs	0-<2 yrs	2-6 yrs
Child	0.33	0.67	10	3

Receptor Type	HIF [1]		oSF ADAF	
	7-15 yrs	16+ yrs	7-15 yrs	16+ yrs
Adult	0.16	0.84	3	1

[1] Adjustment factor = ED_i / EDtotal (where i = age interval)

Chemical of Interest (COI)	CASRN	Estimated Order of Potency (EOP)	Toxicity Values		Child				Adult				Target Risk: 1E-06
					HIF_{fish} (kg ww/kg-d): 1.8E-03				HIFfish (kg ww/kg-d): 1.4E-02				
					0-<2 yrs		2-6 yrs		7-15 yrs		16+ yrs		RBC (mg/kg ww)
			oSF $(mg/kg\text{-}d)^{-1}$	oSF Source	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	HIF Adj.	oSF Adj.	
Benzo(a)anthracene	56553	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05
Benzo(a)pyrene	50328	1	7.3	I		73		21.9		21.9		7.3	5.0E-06
Benzo(b)fluoranthene	205992	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05
Benzo(k)fluoranthene	207089	0.01	0.073	O	0.00059	0.73	0.00117	0.219	0.00216	0.219	0.01168	0.073	5.0E-04
Chrysene	218019	0.001	0.0073	O		0.073		0.0219		0.0219		0.0073	5.0E-03
Dibenz(a,h)anthracene	53703	1	7.3	O		73		21.9		21.9		7.3	5.0E-06
Indeno(1,2,3-cd)pyrene	193395	0.1	0.73	O		7.3		2.19		2.19		0.73	5.0E-05

HIF Adj. = HIF * age-specific adjustment factor
oSF Adj. = oSF * age-specific adjustment factor

Risk = $\sum$ Cw * HIF_r * $HIF_{r,i}$ adjustment factor * SF * $ADAF_{r,i}$
where: r = receptor (adult, child); i = age interval

APPENDIX H

Human Intake Factor for Incidental Ingestion of Surface Sediment (HIF_{sed})

Maximally exposed receptor = Traditional subsistence scenario

Exposure Parameter	Units	RME Value and Source			
		Adult		Child	
Body weight	kg	70	USEPA 2005	17.2	USEPA 2005
Exposure Frequency	days/yr	365	Prof. judgment, Harper et al. 2002	365	Prof. judgment, Harper et al. 2002
Exposure Duration	years	64	Harper et al. 2002	4	Harper et al. 2002
Exposure Time	hrs/d	4	Prof. judgment	4	Prof. judgment
Averaging Time (non-cancer)	days	23,360	USEPA 1989	1,460	USEPA 1989
Averaging Time (cancer)	days	25,550	USEPA 1989	25,550	USEPA 1989
Ingestion rate of sediment	mg/day	300	Harper et al. 2002 [1]	300	Harper et al. 2002 [2]
Conversion factor	*kg/mg*	*1E-06*		*1E-06*	
HIF (non-cancer)	**kg/kg-d**	**4.29E-06**		**1.74E-05**	
HIF (cancer)	**kg/kg-d**	**3.92E-06**		**9.97E-07**	
HIF_{TWA} (cancer)	**kg/kg-d**	**4.92E-06**			

Harper et al. 2002. Spokane Tribe RME Exposure Parameters.
USEPA 1989. Risk Assessment Guidance for Superfund (RAGS), Part A.
USEPA 2005. Midnite Mine HHRA.

[1] Table 1. Soil intake rate is reported as 400 mg/d (100 mg/d from indoor sources + 300 mg/d for outdoor scenarios). For the purposes of the HHRA Workplan, it was assumed that UCR site exposures were restricted to outdoor scenarios only (300 mg/d). Reported soil intake rates were assumed to apply to sediment exposures.

[2] Intake rates for child assumed to be equal to adult. This is supported by Section 3.7 in Harper et al. (2002) which identifies soil intake rates for child and adult as being equal.