APPENDIX B
ESTIMATING MEDIA CONCENTRATION EQUATIONS AND VARIABLE VALUES

TABLE B-4-27

FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION (CONSUMPTION OF FISH EQUATIONS)

Description

This equation calculates fish concentration from dissolved COPC concentration by using a bioaccumulation factor. Uncertainty associated with this equation include the following:

Calculating C_{dw} uses on default values for variables F_{water} and C_{wtot}. Values for these two variables, in turn, depend on default medium-specific *OC* content values. Because *OC* content can vary widely at different locations in the same medium, significant uncertainty may be associated with F_{water} and C_{wtot} and, in turn, C_{wt} in specific instances.

Equation

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

For mercury modeling, the concentration of COPC in fish is calculated for divalent mercury (Hg^{2+}) and methyl mercury (MHg) as shown in the following equations:

$$C_{fish_{(Hg^{2+})}} = C_{dw_{(Hg^{2+})}} \cdot BAF_{fish_{(Hg^{2+})}}$$

$$C_{fish_{(MHg)}} = C_{dw_{(MHg)}} \cdot BAF_{fish_{(MHg)}}$$

Variable	Description	Units	Value
C_{fish}	Concentration of COPC in fish	mg COPC/kg FW tissue	

FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION (CONSUMPTION OF FISH EQUATIONS)

Variable	Description	Units	Value
C_{dw}	Dissolved phase water concentration	mg COPC/L	**Varies** This variable is COPC- and site-specific, and is calculated using the equation in Table B-4-24. Uncertainties associated with this variable include the following: (1) The variables in the equation in Table B-4-24 are site-specific. Therefore, using default values rather than site-specific values, for any or all of these variables, will contribute to under- or overestimating C_{dw}. We expect the degree of uncertainty associated with *TSS* to be relatively small, because information regarding reasonable site-specific values for this variable is generally available or can be easily measured. (2) The uncertainty associated with the variables C_{wctot} and Kd_{sw} depends on estimates of *OC* content. Because *OC* content values can vary widely for different locations in the same medium, the uncertainty associated with using different *OC* content values may be significant in specific cases.
BAF_{fish}	Bioaccumulation factor for COPC in fish	L/kg FW tissue	**Varies** This variable is COPC-specific. We discuss this variable in detail in Appendix A-2, and offer COPC-specific values in the HHRAP companion database. As discussed in Appendix A-2, BAF_{fish} values were adjusted for dissolved water concentrations. We obtained BAFs for all organics with a log K_{ow} greater than or equal to 4.0 from U.S. EPA (1998), which cites U.S. EPA (1995a), U.S. EPA (1995b), and U.S. EPA (1994b). We calculated the BAF_{fish} value for lead as a geometric mean of data from various literature sources described in U.S. EPA (1998). We don't expect Elemental mercury to deposit significantly onto soils and surface water; therefore, assume no transfer of elemental mercury to fish. Assume that all mercury in fish exists or is converted to the methyl mercury (organic) form after uptake into the fish tissue. For this HHRAP, we use the BAF_{fish} value for methyl mercury listed in U.S. EPA (1997) for a trophic level 4 fish. The following uncertainty is associated with this variable: The COPC-specific *BAF* values may not accurately represent site-specific water body conditions, because estimates of *BAFs* can vary, based on experimental conditions.

REFERENCES AND DISCUSSION

NC DEHNR. 1997. *Final NC DEHNR Protocol for Performing Indirect Exposure Risk Assessments for Hazardous Waste Combustion Units.* January.

This document cites the following documents as its sources of information regarding *BAFs*:

TABLE B-4-27

FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION (CONSUMPTION OF FISH EQUATIONS)

U.S. EPA. 1993. "*Derivation of Proposed Human Health and Wildlife Bioaccumulation Factors for the Great Lakes Initiative*." Office of Research and Development, U.S. Environmental Research Laboratory. Duluth, Minnesota. March.

This study presents three methods for estimating *BAFs*, in the following order of preference (first to last): (1) measured *BAF*; (2) measured *BCF* multiplied by a food-chain multiplier estimated from log K_{ow}; and (3) *BAF* estimated from log K_{ow}.

U.S. EPA 57 Federal Register 20802. 1993. "Proposed Water Quality Guidance for the Great Lakes System." April.

This document recommends using *BAFs* for compounds with a log K_{ow} greater than 5.5.

U.S. EPA. 1994. *Revised Draft Guidance for Performing Screening Level Risk Analysis at Combustion Facilities Burning Hazardous Wastes Attachment C, Draft Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities.* Office of Emergency and Remedial Response. Office of Solid Waste. December.

U.S. EPA. 1995a. *Review Draft Development of Human Health-Based and Ecologically-Based Exit Criteria for the Hazardous Waste Identification Project. Volumes I and II.* Office of Solid Waste. March 3.

This document recommends that the following references be used.

- *BAFs* for organic COPCs with log K_{ow} greater than 4.0 but less than 6.5 should be calculated from the following references for the limetic ecosystem and the literal ecosystem, respectively.
  - Thomann, R.V. 1989. "Bioaccumulation Model of Organic Chemical Distribution in Aquatic Food Chains." *Environmental Science and Technology.* 23(6):699-707.
  - Thomann, R.V., J.P. Connolly, and T.F. Parkerton. 1992. "An Equilibrium Model of Organic Chemical Accumulation in Aquatic Food Webs with Sediment Interaction." *Environmental Toxicology and Chemistry.* 11:6115-629.
- *BAFs* for compounds with logK_{ow} greater than 6.5 were allowed to equal 1,000, based on an analysis of available data on PAHs and the following document:
  - Stephan, C.E. et al. 1993. "Derivation of Proposed Human Health and Wildlife Bioaccumulation Factors for the Great Lakes Initiative." Office of Research and Development, U.S. Environmental Research Laboratory. PB93-154672. Springfield, Virigina.

All *BAFs* were corrected to 5 percent lipid, reflecting a typical value for a fish fillet.

U.S. EPA. 1995b. *Great Lakes Water Quality Initiative. Technical Support Document for the Procedure to Determine Bioaccumulation Factors.* Office of Water. EPA-820-B-95-005. March.

U.S. EPA. 1997. *Mercury Study Report to Congress. Volume III: Fate and Transport of Mercury in the Environment.* Office of Air Quality and Planning and Standards and Office of Research and Development. EPA 452/R-97-005. December.

U.S. EPA. 1998. "*Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions*." Update to EPA/600/6-90/003. Office of Research and Development, National Center for Environmental Assessment, U.S. EPA. EPA/600/R-98/137. December.

U.S. EPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities.* Peer Review Draft. Office of Solid Waste. August.

TABLE B-4-28

FISH CONCENTRATION FROM BIOTA-TO-SEDIMENT ACCUMULATION FACTORS USING COPC SORBED TO BED SEDIMENT (CONSUMPTION OF FISH EQUATIONS)

Description

This equation calculates fish concentration from bed sediment concentration, by using a biota-to-sediment accumulation factor (*BSAF*). Uncertainties associated with this equation include the following:

(1) Calculation of C_{sb} is largely dependent on default medium-specific *OC* content values. Because *OC* content can vary widely within a medium, significant uncertainty may be associated with estimates of C_{sb} in specific instances.
(2) Lipid content varies between different species of fish. Therefore, use of a default f_{lipid} value results in a moderate degree of uncertainty.
(3) Some species of fish have limited, if any, contact with water body sediments. Therefore, use of *BSAFs* to estimate the accumulation of COPCs in these species may be significantly uncertain.

Equation

$$C_{fish} = \frac{C_{sb} \cdot f_{lipid} \cdot BSAF}{OC_{sed}}$$

Variable	Description	Units	Value
C_{fish}	Concentration of COPC in fish	mg COPC/kg FW tissue	
C_{sb}	Concentration of COPC sorbed to bed sediment	mg COPC/kg bed sediment	**Varies** This variable is COPC- and site-specific, and is calculated using the equation in Table B-4-25. Uncertainties associated with this variable include the following: (1) The default variable values recommended for use in the equation in Table B-4-25 may not accurately represent site-specific water body conditions. We expect the degree of uncertainty associated with variables θ_{bs}, *TSS*, d_{wc}, and d_{bs} to be limited either because the probable ranges for these variables are narrow or information allowing reasonable estimates is generally available. (2) Uncertainty associated with variables f_{bs}, C_{wtot}, and Kd_{bs} is largely associated with the use of default *OC* content values. Because *OC* content is known to vary widely in different locations in the same medium, use of default medium-specific values can result in significant uncertainty in some instances.