Updates to Subpart F: Procedures for Determining Water Quality Criteria (Human Health)

Bureau of Water/Water Pollution Control/Water Quality Standards

Outline

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- Proposed Subpart F Input Parameter Updates
  - Body Weight
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Background

Subpart F

- Contains procedures for determining water quality criteria
  - Over three decades old
  - Updates needed to reflect current science and for continued protection
- Focus of updates
  - Human Health criteria derivation
  - U.S. EPA – Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)
  - U.S. EPA – Updated Ambient Water Quality Criteria for the Protection of Human Health (2015)
  - Subpart E – Lake Michigan Basin Water Quality Standards or WQS (Great Lakes Initiative)
  - U.S. EPA – Great Lakes Water Quality Initiative Technical Support Document for Human Health Criteria and Values (1995)

Section by Section Changes

- 302.210
  - Adjusted the reference for Human Health Threshold Criterion
  - Adjusted the reference for Human Health Nonthreshold Criterion
- 302.410
  - Adjusted the reference for Human Health Threshold Criterion
    - The word “Sections” should not have been deleted.
  - Adjusted the reference for Human Health Nonthreshold Criterion
- 302.601
  - Added definitions

Section by Section Changes Cont'd

- Deleted Sections
  - 302.642
  - 302.645
  - 302.648
  - 302.651
  - 302.654
  - 302.657

- 302.640 **Procedures of Deriving Bioaccumulation Factors**
  - Based on Lake Michigan (302.570)
  - updated POC and DOC default values

Section by Section Changes Cont'd

- 302.641 **Procedures for Deriving Water Quality Criteria and Values to Protect Human Health – General**
  - Based on Lake Michigan (302.580)

- 302.643 **Procedure for determining the Human Health Threshold Criterion (HHTC) and the Human Health Threshold Value (HHTV)**
  - Based on Lake Michigan (302.585)
  - Updated RSC
  - Updated body weight
  - Updated water consumption
    - Drinking Water
    - Incidental daily water ingestion (same)
  - Updated fish consumption rate
    - Trophic Level 3
    - Trophic Level 4

Section by Section Changes Cont'd

- 302.652 **Procedure for Determining the Human Health Nonthreshold Criterion (HHNC) or the Human Health Nonthreshold Value (HHNV)**
  - Based on Lake Michigan (302.590)
  - Updated body weight
  - Updated water consumption
    - Drinking Water
    - Incidental daily water ingestion (same)
  - Updated fish consumption rate
    - Trophic Level 3
    - Trophic Level 4
  - Risk Level

- 302.666 **Utilizing the Bioconcentration Factor**
  - Removed reference to the Sections that are proposed to be deleted.

Input Update – Body Weight (BW)

- Current default body weight (BW) in kilograms (kg) – 70 kg
- Proposed default body weight – 80 kg
  - Mean adult body weight – age 21 and older
  - Sources
    - *Human Health Ambient Water Quality Criteria: 2015 Update* (U.S. EPA 2015)
    - *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (U.S. EPA 2014)

Input Update – Water Consumption (WC)

- Current default Illinois EPA WC in liters/day (L/day) – 2.0 L/day
- Proposed default Illinois EPA WC – 2.5 L/day
  - Per capita consumption – drinking and incidental exposure for surface waters classified as public water supplies
  - Consistent Agency-wide value
  - Source – *Exposure Factors Handbook Ingestion of Water and Other Select Liquids* (U.S. EPA 2011), Table 3-33.
- Updated U.S. EPA default WC – 2.4 L/day
  - Per capita consumption – estimate of community water ingestion at the 90th percentile for adults ages 21 and older
  - Source – *Human Health Ambient Water Quality Criteria: 2015 Update* (U.S. EPA 2015)

Input Update – Water Consumption (WC) Cont'd

- Incidental daily water ingestion – 0.01 L/day
  - Per capita ingestion for surface waters not used as human drinking water sources
  - Source – *Great Lakes Water Quality Initiative Technical Support Document for Human Health Criteria and Values* (U.S. EPA 1995)
- No recommendation in the *Human Health Ambient Water Quality Criteria: 2015 Update* (U.S. EPA 2015) or the *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (U.S. EPA 2000)

Input Update – Fish Consumption (FC)

- Fish consumption rate: quantity of fish and shellfish in kilograms consumed per person per day
- Default national fish consumption rate (U.S. EPA) – 0.022 kilograms per day (kg/day)
  - For trophic level 3 (TL3) – 0.0086 kg/day default
  - For trophic level 4 (TL4) – 0.0051 kg/day default
  - Source – *Human Health Ambient Water Quality Criteria: 2015 Update* (U.S. EPA 2015)
    - Based on data from *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (U.S. EPA 2014)

- Hierarchical recommendation for data use – most to least preferred (U.S. EPA)
  - Local data
  - Data reflecting similar geography/population groups
  - Data from national surveys
  - U.S. EPA default consumption rates

Input Update – Fish Consumption (FC) Cont'd

- Proposed Illinois EPA fish consumption rate
  - NHANES regional data
    - Inland Midwest
    - Adult population: people aged 21 years and older

- Inland Midwest regional consumption of freshwater and estuarine fish for adults – 90th percentile
  - For trophic level 3 (TL3) fish – 0.0039 kg/day
  - For trophic level 4 (TL4) fish – 0.0051 kg/day
  - Source – *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (U.S. EPA 2014)

Input Update – Relative Source Contribution

- Relative source contribution (RSC): percent total exposure attributed to surface water through water intake and fish consumption
- Applies to human health equations for noncarcinogens
- 0.2 default or calculated ≤ 0.8
  - For unknown sources of exposure to a chemical, value of 0.2 to be included in equation
  - For well-known and documented sources of exposure calculated value no greater than 0.8 to be included in equation
  - Source – *U.S. EPA 2015 Human Health Ambient Water Quality Criteria: 2015 Update*

Input Update – Relative Source Contribution (Cont'd)

- The higher the contribution of a contaminant from water sources, the lower the RSC and the more stringent the resultant criteria. Reverse is also true.
- Therefore, an
  - RSC of 1.0 results in no change the resulting criteria calculation
  - RSC of 0.8 makes a criterion more stringent by 20%
  - RSC of 0.5 makes a criterion more stringent by 50%
  - RSC of 0.2 makes a criterion more stringent by 80%

  - Source – *U.S. EPA 2015 Human Health Ambient Water Quality Criteria: 2015 Update*

Input Update – Risk Level

- Risk level needed to determine human health criteria for single/combination of substances
  - Upper bound estimate of excess lifetime cancer risk
  - Management-based policy decision, not scientific

- Range of 10,000,000 or (10^{-7}) to 10,000 or (10^{-4}) deemed acceptable by U.S. EPA
  - Adoption of a 1 in 100,000 (10^{-5}) or 1 in 1,000,000 (10^{-6}) risk level is a generally acceptable risk management decision

- Current Subpart F – Single substance: 10^{-6} ; Combination of substances: 10^{-5}

  - Source – *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (U.S. EPA 2000)

Input Update – Risk Level (Cont'd)

- Proposed Subpart F update: 10^{-5} acceptable cancer risk level for single/combination of substances
  - Within historical range used in U.S. EPA and state actions designed to protect human health
  - For criterion derived based on 10^{-5} cancer risk level, individuals consuming up to 10x the assumed rate would not exceed a 10^{-4} risk level
  - Sources
    - *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (U.S. EPA 2000)
    - *Great Lakes Water Quality Initiative Technical Support Document for Human Health Criteria and Values* (U.S. EPA 1995)

Input Update – Particulate and Dissolved Organic Carbon

- Particulate organic carbon (POC): the concentration of particulate organic carbon (in kilograms of particulate organic carbon/ liter of water)
- Dissolved organic carbon (DOC): the concentration of particulate organic carbon (in kilograms of particulate organic carbon/liter of water)
- Total organic carbon (TOC): the sum of POC and DOC
- POC/DOC are applied in the calculation of Human Health BAFs for organic chemicals

Input Update – Particulate and Dissolved Organic Carbon (Cont'd)

- National default values (U.S. EPA):
  - POC = 0.0000005 (or 5×10^{-7}) kg/L
  - DOC = 0.0000029 (or 2.9×10^{-6}) kg/L
- Proposed Subpart F update:
  - Analyzed paired state DOC and TOC data collected April 2023 – March 2025
  - Determined mean DOC and TOC and estimated POC from these values
  - Mean stream POC = 0.0000002 kg/L
  - Mean stream DOC = 0.00000459 kg/L, or
  - Site-specific waterbody POC and DOC concentrations (in kg/L) with sufficient data
- POC/DOC specifically go in the bioavailability / fraction freely dissolved (f_{fd}) equation

$$f_{fd} = \frac{1}{\left\{1+\left(\frac{DOC \bullet Kow}{10}\right)+(POC \bullet Kow)\right\}}$$

  - f_{fd} = fraction of total chemical that is freely dissolved in ambient water – plugs into BAF equations

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Input Update – Bioaccumulation Factor (BAF)

- Bioaccumulation Factor (BAF)
  - Ratio that relates a substance's concentration in an aquatic organism to the substance's concentration in waters in which it resides – exposure routes from ambient water and food included
- Bioconcentration Factor (BCF)
  - uptake and retention of a chemical by an aquatic organism from water only
- Current Subpart F applies BCF in human health derived criteria calculations
- Proposed update applies BAF to account for more potential exposure pathways
  - BAFs will be calculated and applied to TL 3 (forage fish) and TL 4 (piscivorous fish)
  - TL 3 and 4 account for varied bioaccumulation in commonly consumed aquatic species in Illinois

Human Health BAF Equations

Concerns organic chemicals

- Equation for TL3: $Human\ Health\ BAF_{HHTL3} = \{(baseline\ BAF \bullet 0.0182) + 1\} \bullet f_{fd}$
- Equation For TL4: $Human\ Health\ BAF_{HHTL4} = \{(baseline\ BAF \bullet 0.0310) + 1\} \bullet f_{fd}$

where:

- 0.0182 and 0.0310 = standardized fraction lipid values for TL 3 and 4, respectively used to derive human health criteria and values

Input Update – Lipid Values

Lipid values: are used to derive BAFs that are subsequently applied in human health criteria calculations

- National lipid fraction values: TL2 = 0.019; TL3 = 0.026; TL4 = 0.030

Proposed Subpart F lipid fractions are based on the Great Lakes Water Quality Initiative 1995 methodology (or GLI)

- Regional values as proxy for unavailable local state data in proposed update – considers only TL3 and 4
- Specified GLI guidance for percent (or fraction) lipid values: TL3 = 1.82 (0.0182); TL4 = 3.10 (0.0310)

- Sources
  - *Development of National Bioaccumulation Factors: Supplemental Information for EPA's 2015 Human Health Criteria Update* (U.S. EPA, 2016)
  - *Great Lakes Water Quality Initiative Technical Support Document for the Procedure to Determine Bioaccumulation Factors* (U.S. EPA,1995)
  - *Water Quality Guidance for the Great Lakes System: Supplementary Information Document* (U.S. EPA, 1995)

Derived Criteria

Based on GLI 1995 methodology

- Two-tiered approach based on data and information available to derive criteria
  - Tier I – used when sufficient data are available; includes at least one epidemiological or animal study longer than 90 days
  - Tier II – approach used when minimum data for deriving Tier I criteria are unavailable
- Human Health Threshold Criteria (HHTC) or Human Health Threshold Value (HHTV)
- Human Health Nonthreshold Criteria (HHNC) or Human Health Nonthreshold Value (HHNV)
- Utilized under current Subpart E: Lake Michigan Basin WQS
- Equations equivalent to U.S. EPA 2000 methodology

Human Health Threshold Criteria/Value

Human Health Threshold Criteria (HHTC) or Human Health Threshold Value (HHTV)

- In milligrams per liter (mg/L)
- Derived for all toxic substances from the most sensitive endpoint for which there exists a dosage or concentration below which no adverse effect or response is likely to occur
  - For noncancer effects and carcinogens with nonlinear modes of action
- Equivalent to U.S. EPA 2000 methodology equations for cancer effects – nonlinear low dose extrapolation and noncancer equations
- Noncancer

$$AWQC = RfD \cdot RSC \cdot \left(\frac{BW}{DI + \sum_{i=2}^{4} (FI_i \cdot BAF_i)} \right)$$

Cancer Effects: Nonlinear low dose

$$AWQC = \frac{POD}{UF} \cdot RSC \cdot \left(\frac{BW}{DI + \sum_{i=2}^{4} (FI_i \cdot BAF_i)} \right)$$

Proposed Derived Criteria Equation – HHTC/V

$$HHTC\ or\ HHTV = \frac{ADE \bullet BW \bullet RSC}{\{WC + (FC_{TL3} \bullet BAF_{HHTL3}) + (FC_{TL4} \bullet BAF_{HHTL4})\}}$$

Where:

- ADE – Acceptable daily exposure
- BW – weight of average adult human = 80 kg
- RSC – 0.2 default or calculated ≤ 0.8
- WC – per capita water consumption (drinking and incidental exposure) for surface waters classified as PWS = 2.5 L/day; or per capita incidental daily water ingestion for surface waters not used as human drinking water sources = 0.01 L/day
- FC_{TL3} – mean consumption of TL 3 fish by regional sport fishers of regionally caught freshwater fish = 0.0039 kg/day
- FC_{TL4} – mean consumption of TL 4 fish by regional sport fishers of regionally caught freshwater fish = 0.0051 kg/day
- BAF_{HHTL3} = HH bioaccumulation factor for edible portion of trophic level 3 fish, as derived using BAF methodology in proposed Section 302.640, presented in units of L/kg
- BAF_{HHTL4} = HH bioaccumulation factor for edible portion of trophic level 4 fish, as derived using BAF methodology in proposed Section 302.640, presented in units of L/kg

Human Health Nonthreshold Criteria/Value

Human Health Nonthreshold Criteria (HHNC) or Human Health Nonthreshold Value (HHNV)

- In milligrams per liter (mg/L)
- Derived for those toxic substances for which any exposure, regardless of extent, carries some risk of damage from cancer or a nonthreshold toxic mechanism.
  - For cancer effects
  - Risk level of 1 in 100,000 (or 10^{-5}) must be used
- Equivalent to U.S. EPA 2000 methodology equations for cancer effects – linear low-dose extrapolation

Cancer effects – linear low dose

$$AWQC = RSD \cdot \left(\frac{BW}{DI + \sum_{i=2}^{4} (FI_i \cdot BAF_i)} \right)$$

Proposed Derived Criteria Equation – HHNC/HHNV

$$HHNC\ or\ HHNV = \frac{RAD \bullet BW}{\{WC + (FC_{TL3} \bullet BAF_{HHTL3}) + (FC_{TL4} \bullet BAF_{HHTL4})\}}$$

Where:

- RAD – risk-associated dose of a substance or combination of substances in milligrams per day (mg/d) which is associated with a lifetime cancer risk level equal to a ratio of 1 to 100,000 or 10^{-5}
- BW – weight of average adult human = 80 kg
- WC – per capita water consumption (drinking and incidental exposure) for surface waters classified as PWS = 2.5 L/day; or per capita incidental daily water ingestion for surface waters not used as human drinking water sources = 0.01 L/day
- FC_{TL3} – mean consumption of TL 3 fish by regional sport fishers of regionally caught freshwater fish = 0.0039 kg/day
- FC_{TL4} – mean consumption of TL 4 fish by regional sport fishers of regionally caught freshwater fish = 0.0051 kg/day
- BAF_{HHTL3} = HH bioaccumulation factor for edible portion of trophic level 3 fish, as derived using BAF methodology in Section 302.640, presented in units of L/kg
- BAF_{HHTL4} = HH bioaccumulation factor for edible portion of trophic level 4 fish, as derived using BAF methodology in Section 302.640, presented in units of L/kg

Proposed Derived Human Health Criteria – Examples

Comparison of Human Health Criteria		2019 Human Health Criteria		Updated Human Health Criteria		
Chemical	CASRN	HHTC	HHNC	Updated HHTC	Updated HHNC	Units
Benzo(a)pyrene	50-32-8	--	0.016	--	0.00038	µg/L
Carbon tetrachloride	56-23-5	--	1.4	--	94 (Incidental Ing. Only) 4.4 (PWS and Incidental Ing.)	µg/L
Chlorobenzene	108-90-7	4.5	--	1.8 (Incidental Ing. Only) 0.12 (PWS and Incidental Ing.)	--	mg/L
Fluoranthene	206-44-0	120	--	16 (Incidental Ing. Only) 15 (PWS and Incidental Ing.)	--	µg/L
Nitrobenzene	98-95-3	0.53	--	0.92 (Incidental Ing. Only) 0.013 (PWS and Incidental Ing.)	--	mg/L
Pentachlorophenol	87-86-5	--	2.5	--	0.564 (Incidental Ing. Only) 0.331 (PWS and Incidental Ing.)	µg/L
Trichloroethylene	79-01-6	--	2.5 26 (G) 2.5 (PWS)	--	150 (Incidental Ing. Only) 6.7 (PWS and Incidental Ing.)	µg/L
Vinyl chloride	75-01-4	--	1.5 2.0 (G) 0.025 (PWS)	--	46 (Incidental Ing. Only) 0.44 (PWS and Incidental Ing.)	µg/L

Chemical-Specific Toxicity Values

Chemical	CASRN	ADE (mg/kg-day)	ADE Source	q_1* (mg/kg-day)	q_1* Source	RSC	RSC Source
Benzo(a)pyrene	50-32-8	3.0E-04	IRIS	1.0E+00	IRIS	0.2	EPA DW Advisory
Carbon tetrachloride	56-23-5	4.0E-03	IRIS	7.0E-02	IRIS	0.3	EPA DW Advisory
Chlorobenzene	108-90-7	2.0E-02	IRIS	--		0.2	EPA DW Advisory
Fluoranthene	206-44-0	4.0E-02	IRIS	--		0.2	EPA DW Advisory
Nitrobenzene	98-95-3	2.0E-03	IRIS	--		0.2	EPA DW Advisory
Pentachlorophenol	87-86-5	5.0E-03	IRIS	4.0E-01	IRIS	0.2	EPA DW Advisory
Trichloroethylene	79-01-6	5.0E-04	IRIS	4.6E-02	IRIS	0.2	EPA DW Advisory
Vinyl chloride	75-01-4	3.0E-03	IRIS	7.2E-01	IRIS	0.2	EPA DW Advisory

Chemical Specific BAFs					
Chemical	**CASRN**	**BAF_{TL3} (L/kg)**	**BAF_{TL3} Source**	**BAF_{TL4} (L/kg)**	**BAF_{TL4} Source**
Benzo(a)pyrene	50-32-8	120000	TL Baseline BAF – Log K_{ow} Method	320000	TL Baseline BAF – Log K_{ow} Method
Carbon tetrachloride	56-23-5	8.9	TL Baseline BAF – Log K_{ow} Method	15	TL Baseline BAF – Log K_{ow} Method
Chlorobenzene	108-90-7	14	TL Baseline BAF – Log K_{ow} Method	22	TL Baseline BAF – Log K_{ow} Method
Fluoranthene	206-44-0	3600	TL Baseline BAF – Log K_{ow} Method	5000	TL Baseline BAF – Log K_{ow} Method
Nitrobenzene	98-95-3	2.3	TL Baseline BAF – Log K_{ow} Method	3.1	TL Baseline BAF – Log K_{ow} Method
Pentachlorophenol	87-86-5	200	TL Baseline BAF – BCF Method	540	TL Baseline BAF – BCF Method
Trichloroethylene	79-01-6	8.4	TL Baseline BAF – Log K_{ow} Method	14	TL Baseline BAF – Log K_{ow} Method
Vinyl chloride	75-01-4	1.4	TL Baseline BAF – Log K_{ow} Method	1.7	TL Baseline BAF – Log K_{ow} Method

Questions?

Comments are due by December 12, 2025

Agency Contact

Name: Kaitlyn Hutchinson

Title: Assistant Counsel

Bureau/Office/Section Description: Bureau of Water/Legal Counsel/Regulation

Email Address: kaitlyn.hutchison@illinois.gov