Drexel PFAS Workbook June, 2020

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Definition of Point of Departure (POD) and How to Use It to Calculate Toxicological Reference Dose (RfD)

In toxicology, point of departure (POD) is defined as the point on a toxicological dose-response curve established from experimental data or observational data generally corresponding to an estimated no effect level. It marks the beginning of extrapolation to toxicological reference dose RfD.
US EPA defines RfD as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral or dermal exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Its unit is usually mg/kg bw/day or mg/kg/day.

BMD = Benchmark Dose (Definition: A dose or concentration that produces a predetermined change in response rate of an adverse effect (called the benchmark response or BMR) compared to background.)
Acronym:

BMR = Benchmark Response (Definition: An adverse effect, used to define a benchmark dose from which an RfD (or RfC) can be developed. The change in response rate over background of the BMR is usually in the range of 5-10%, which is the limit of responses typically observed in well-conducted animal experiments.)

POD = Point of Departure (Definition: The dose-response point that marks the beginning of a low-dose extrapolation. This point can be the lower bound on dose for an estimated incidence or a change in response level from a dose-response model (BMD), or a NOAEL or LOAEL for an observed incidence, or change in level of response.)

The most typical POD used to derive RfD is no-observed-adverse-effect level (NOAEL), lowest-observed-adverse-effect level (LOAEL), or statistical benchmark dose (BMD). Benchmark Dose is derived by entering raw experimental data into a statistical package to determine what dose will cause a certain percentage adverse response. BMD10 for example would be a 10% response compared to an unexposed population. The EPA prefers BMD as the primary means of calculating POD, but data available is not always sufficient to support this approach. In those cases, a LOAEL

RfD values can be calculated by dividing the point of departure with corresponding uncertainty factors (UF). Differences chronic dose response studies are used (often with adjustment factors) to to derive chronic reference dose is necessary. Sometimes, you have to modify the point of departure first before using the equation below.

RfD = [POD * (Adjustment factors)] / Uncertainty Factor * Uncertainty Factor * Uncertainty Factor….

Uncertainty factors are used to address the differences between the experimental data and the human exposure scenarios. They include uncertainties for interspecies differences, intraspecies differences, differences in duration of exposure, issues related to dose-response, quality of data. They are expressed as orders of magnitude of ten. For example, 100 (or 1), 100.5 (or 3), 101 (or 10), 102 (or 100).

From the RfD, a Threshold Level (or Health Advisory Level, MCL, MCLG, etc depending on the authority) is determined by adjusting for the daily water intake (DWI), body weight, and the Relative Source Contribution (percentage of intake from water that is expected to contribute to the body burden of the substance).

Threshold Level = RfD x (Body Weight/Daily Water Intake) x Relative Source Contribution

	Advisory level in PPT	
	PFOA	PFOS
EPA	70*	70*
CA	2	7
MI	10	16
NY	10	10
NH	12	15
NJ	14	13
MA	20*	20*
VT	20	20
MN	35	15
*max sum for all PFAS species		

Table 1: showing PFOA and PFOS Health Advisory Levels (HAL) by State

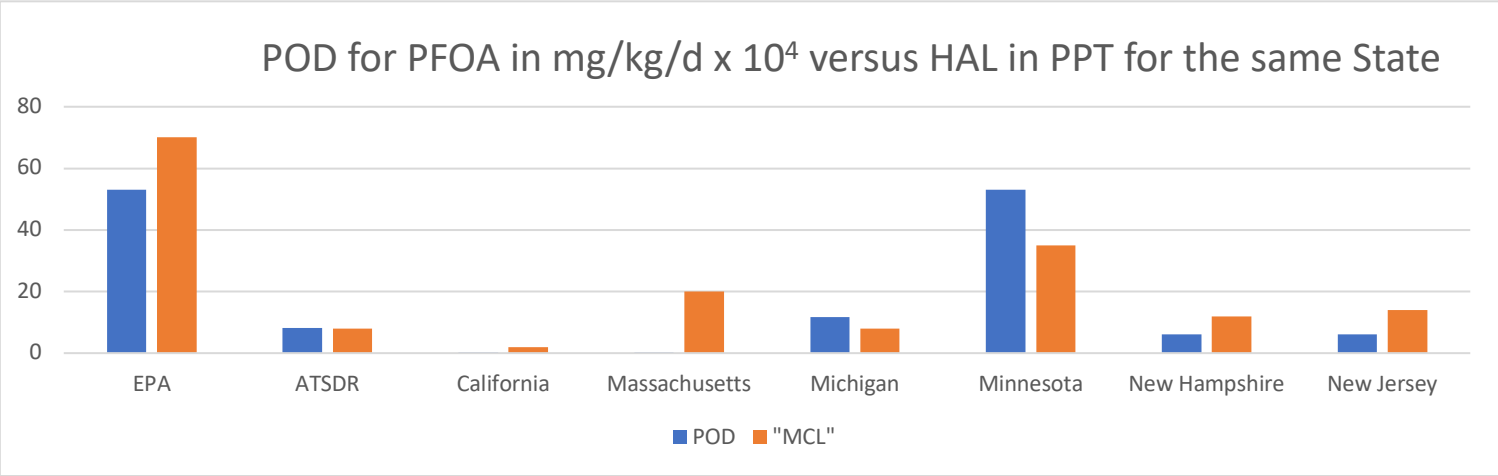

Figure 1: How POD and HAL relate for PFOA by State.

How to use this workbook

Health recommendations are classified by type of PFAS and by State/Authority. The pattern is generally the same State to State but there are notable differences in the adjustment factors, uncertainty factors used, and methods to determine water intake.

1. Critical effect selected

3. POD adjusted by using preferred methods to derive Human Equivalent Dose (HED)

5. Final adjustment made based on intake to derive Threshold Level (e.g. MCL, MCLG, HAL etc)

PFOA	
US EPA	
Office of Water 2016	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	Developmental (reduced ossification, accelerated puberty) Lau, C., J.R. Thibodeaux, R.G. Hanson, M.G. Narotsky, J.M. Rogers, A.B. Lindstrom, and M.J. Strynar. 2006. Effects of perfluorooctanoic acid exposure during pregnancy in the mouse. Toxicological Science 90:510–518.
Species	Mice
Study Exposure Duration (days)	17 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Modeled AUC
Method to Derive Human Equivalent Dose	Dose adjustment factor of 0.00014 L/kg-day, based on first order kinetic clearance rate (Vd x (ln 2 ÷ t½))
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	38 ug/mL
POD x DAF = Human Equiv Dose	0.0053 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	(2 x 10-5 mg/kg-day) or 20 ng/kg/d
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg-day)	0.054
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOA cannot exceed this level)
Additional Information	90th percentile consumers only estimate of combined direct and indirect community water ingestion for lactating women (see Table 3-81 in USEPA 2011b).
Reference	Health Effects Support Document for Perfluorooctanoic Acid, U.S. Environmental Protection Agency Office of Water (4304T) Health and Ecological Criteria Division, EPA Document Number: 822-R-16-003. May 2016. and Drinking Water Health Advisory for Perfluorooctanoic Acid, U.S. Environmental Protection Agency Office of Water (4304T) Health and Ecological Criteria Division, EPA Document Number: 822-R-16-005. May 2016 https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos

2. POD determined by critical review of study

4. HED divided by Uncertainty Factors to achieve Reference Dose RfD in target population

SUBSTANCE	
STATE	
AUTHORITY AND YEAR	
Standard / Guidance	MCL, HA
Media Type	GW, DW
Threshold Level (ug/L) or (PPT)	Recommendation expressed as ug/L or PPT (repeated below)
Key Study Information	
Critical Effect Key Study Reference	The effect and study are listed here
Species	e.g. mice, rats. Monkeys, etc
Study Exposure Duration (days)	in days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	If there was not a measurable serum level, how was the dose converted to a serum level
Method to Derive Human Equivalent Dose	What method was used to derive the human equivalent dose – e..g. how was the Dose Adjustment Factor (DAF) calculated
Dose-Response	
Dose Response Modeling Method	Benchmark Dose, NOAEL, or LOAEL
POD	POD is listed here
POD x DAF = HED	The HED is calculated here by multiplying the POD by the Dose Adjustment Factor
Uncertainty Extrapolation	
Human Variability (UFH)	Set by the toxicologist interpreting the data
Animal to Human (UFA)	Set by the toxicologist interpreting the data
Subchronic to Chronic (UFS)	Set by the toxicologist interpreting the data
LOAEL to NOAEL (UFL)	Set by the toxicologist interpreting the data
Database (UFD)	Set by the toxicologist interpreting the data
Total Composite (UFT)	The final multiplication of all the UF's
HED/UFT= Reference Dose (mg/kg-day)	The HED is divided by the UFT here
Receptor	Who did they consider (adult, infant, child, breast fed, bottle fed)
Exposure	
Ingestion Rate (L/day)	How many liters a day they assume a person drinks (2L for adult 1 L for child typical)
Body Weight (Kg)	Typically 70 kg adult
Normalized Drinking Water Intake (L/kg/day)	Ingestion rate divided by weight
RSC (Relative Source Contribution)	How much of the PFAS are assumed to come from water as a percentage
Threshold Level (ug/L) or (PPT)	Reference Dose x (Ingestion rate/ Body Weight) x RSC (although not all use this method) Recommendation expressed as ug/L or PPT (repeated above)
Additional Information	
Reference	

PFOA

PFOA	
Canada	
Standard / Guidance	Health Based Value
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.200 ug/L 200 PPT
Key Study Information	
Critical Effect Key Study Reference	Liver hypertrophy Perkins R, Butenhoff J, Kennedy G, Palazzolo M. 2004. 13- Week dietary toxicity study of ammonium perfluorooctanoate (APFO) in male rats. Drug Chem. Toxicology., 27:361-378.
Species	Rates
Study Exposure Duration (days)	13 weeks (91 days)
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Used administered dose
Method to Derive Human Equivalent Dose	Adjustment of UFA (termed "AK_{UF}") using ratios of PBPK model-(Loccisano 2011, 2012a,b, 2013) predicted dose metrics, using steady-state plasma concentrations. These chemical-specific adjustment factors (CSAFs) and PBPK modelling were used to derive an AK_{UF} reflecting interspecies toxicokinetic differences AK_{UF} = CLanimal/ CLhuman [CL is clearance (e.g., mL/kg bw per day)]
Dose-Response	
Dose Response Modeling Method	Benchmark Dose Modeling
POD	0.05 mg/kg per day is the BMDL10 for hepatocellular hypertrophy
POD x DAF = HED	0.000521 mg/kg-day = (0.05 mg/kg per day) / 96 96 is the dose-specific AKUF for rats in the 0.01 mg/kg bw per day range
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	2.5
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	25
Toxicity Value RfD (mg/kg-day)	
Receptor	Adult
Exposure	
Ingestion Rate (L/day)	1.5
Body Weight (Kg)	70
Normalized Drinking Water Intake (L/kg-day)	0.02
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.200 ug/L 200 PPT
Additional Information	An interspecies uncertainty factor of 2.5 was used to reflect only the toxicodynamic component of the default interspecies uncertainty factor, because the toxicokinetic differences between rats and humans were already incorporated when calculating the PODHEQ. Likewise, a default value of 10 was applied for the intraspecies UF. If further studies of PFOA consistently indicate a 10-fold difference in pharmacokinetics within the population, a higher intraspecies UF might be warranted to ensure that pharmacodynamic differences between humans are also quantitatively addressed. No uncertainty factor was used for subchronic-to-chronic extrapolation, as liver effects were investigated in a chronic study (Butenhoff et al., 2012b), and increasing duration of exposure did not appear to worsen the effects in the key study (Perkins et al., 2004).
Reference	Health Canada. Guidelines for Canadian Drinking Water Quality, Guideline Technical Document, Perfluorooctanoic Acid. December 2018 Loccisano AE, Campbell JL, Jr., Butenhoff JL, et al. 2012a. Comparison and evaluation of pharmacokinetics of PFOA and PFOS in the adult rat using a physiologically based pharmacokinetic model. Reprod Toxicol 33(4):452-467.Loccisano AE, Campbell JL, Jr., Butenhoff JL, et al. 2012b. Evaluation of placental and lactational pharmacokinetics of PFOA and PFOS in the pregnant, lactating, fetal and neonatal rat using a physiologically based pharmacokinetic model. Reprod Toxicol 33(4):468-490. Loccisano AE, Longnecker MP, Campbell JL, Jr., et al. 2013. Development of PBPK models for PFOA and PFOS for human pregnancy and lactation life stages. J Toxicol Environ Health A 76(1):25-57.

PFOA	
US EPA	
Office of Water 2016	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	Developmental (reduced ossification, accelerated puberty) Lau, C., J.R. Thibodeaux, R.G. Hanson, M.G. Narotsky, J.M. Rogers, A.B. Lindstrom, and M.J. Strynar. 2006. Effects of perfluorooctanoic acid exposure during pregnancy in the mouse. Toxicological Science 90:510–518.
Species	Mice
Study Exposure Duration (days)	17 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Modeled AUC
Method to Derive Human Equivalent Dose	Dose adjustment factor of 0.00014 L/kg-day, based on first order kinetic clearance rate (Vd x (ln 2 ÷ t½))
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	38 mg/L
POD x DAF = Human Equiv Dose	0.0053 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	(2 x 10-5 mg/kg-day) or 20 ng/kg/d
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg-day)	0.054
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOA cann ot exceed this level)
Additional Information	90th percentile consumers only estimate of combined direct and indirect community water ingestion for lactating women (see Table 3-81 in USEPA 2011b).
Reference	Health Effects Support Document for Perfluorooctanoic Acid, U.S. Environmental Protection Agency Office of Water (4304T) Health and Ecological Criteria Division, EPA Document Number: 822-R-16-003. May 2016. and Drinking Water Health Advisory for Perfluorooctanoic Acid, U.S. Environmental Protection Agency Office of Water (4304T) Health and Ecological Criteria Division, EPA Document Number: 822-R-16-005. May 2016 https://www.epa.gov/ground-water-and-drinking-water/drinking-water-health-advisories-pfoa-and-pfos

PFOA	
US DHHS	
ATSDR DRAFT June 2018	
Standard / Guidance	Minimal Risk Level
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	None at present
Key Study Information	
Critical Effect Key Study Reference	Onishchenko N, Fischer C, Wan Ibrahim WN, Negri S, Spulber S, Cottica D, Ceccatelli S. 2011. Prenatal exposure to PFOS or PFOA alters motor function in mice in a sex-related manner. Neurotox. Res. 19(3):452-61. Pregnant C57BL/6 mice were exposed to 0 or 0.3 mg PFOA/kg/day throughout pregnancy. The critical effects considered were Neurobehavioral effects (decreased number of inactive periods, altered novelty induced activity) at 5-8 weeks of age. Koskela A, Finnilä MA, Korkalainen M, Spulber S, Koponen J, Håkansson H, Tuukkanen J, Viluksela M. 2016. Effects of developmental exposure to perfluorooctanoic acid (PFOA) on long bone morphology and bone cell differentiation. Toxicol. Appl. Pharmacol. 301:14-21. Pregnant C57BL/6 mice were exposed to PFOA mixed with food at the dose of 0 or 0.3 mg PFOA/kg/day throughout pregnancy. Group of five offspring (female) were sacrificed at either 13 or 17 months of age. The critical effects considered were skeletal alteration such as bone morphology and bone cell differentiation in the femurs and tibias.
Species	Pregnant C57BL/6 mice
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The average serum concentration was estimated in the mice (8.29 mg/L) using a three-compartment pharmacokinetic model (Wambaugh et al. 2013) using animal species-, strain-, sex-specific parameters.
Method to Derive Human Equivalent Dose	LOAEL HED = (TWA serum x ke x Vd) = 0.001163 mg/kg/day Ke = 0.000825175 (8.2 x 10-4) based on a human serum half-life of 840 days (Bartell et al. 2010) Vd = 0.17 L/kg (Thompson et al. 2010)
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	8.29 mg/L
POD x DAF = Human Equiv Dose	0.000821 mg/kg/day or 8.21×10^{-4} mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	2.7×10^{-6} mg/kg/day (rounded to 3.0×10^{-6} mg/kg/day
Receptor	None selected at present
Exposure	
Ingestion Rate (L/day)	Not determined at present
Body Weight (Kg)	Assuming the ATSDR uses the EPA methodology the Threshold Level would be 8 PPT
Normalized Drinking Water Intake (L/kg-day)	
Relative Source Contribution	
Threshold Level (ug/L) or (PPT)	*8 PPT presumptive*
Additional Information	Draft Commentary awaiting further review
Reference	https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237

PFOA	
ALASKA	
Dept. of Environmental Conservation 2019	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://dec.alaska.gov/spar/csp/pfas/

PFOA	
ALABAMA	
ADEM 2019	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://adem.alabama.gov/newsEvents/reports/PFASinAlabama.pdf

PFOA	
California	
August 2019	
Standard / Guidance	Noncancer Notification Levels Guidance
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.002 ug/L L or 2 ppt
Key Study Information	
Critical Effect Key Study Reference	Li K, Sun J, Yang J, et al. (2017). Molecular Mechanisms of Perfluorooctanoate- Induced Hepatocyte Apoptosis in Mice Using Proteomic Techniques. Environ Sci Technol 51(19): 11380-11389. Based on hepatic mitochondrial membrane potential changes and increased apoptosis and oxidative DNA damage
Species	Male and female Balb/c mice
Study Exposure Duration (days)	28 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	LOAEL is 0.05 mg/kg-day which corresponds to a serum concentration of 0.97 mg/L
Method to Derive Human Equivalent Dose	Dose adjustment factor of 0.00014 L/kg-day, based on first order kinetic clearance rate (Vd x (ln 2 ÷ t½))
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	0.97 mg/L
PODxDAF=HED (mg/kg/day)	1.35 10-4 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	3
Database (UFD)	3 (potential for developmental toxicity at the point of departure)
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	0.45 ng/kg-day or (0.45 X 10-6 mg/kg/day)
Receptor	
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.053 L/kg-day
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	2 ng/L or 2 ppt
Additional Information	Note: California uses an intermediate step called ADD or acceptable daily dose which is expressed as a target serum level and then a dose. This corresponds to the Reference Dose in this table
Reference	Notification Level Recommendations for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) https://oehha.ca.gov/media/downloads/water/chemicals/nl/final-pfoa-pfosnl082119.pdf

PFOA	
California	
August 2019	
Standard / Guidance	**Cancer Reference Level**
Media Type	one in one million cancer risk from PFOA in tap water
Threshold Level (ug/L) or (PPT)	0.0001 ug/L or 0.1 ppt
Key Study Information	
Critical Effect Key Study Reference	NTP (2018c). TR-598: Technical Report Pathology Tables and Curves - PFOA. National Toxicology Program, Research Triangle Park, North Carolina. https://tools.niehs.nih.gov/cebs3/views/?action=main.dataReview&bin_id=13658 (last accessed March 20, 2019).
Species	
Study Exposure Duration (days)	
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Using the HEDs as the dose metric, multisite benchmark dose modeling was performed to determine the cancer slope factor (CSF) for the hepatic and pancreatic tumors in male rats.
Method to Derive Human Equivalent Dose	
Dose-Response	
Dose Response Modeling Method	$BMDL_{05(human)} = BMDL_{05(animal)} \times (BW_{animal}/BW_{human})^{1/8}$
POD	$BMDL_{05\ animal}$ of 0.000648 mg/kg-day
PODxDAF=HED (mg/kg/day)	$BMDL_{05(human)}$ is 3.5×10^{-4} mg/kg-day. CSF = BMR ÷ $BMDL_{05}$ = 0.05 ÷ 3.5×10^{-4} mg/kg-day = 143 $(mg/kg\text{-}day)^{-1}$
Uncertainty Extrapolation	
Human Variability (UFH)	
Animal to Human (UFA)	
Subchronic to Chronic (UFS)	
LOAEL to NOAEL (UFL)	
Database (UFD)	
Total Composite (UFT)	
HED/UFT= Reference Dose (mg/kg-day)	RL = R ÷ (CSF X DWI) R = default risk level of one in one million, or 10^{-6} RL = 10^{-6} ÷ $(143\ (mg/kg\text{-}day)^{-1}$. 0.053 L/kg-day) = 1.3 . 10^{-7} mg/L
Receptor	All ages: Age sensitivity factors (ASFs) were not applied
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.053 L/kg-day
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.0001 ug/L or 0.1 ppt (1.3×10^{-7} mg/L)
Additional Information	OEHHA recommends that SWRCB set the final NLs at the lowest levels at which PFOA and PFOS can be reliably detected in drinking water using currently available and appropriate technologies.
Reference	Notification Level Recommendations for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) https://oehha.ca.gov/media/downloads/water/chemicals/nl/final-pfoa-pfosnl082119.pdf

PFOA	
Colorado	
CPHE 2018	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://www.colorado.gov/pacific/cdphe/PFCs/health/advisory

PFOA	
Connecticut	
CT DPH 2019	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFOA	
Delaware	
DNREC-DWHS 2018	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://www.dnrec.delaware.gov/dwhs/SIRB/Documents/DWHS%20PFAS%20Sampling%20Policy.pdf

PFOA	
Florida	
DOH 2016	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://www.floridahealth.gov/environmental-health/drinking-water/_documents/pfoa-pfos-fs-20161.pdf

PFOA	
Idaho	
DEQ 2017	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://www.deq.idaho.gov/water-quality/drinking-water/drinking-water-health-advisories/

PFOA	
Iowa	
DNR 2019	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT PFOA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT PFOA
Additional Information	
Reference	https://programs.iowadnr.gov/riskcalc/Chemical/Index/286

PFOA	
Maine	
DEP 2020	
Standard / Guidance	RAG
Media Type	DW
Threshold Level (ug/L) or (PPT)	PFOA exceeds 0.070 ug/L or 70 or sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	PFOA exceeds 0.070 ug/L or 70 or sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Additional Information	
Reference	https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFOA	
Maine	
PFAS Task Force 2020	
Standard / Guidance	Health Advisory
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT for PFOS + PFOA, 0.4 ug/L or 400 PPT for all PFAS combined
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT for PFOS + PFOA, 0.4 ug/L or 400 PPT for all PFAS combined
Additional Information	
Reference	https://www1.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFOA	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFOA	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.008 ug/L or 8 PPT
Key Study Information	
Critical Effect Key Study Reference	Onishchenko N, Fischer C, Wan Ibrahim WN, Negri S, Spulber S, Cottica D, Ceccatelli S. 2011. Prenatal exposure to PFOS or PFOA alters motor function in mice in a sex-related manner. Neurotox. Res. 19(3):452-61. Pregnant C57BL/6 mice were exposed to 0 or 0.3 mg PFOA/kg/day throughout pregnancy. The critical effects considered were Neurobehavioral effects (decreased number of inactive periods, altered novelty induced activity) at 5-8 weeks of age. Koskela A, Finnilä MA, Korkalainen M, Spulber S, Koponen J, Håkansson H, Tuukkanen J, Viluksela M. 2016. Effects of developmental exposure to perfluorooctanoic acid (PFOA) on long bone morphology and bone cell differentiation. Toxicol. Appl. Pharmacol. 301:14-21. Pregnant C57BL/6 mice were exposed to PFOA mixed with food at the dose of 0 or 0.3 mg PFOA/kg/day throughout pregnancy. Group of five offspring (female) were sacrificed at either 13 or 17 months of age. The critical effects considered were skeletal alteration such as bone morphology and bone cell differentiation in the femurs and tibias.
Species	Pregnant C57BL/6 mice
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The average serum concentration was estimated in the mice (8.29 mg/L) using a three-compartment pharmacokinetic model (Wambaugh et al. 2013) using animal species-, strain-, sex-specific parameters.
Method to Derive Human Equivalent Dose	LOAEL HED = (TWA serum x ke x Vd) = 0.001163 mg/kg/day Ke = 0.000825175 (8.2 x 10-4) based on a human serum half-life of 840 days (Bartell et al. 2010) Vd = 0.17 L/kg (Thompson et al. 2010)
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	8.29 mg/L
PODxDAF=HED (mg/kg/day)	0.001163 mg/kg/day or 1.163 x 10-3 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	3
Database (UFD)	3
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	3.9 ng/kg/day (3.9 x 10-6 mg/kg/day) which corresponds to a serum concentration of 0.028 mg/L
Receptor	Breast Fed Infant
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50% Based on NHANES 95th percentiles for 3-11 (2013-2014) and over 12 years old (2015-2016) participants (CDC 2019)
Threshold Level (ug/L) or (PPT)	0.008 ug/L or 8 PPT
Additional Information	The Workgroup discussed the Goeden et al. (2019) model which considered full life stage exposure, from fetal exposure, to infant exposure through breastfeeding, and into adulthood. While the model was also developed for a formula-fed infant, the breastfed infant scenario is protective of a formula-fed infant. The Workgroup selected this model for developing drinking water HBVs when the needed inputs were available.
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

PFOA	
Minnesota	
DOH 2017	
Standard / Guidance	Health Risk Limit
Media Type	DW & GW
Threshold Level (ug/L) or (PPT)	0.035 ug/L or 35 PPT
Key Study Information	
Critical Effect Key Study Reference	Koskela A, Finnilä MA, Korkalainen M, Spulber S, Koponen J, Håkansson H, Tuukkanen J, Viluksela M. 2016. Effects of developmental exposure to perfluorooctanoic acid (PFOA) on long bone morphology and bone cell differentiation. Toxicol. Appl. Pharmacol. 301:14-21.
Species	CD-1 Mice
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	38 mg/L serum concentration (US EPA 2016a predicted average serum concentration for maternal animals from Lau et al 2006) EPA modeled average serum concentration (predicted AUC u/mL/hr divided by (24hr/day x 18 days)
Method to Derive Human Equivalent Dose	DAF Dose adjustment factor of 0.00014 L/kg-day, based on first order kinetic clearance rate (ln 2/t½ of 840 days) x 0.17 L/kg (Vd) (SAME AS EPA)
Dose-Response	
Dose Response Modeling Method	LOAEL
POD	38 mg/L
POD x DAF = HED mg/kg/day	38 mg/L x 0.00014 L/kg/day = 0.0053 mg/kg/day = 5.3 x 10-3 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	3
Database (UFD)	3
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	0.000018 (18 x 10^{-6} mg/kg/d) or 18 ng/kd/d
Receptor	Infant exposure via breastmilk for 1 year, from mother chronically exposed via water, followed by lifetime of exposure via drinking water. Protective for short-term, subchronic and chronic.
Exposure	
Ingestion Rate (L/day)	The 95th percentile water intake rates (Table 3-1 and 3-3, USEPA 2011) or upper percentile breastmilk intake rates (Table 15-1, USEPA 2011) were used.
Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Goeden 2019 Minnesota Model. MDH derived the nHBV based on an internal serum concentration that would not exceed 0.5 (RSC) of the serum concentration corresponding to the RfD (0.13 mg/L) from infancy through lifetime of exposure. RSC was based on ceiling of 80% minus 'background' exposure, based on the most recent NHANES dataset. The 95th percentile water intake rates (Table 3-1 and 3-3, USEPA 2011) or upper percentile breastmilk intake rates (Table 15-1, USEPA 2011) were used. Breastmilk concentrations were calculated by multiplying the maternal serum concentration by a PFOA breastmilk transfer factor of 5.2%. Breastmilk transfer value was based on average breastmilk to maternal serum concentration ratios reported in the literature. The simulated individuals began life with a pre-existing body burden through placental transfer (maternal serum concentration x 87%. Placental transfer value was based on average cord to maternal serum concentration ratios reported in the literature.
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.035 ug/L or 35 PPT
Additional Information	MDH Health Based Guidance for Water Health Risk Assessment Unit, Environmental Health Division, 651-201-4899.Toxicological Summary for: Perfluorooctanoic Acid. May 2017 https://www.nature.com/articles/s41370-018-0110-5https://www.health.state.mn.us/communities/environment/risk/guidance/waterguidance.html http://www.legislature.mi.gov/documents/2017-2018/resolutionintroduced/House/htm/2018-HIR-0228.htm https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/pfoa.pdf

PFOA	
New Hampshire	
NH Department of Environmental Services 2019	
Standard / Guidance	Proposed MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.012 ug/L or 12 PPT
Key Study Information	
Critical Effect Key Study Reference	Increased liver wt. Loveless, S.E., Finlay, C., Everds, N.E., Frame, S.R., Gillies, P.J., O'Connor, J.C., Powley, C.R., Kennedy, G.L. (2006). Comparative responses of rats and mice exposed to linear/branched, linear, or branched ammonium perfluorooctanoate (APFO). Toxicology 220: 203–217. (rejected Macon 2011 Mammary Gland Development because target human serum level was above current serum levels in population)
Species	Mice
Study Exposure Duration (days)	14 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	
Method to Derive Human Equivalent Dose	DAF = 170 mL/kg x (Ln(2)/840 days) = 1.4 x 10-4 L/kg/d
Dose-Response	
Dose Response Modeling Method	lower confidence limit on the BMD (BMDL) for the serum PFOA level resulting in a 10 percent increase in liver weight in mice
POD HED Units	4.35 mg/L
POD x DAF = HED	609 ng/kg/day = 4.35 mg/L * 1.4 x 10-4 L/kg/day (EPA Clearance Factor) = 0.609 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	100
HED/UFT= Reference Dose (mg/kg-day)	6.1 x 10^{-6} mg/kg/d (RfD)
Receptor	Adult
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.012 ug/L or 12 PPT
Additional Information	UFs applied to animal serum level BMDL to obtain Target Human Serum Level of 14.5 ng/mL which is then converted to RfD using 1.4 x 10-4 L/kg/day (EPA Clearance Factor). RSC stated to account for higher exposure of young infants, at least partially.
Reference	https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/Summary-of-Comments-Responses-with-Attachments.pdf

PFOA	
New Jersey	
Drinking Water Quality Institute 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.014 ug/L or 14 PPT proposed
Key Study Information	
Critical Effect Key Study Reference	Increased liver wt. Loveless, S.E., Finlay, C., Everds, N.E., Frame, S.R., Gillies, P.J., O'Connor, J.C., Powley, C.R., Kennedy, G.L. (2006). Comparative responses of rats and mice exposed to linear/branched, linear, or branched ammonium perfluorooctanoate (APFO). Toxicology 220: 203–217. (rejected Macon 2011 Mammary Gland Development because target human serum level was above current serum levels in population)
Species	Mice
Study Exposure Duration (days)	14 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Ke = 0.000489165 (4.8 x 10-4) based on a human serum half-life of 1417 days (calculated from Zhang et al. [2013] as described above)
Method to Derive Human Equivalent Dose	clearance factor (1.4 x 10-4 L/kg/day; USEPA, 2016a)
Dose-Response	
Dose Response Modeling Method	lower confidence limit on the BMD (BMDL) for the serum PFOA level resulting in a 10 percent increase in liver weight in mice
POD HED Units	4.35 mg/L
POD x DAF = HED	4.35 mg/L * 1.4 x 10-4 L/kg/day (EPA Clearance Factor) = 609 ng/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	2×10^{-6} mg/kg/d (RfD)
Receptor	Adult
Exposure	
Ingestion Rate (L/day)	2
Body Weight (Kg)	70
Normalized Drinking Water Intake (L/kg/day)	.029
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.014 ug/L or 14 PPT proposed
Additional Information	UFs applied to animal serum level BMDL to obtain Target Human Serum Level of 14.5 ng/mL which is then converted to RfD using 1.4 x 10-4 L/kg/day (EPA Clearance Factor). RSC stated to account for higher exposure of young infants, at least partially.
Reference	Maximum Contaminant Level Recommendation for Perfluorooctanoic Acid in Drinking Water, Basis and Background. New Jersey Drinking Water Quality Institute. https://www.nj.gov/dep/watersupply/pdf/pfoa-recommend.pdf https://www.nj.gov/dep/watersupply/pdf/pfoa-appendixa.pdf

PFOA	
New York	
Drinking Water Quality Council 2018	
Standard / Guidance	Recommended MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.010 ug/L or 10 PPT proposed
Key Study Information	
Critical Effect Key Study Reference	Mammary gland development Macon MB, Villanueva LR, Tatum-Gibbs K, et al. 2011. Prenatal perfluorooctanoic acid exposure in CD-1 mice: Low-dose developmental effects and internal dosimetry. Toxicol Sci 122(1):134-145.
Species	Mice
Study Exposure Duration (days)	17 day gestational exposure
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Not published
Method to Derive Human Equivalent Dose	Not published
Dose-Response	
Dose Response Modeling Method	Not published
POD HED Units	Not published
POD x DAF = HED	Not published
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	100
HED/UFT= Reference Dose (mg/kg-day)	1.5×10^{-6} mg/kg/d
Receptor	None given
Exposure	
Ingestion Rate (L/day)	None given
Body Weight (Kg)	None given
Normalized Drinking Water Intake (L/kg/day)	None given
Relative Source Contribution	None given
Threshold Level (ug/L) or (PPT)	0.010 ug/L or 10 PPT proposed
Additional Information	Initial rule making now in the deferral provision phase - Determined by vote at Drinking Water Quality Council (considered 6, 10, and 14 PPT)
Reference	https://www.health.ny.gov/press/releases/2018/2018-12-18_drinking_water_quality_council_recommendations.htm https://totalwebcasting.com/view/?func=VOFF&id=nysdoh&date=2020-02-04&seq=1 https://www.health.ny.gov/environmental/water/drinking/dwqc/

PFOA	
North Carolina	
North Carolina Department of Environment Quality 2019	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Health Advisory
Relative Source Contribution	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Additional Information	
Reference	https://files.nc.gov/ncdeq/GenX/SAB/PFOS-and-PFOA-proposed-standard.pdf

PFOA	
Oregon	
Standard / Guidance	Health Advisory
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/OPERATIONS/Pages/EmergingContaminants.aspx

PFOA	
Texas	
Office of Water 2016	
Standard / Guidance	Health Advisory
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Additional Information	Texas has developed a number of reference dose recommendations for a wide range of PFAS for groundwater but defers to EPA for Drinking Water
Reference	Perfluorcoumpunds (PFCs) January 2016 https://www.tceq.texas.gov/assets/public/implementation/tox/evaluations/pfcs.pdf

PFOA	
Vermont	
Department of Environmental Conservation / Department of Environmental Quality 2018	
Standard / Guidance	Maximum Allowable Concentration
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	0.000021 (2.1 x 10-5)
Receptor	Infant less than a year
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.175
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Additional Information	The 95th percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kgBW-d.
Reference	Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) July 2018 https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf

PFOA	
West Virginia	
Department of Health and Human Resources 2018	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOA cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOA cannot exceed this level)
Additional Information	
Reference	Perfluorinated Compounds Drinking Water Health Advisory https://www.wvdhhr.org/oehs/documents/BPH_pfoa%20pfos_FL.pdf

PFOS

PFOS	
US EPA	
Office of Water 2016	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	decreased maternal body weight, gestation length and pup survival Luebker DJ, Case MT, York RG, et al. 2005. Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats. Toxicology 215(1-2):126-148.
Species	femaleSprague Dawley rats
Study Exposure Duration (days)	84 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The average serum concentration was estimated in the mice (6.26 mg/L) using a three-compartment pharmacokinetic model (Wambaugh et al. 2013) using animal species-, strain-, sex-specific parameters.
Method to Derive Human Equivalent Dose	Dose adjustment factor of 0.000081 (8.1 x 10-5) L/kg-day, based on first order kinetic clearance rate (Vd x (ln 2 ÷ t½))
Dose-Response	
Dose Response Modeling Method	NOAEL
POD	6.26 mg/L
POD x DAF = Human Equiv Dose	0.0051 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	30
HED/UFT= Reference Dose (mg/kg-day)	(2 x 10-5 mg/kg-day) or 20 ng/kg/d
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg-day)	0.054
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Additional Information	Because the critical effect identified for PFOS is a developmental endpoint and can potentially result from a short-term exposure during a critical period of development, EPA concludes that the lifetime HA for PFOA is applicable to both short-term and chronic risk assessment scenarios. Thus, the lifetime HA of 0.07 µg/L also applies to short-term exposure scenarios (i.e., weeks to months) to PFOA in drinking water, including during pregnancy and lactation.
Reference	https://www.epa.gov/sites/production/files/2016-05/documents/pfos_health_advisory_final_508.pdf

PFOS	
US DHHS	
ATSDR DRAFT June 2018	
Standard / Guidance	Minimal Risk Level
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	None at present in draft phase
Key Study Information	
Critical Effect Key Study Reference	Delayed eye opening and decreased pup body weight Luebker DJ, Case MT, York RG, et al. 2005a. Two-generation reproduction and cross-foster studies of perfluorooctanesulfonate (PFOS) in rats. Toxicol 215: 126-148
Species	Sprague-Dawley rats (P generation)
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The average serum concentration for NOAEL (0.1 mg/kg/day) was estimated using an empirical clearance model (Wambaugh et al., 2013). The estimated time-weighted average serum concentration corresponding to the NOAEL was 7.43 mg/L.
Method to Derive Human Equivalent Dose	NOAEL HED = 5.5 x 10-5 mg/kg-day = (TWA serum x ke x Vd) TWA serum = 0.674 mg/L (Human Clearance Factor US EPA, 2016b) = 8.1×10^{-5} L/kg-day
Dose-Response	
Dose Response Modeling Method	NOAEL
POD	7.43 mg/L
POD x DAF = Human Equiv Dose	0.000515 mg/kg/day or 5.15×10^{-4} mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Modifying Factor (MF)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	$1.7\ 0 \times 10^{-6}$ mg/kg/day rounded to 2.0×10^{-6} mg/kg/day and called a Minimal Risk Level
Receptor	None selected at present
Exposure	
Ingestion Rate (L/day)	Not determined at present
Body Weight (Kg)	Assuming the ATSDR uses the EPA methodology the Threshold Level would be 9 PPT
Normalized Drinking Water Intake (L/kg-day)	
Relative Source Contribution	
Threshold Level (ug/L) or (PPT)	*9 PPT presumptive*
Additional Information	Draft Commentary awaiting further review modifying factor of 10 for concern that immunotoxicity may be a more sensitive endpoint than developmental toxicity Dong et al 2011 was considered and with MF would have resulted in same MRL
Reference	https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=1117&tid=237

PFOS	
ALASKA	
Dept. of Environmental Conservation 2019	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://dec.alaska.gov/spar/csp/pfas/

PFOS	
ALABAMA	
ADEM 2019	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://adem.alabama.gov/newsEvents/reports/PFASinAlabama.pdf

PFOS	
California	
August 2019	
Standard / Guidance	Notification Levels NonCancer
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.007 ug/L or 7 PPT
Key Study Information	
Critical Effect Key Study Reference	Dong GH, Zhang YH, Zheng L, Liu W, Jin YH, He QC (2009). Chronic effects of perfluorooctanesulfonate exposure on immunotoxicity in adult male C57BL/6 mice. Arch Toxicol 83(9): 805-815. Decreased plaque forming cell response was the most sensitive endpoint, and a NOAEL of 0.008 mg/kg-day was identified.
Species	adult male mice
Study Exposure Duration (days)	60 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	NOAEL 0.674 mg/L
Method to Derive Human Equivalent Dose	HED = 5.5 x 10-5 mg/kg-day = (TWA serum x ke x Vd) TWA serum = 0.674 mg/L (Human Clearance Factor US EPA, 2016b) = 8.1×10^{-5} L/kg-day
Dose-Response	
Dose Response Modeling Method	NOAEL (no fit found for BMDL)
POD	0.674 mg/L
PODxDAF=HED (mg/kg/day)	HED = 5.5 x 10-5 mg/kg-day mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	30
HED/UFT= Reference Dose (mg/kg-day)	1.8x10-6 mg/kg/day
Receptor	adult
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.053 L/kg-day
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.007 ug/L or 7 ppt
Additional Information	Note: California uses an intermediate step called ADD or acceptable daily dose which is expressed as a target serum level and then a dose. This corresponds to the Reference Dose in this table
Reference	Notification Level Recommendations for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) https://oehha.ca.gov/media/downloads/water/chemicals/nl/final-pfoa-pfosnl082119.pdf

PFOS	
California	
August 2019	
Standard / Guidance	Cancer Reference Level
Media Type	one in one million cancer risk from PFOS in tap water
Threshold Level (ug/L) or (PPT)	0.0001 ug/L or 0.1 ppt
Key Study Information	
Critical Effect Key Study Reference	NTP (2018c). TR-598: Technical Report Pathology Tables and Curves - PFOA. National Toxicology Program, Research Triangle Park, North Carolina. https://tools.niehs.nih.gov/cebs3/views/?action=main.dataReview&bin_id=13658 (last accessed March 20, 2019).
Species	Rats
Study Exposure Duration (days)	
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Using the HEDs as the dose metric, multisite benchmark dose modeling was performed to determine the cancer slope factor (CSF) for the hepatic and pancreatic tumors in male rats.
Method to Derive Human Equivalent Dose	
Dose-Response	
Dose Response Modeling Method	BMDL05(human) = BMDL05(animal) × (BWanimal/BWhuman)1/8
POD	BMDL05 of 0.0020 mg/kg-day for male rats
PODxDAF=HED (mg/kg/day)	BMDL05(human) 0.0011 mg/kg- day CSF = BMR ÷ BMDL05 = 0.05 ÷ 3.5 × 10-4 mg/kg-day = 45.5 (mg/kg-day)-1 for males
Uncertainty Extrapolation	
Human Variability (UFH)	
Animal to Human (UFA)	
Subchronic to Chronic (UFS)	
LOAEL to NOAEL (UFL)	
Database (UFD)	
Total Composite (UFT)	
HED/UFT= Reference Dose (mg/kg-day)	RL = R ÷ (CSF X DWI) R = default risk level of one in one million, or 10-6 RL = 10-6 ÷ (45.5 (mg/kg-day)-1 . 0.053 L/kg-day) = 4.2 . 10-7 mg/L RL = 0.4 ng/L or 0.4 ppt (rounded)
Receptor	All ages: Age sensitivity factors (ASFs) were not applied
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.053 L/kg-day
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	4.2 . 10-7 mg/L or 0.4 ng/L or 0.4 ppt (rounded)
Additional Information	OEHHA recommends that SWRCB set the final NLs at the lowest levels at which PFOA and PFOS can be reliably detected in drinking water using currently available and appropriate technologies.
Reference	Notification Level Recommendations for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) https://oehha.ca.gov/media/downloads/water/chemicals/nl/final-pfoa-pfosnl082119.pdf

PFOS	
Colorado	
CPHE 2018	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://www.colorado.gov/pacific/cdphe/PFCs/health/advisory

PFOS	
Connecticut	
CT DPH 2016	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFOS	
Delaware	
DNREC-DWHS 2018	
Standard / Guidance	Health Advisoru Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://www.dnrec.delaware.gov/dwhs/SIRB/Documents/DWHS%20PFAS%20Sampling%20Policy.pdf

PFOS	
Florida	
DOH 2016	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	http://www.floridahealth.gov/environmental-health/drinking-water/_documents/pfoa-pfos-fs-20161.pdf

PFOS	
Idaho	
DEQ 2017	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Additional Information	
Reference	https://www.deq.idaho.gov/water-quality/drinking-water/drinking-water-health-advisories/

PFOS	
Iowa	
DNR 2019	
Standard / Guidance	Health Advisory Level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT PFOS
Additional Information	
Reference	https://programs.iowadnr.gov/riskcalc/Chemical/Index/287

PFOS	
Maine	
PFAS Task Force 2020	
Standard / Guidance	Health Advisory
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT for PFOS + PFOA, 0.4 ug/L or 400 PPT for all PFAS combined
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT for PFOS + PFOA, 0.4 ug/L or 400 PPT for all PFAS combined
Additional Information	
Reference	https://www1.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFOS	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFOS	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.016 ug/L or 16 PPT
Key Study Information	
Critical Effect Key Study Reference	Dong GH, Zhang YH, Zheng L, Liu W, Jin YH, He QC (2009). Chronic effects of perfluorooctanesulfonate exposure on immunotoxicity in adult male C57BL/6 mice. Arch Toxicol 83(9): 805-815. Decreased plaque forming cell response was the most sensitive endpoint, and a NOAEL of 0.008 mg/kg-day was identified.
Species	adult make mice
Study Exposure Duration (days)	60 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	NOAEL 0.674 mg/L
Method to Derive Human Equivalent Dose	HED = 5.5 x 10-5 mg/kg-day = (TWA serum x ke x Vd) TWA serum = 0.674 mg/L (Human Clearance Factor US EPA, 2016b) = 8.1×10^{-5} L/kg-day
Dose-Response	
Dose Response Modeling Method	NOAEL (no fit found for BMDL)
POD HED Units	0.674 mg/L
POD x DAF = HED	HED = 5.5 x 10-5 mg/kg-day mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	30
HED/UFT= Reference Dose (mg/kg-day)	2.89 x 10-6 mg/kg/day) which corresponds to a serum concentration of 0.022 µg/ml
Receptor	Breast fed infant
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50% Based on NHANES 95th percentiles for 3-11 (2013-2014) and over 12 years old (2015-2016) participants (CDC 2019)
Threshold Level	0.016 ug/L or 16 PPT
Additional Information	The Workgroup discussed the Goeden et al. (2019) model which considered full life stage exposure, from fetal exposure, to infant exposure through breastfeeding, and into adulthood. While the model was also developed for a formula-fed infant, the breastfed infant scenario is protective of a formula-fed infant. The Workgroup selected this model for developing drinking water HBVs when the needed inputs were available.
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

PFOS	
Minnesota	
DOH 2019	
Standard / Guidance	Health Based Values
Media Type	
Threshold Level (ug/L) or (PPT)	0.015 ug/L or 15 PPT
Key Study Information	
Critical Effect Key Study Reference	increased IL-4 and decreased SRBC specific IgM levels Dong, G., MM Liu, D Wang, L Zheng, ZF Liang, YH Jin, (2011). "Sub-chronic effect of perfluorooctanesulfonate (PFOS) on the balance of type 1 and type 2 cytokine in adult C57BL6 mice." Archives of Toxicology 85: 1235-1244.
Species	adult C57BL/6 male Mice
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	38 mg/L serum concentration (US EPA 2016a predicted average serum concentration for maternal animals from Lau et al 2006) EPA modeled average serum concentration (predicted AUC u/mL/hr divided by (24hr/day x 18 days)
Method to Derive Human Equivalent Dose	DAF = 0.23 L/kg x (Ln(2) ÷ (3.4 y * 365 d/y)) = 1.28x10-1 mL/kg/d
Dose-Response	
Dose Response Modeling Method	NOAEL
POD	2.36 µg/mL(or mg/L)
POD x DAF = HED mg/kg/day	2.36 mg/L x 0.00013 L/kg-d = 0.000307 mg/kg-d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	3 (impacts on serum thyrozine in developing animals at 1/3 of POD)
Total Composite (UFT)	100
HED/UFT= Reference Dose (mg/kg-day)	0.0000031 mg/kg-d corresponding to a serum concentration of *0.024 mg/L.*
Receptor	Infant exposure via breastmilk for 1 year, from mother chronically exposed via water, followed by lifetime of exposure via drinking water. Protective for short-term, subchronic and chronic.
Exposure	
Ingestion Rate (L/day)	The 95th percentile water intake rates (Table 3-1 and 3-3, USEPA 2011) or upper percentile breastmilk intake rates (Table 15-1, USEPA 2011) were used.
Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al. Placental transfer of 40% (MDH 2019). Breastmilk transfer of 1.7% (MDH 2019). Human Serum half-life of 1241 days (Li et al. 2018) Volume of distribution of 0.23 L/kg (USA EPA 2016c) 95th percentile drinking water intake, consumers only, from birth to more than 21 years old (Goeden et al. [2019]) Upper percentile (mean plus two standard deviations) breast milk intake rate (Goeden et al. [2019]) Time-weighted average water ingestion rate from birth to 30-35 years of age (to calculate maternal serum concentration at delivery) (Goeden et al. [2019])
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.015 ug/L or 15 PPT
Additional Information	https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/pfos.pdf

PFOS	
New Hampshire	
NH Department of Environmental Services 2019	
Standard / Guidance	Proposed MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.015 ug/L or 15 PPT
Key Study Information	
Critical Effect Key Study Reference	decreased SRBC specific IgM levels Dong, G., MM Liu, D Wang, L Zheng, ZF Liang, YH Jin, (2011). "Sub-chronic effect of perfluorooctanesulfonate (PFOS) on the balance of type 1 and type 2 cytokine in adult C57BL6 mice." Archives of Toxicology 85: 1235-1244.
Species	adult C57BL/6 male Mice
Study Exposure Duration (days)	18 days maternal, 17 days pups
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	
Method to Derive Human Equivalent Dose	DAF = 0.23 L/kg x (Ln(2) ÷ (3.4 y * 365 d/y)) = 1.28 x 10-4 L/kg/d
Dose-Response	
Dose Response Modeling Method	NOAEL
POD HED Units	2.360 ug/mL
POD x DAF = HED	3 x 10-4 mg/kg/d = 2.36 ug/mL x 1.28 x 10-4 L/kg/d = 3 x 10-4 mg/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	100
HED/UFT= Reference Dose (mg/kg-day)	3.0 x 10^{-6} mg/kg/d (RfD)
Receptor	Breast feeding infant
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.015 ug/L or 15 PPT
Additional Information	UFs applied to animal serum level BMDL to obtain Target Human Serum Level of 14.5 ng/mL which is then converted to RfD using 1.4 x 10-4 L/kg/day (EPA Clearance Factor). RSC stated to account for higher exposure of young infants, at least partially.
Reference	https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/Summary-of-Comments-Responses-with-Attachments.pdf

PFOS	
New Jersey	
Drinking Water Quality Institute 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.013 ug/L or 13 PPT
Key Study Information	
Critical Effect Key Study Reference	Dong GH, Zhang YH, Zheng L, Liu W, Jin YH, He QC (2009). Chronic effects of perfluorooctanesulfonate exposure on immunotoxicity in adult male C57BL/6 mice. Arch Toxicol 83(9): 805-815. Decreased plaque forming cell response was the most sensitive endpoint, and a NOAEL of 0.008 mg/kg-day was identified.
Species	adult make mice
Study Exposure Duration (days)	60 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	NOAEL 0.674 mg/L
Method to Derive Human Equivalent Dose	HED = 5.5 x 10-5 mg/kg-day = (TWA serum x ke x Vd) TWA serum = 0.674 mg/L ||| (Human Clearance Factor US EPA, 2016b) = 8.1×10^{-5} L/kg-day
Dose-Response	
Dose Response Modeling Method	NOAEL (no fit found for BMDL)
POD HED Units	0.674 mg/L
POD x DAF = HED	HED = 5.5 x 10-5 mg/kg-day mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	30
HED/UFT= Reference Dose (mg/kg-day)	1.8x10-6 mg/kg/day
Receptor	Adult
Exposure	
Ingestion Rate (L/day)	2
Body Weight (Kg)	70
Normalized Drinking Water Intake (L/kg/day)	.029
Relative Source Contribution	.2
Additional Information	0.013 ug/L or 13 PPT
Reference	Maximum Contaminant Level Recommendation for Perfluorooctanoic Acid in Drinking Water, Basis and Background. New Jersey Drinking Water Quality Institute. https://www.nj.gov/dep/rules/proposals/20190401a.pdf

PFOS	
New York	
Drinking Water Quality Council 2018	
Standard / Guidance	Recommended MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.010 ug/L or 10 PPT proposed
Key Study Information	
Critical Effect Key Study Reference	
Species	
Study Exposure Duration (days)	
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	
Method to Derive Human Equivalent Dose	
Dose-Response	
Dose Response Modeling Method	
POD HED Units	
POD x DAF = HED	
Uncertainty Extrapolation	
Human Variability (UFH)	
Animal to Human (UFA)	
Subchronic to Chronic (UFS)	
LOAEL to NOAEL (UFL)	
Database (UFD)	
Total Composite (UFT)	
HED/UFT= Reference Dose (mg/kg-day)	
Receptor	
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	
Threshold Level (ug/L) or (PPT)	0.010 ug/L or 10 PPT proposed
Additional Information	Determined by vote at Drinking Water Quality Council (considered 6, 10, and 14)
Reference	https://www.health.ny.gov/press/releases/2018/2018-12-18_drinking_water_quality_council_recommendations.htm

PFOS	
North Carolina	
North Carolina Department of Environment Quality 2019	
Standard / Guidance	Health Advisory
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Health Advisory
Relative Source Contribution	Drinking Water
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Additional Information	
Reference	https://files.nc.gov/ncdeq/GenX/SAB/PFOS-and-PFOA-proposed-standard.pdf

PFOS	
Texas	
Office of Water 2016	
Standard / Guidance	Health Advisory
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Lactating women
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.07 ug/L 70 PPT (PFOA + PFOS cannot exceed this level)
Additional Information	Texas has developed a number of reference dose recommendations for a wide range of PFAS for groundwater but defers to EPA for Drinking Water
Reference	Perfluorcoumpunds (PFCs) January 2016 https://www.tceq.texas.gov/assets/public/implementation/tox/evaluations/pfcs.pdf

PFOS	
Vermont	
Department of Environmental Conservation / Department of Environmental Quality 2018	
Standard / Guidance	Maximum Allowable Concentration
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	0.000021 (2.1 x 10-5)
Receptor	Infant less than a year
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.175
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Additional Information	The 95th percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kgBW-d.
Reference	Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) July 2018 https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf

PFOS	
Connecticut	
CT DPH 2016	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFNA

PFNA	
Connecticut	
CT DPH 2016	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFNA	
Maine	
DEP 2020	
Standard / Guidance	RAG
Media Type	DW
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Additional Information	
Reference	https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFNA	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFNA	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.006 ug/L or 6 PPT
Key Study Information	
Critical Effect Key Study Reference	Developmental endpoints – Delayed eye opening, preputial separation, and vaginal opening in mouse pups Das KP, Grey BE, Rosen MB, et al. 2015. Developmental toxicity of perfluorononanoic acid in mice. Reproductive Toxicology 51:133- 144.
Species	Timed-pregnant CD-1
Study Exposure Duration (days)	17 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The average serum concentration for NOAEL (1 mg/kg/day) was estimated (6.8 mg/L) in dams using an empirical clearance model (Wambaugh et al., 2013). The estimated time-weighted average serum concentration corresponding to the NOAEL was 6.8 mg/L.
Method to Derive Human Equivalent Dose	The time-weighted average serum concentration of 6.8 mg/L was converted to the HED using the below equation. NOAELHED = (TWA serum x ke x Vd) = 0.000665 mg/kg/day Ke = 0.000489165 (4.8 x 10-4) based on a human serum half-life of 1417 days (calculated from Zhang et al. [2013] as described above) Vd = 0.2 L/kg (ATSDR [2018]; Ohmori et al. [2003]) The Workgroup discussed the human serum half-lives available from Zhang et al. (2013), which were an arithmetic mean of 2.5 years (913 days) for 50 year old or younger females and 4.3 years (1570 days) for females older than 50 years old and all males. An average of 3.9 years (1417 days) was calculated based on those averages. The Workgroup selected the calculated average as it would better represent the entire population.
Dose-Response	
Dose Response Modeling Method	NOAEL
POD HED Units	6.8 mg/L
POD x DAF = HED	The time-weighted average serum concentration of 6.8 mg/L was converted to the HED using the below equation. HED= (TWA serum x ke x Vd) = 0.000665 mg/kg/day Ke = 0.000489165 (4.8 x 10^{-4}) based on a human serum half-life of 1417 days (calculated from Zhang et al. [2013] as described above) Vd = 0.2 L/kg (ATSDR [2018]; Ohmori et al. [2003])
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	2.2 ng/kg/day (2.2 x 10-6 mg/kg/day) which corresponds to a serum concentration of 0.023 mg/L
Receptor	Breast fed infant
Exposure	
Ingestion Rate (L/day) Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al. Placental transfer of 87% (MDH 2017). Breastmilk transfer of 5.2% (MDH 2017). Human Serum half-life of 840 days (Bartell et al. 2010) Volume of distribution of 0.17 L/kg (Thompson et al. [2010]) 95th percentile drinking water intake, consumers only, from birth to more than 21 years old (Goeden et al. [2019]) Upper percentile (mean plus two standard deviations) breast milk intake rate (Goeden et al. [2019]) Time-weighted average water ingestion rate from birth to 30-35 years of age (to calculate maternal serum concentration at delivery) (Goeden et al. [2019])

Relative Source Contribution	50% Based on NHANES 95th percentiles for 3-11 (2013-2014) and over 12 years old (2015-2016) participants (CDC 2019)
Threshold Level	0.006 ug/L or 6 PPT
Additional Information	The Workgroup discussed the Goeden et al. (2019) model which considered full life stage exposure, from fetal exposure, to infant exposure through breastfeeding, and into adulthood. While the model was also developed for a formula-fed infant, the breastfed infant scenario is protective of a formula-fed infant. The Workgroup selected this model for developing drinking water HBVs when the needed inputs were available.
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

PFNA	
New Hampshire	
NH Department of Environmental Services 2019	
Standard / Guidance	Proposed MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.011 ug/L or 11 PPT
Key Study Information	
Critical Effect Key Study Reference	Increased liver weight in pregnant mice Das KP, Grey BE, Rosen MB, et al. 2015. Developmental toxicity of perfluorononanoic acid in mice. Reproductive Toxicology 51:133- 144.
Species	Timed-pregnant CD-1
Study Exposure Duration (days)	17 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	
Method to Derive Human Equivalent Dose	Toxicokinetic Adjustment based on Chemical-Specific Clearance Rate = Volume of Distribution (L/kg) x (Ln2/Half- life, days) = 200 mL/kg x (Ln2/1570 days) = 8.83 x 10 -2 mL/kg/d
Dose-Response	
Dose Response Modeling Method	lower confidence limit on the BMD (BMDL) for the serum PFNA level resulting in a 10 percent increase in liver weight in mice
POD HED Units	4.9 mg/L
POD x DAF = HED	4.3×10^{-6} mg/kg/d = 4.9 mg/L x 8.83 x 10 -2 mL/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	100
HED/UFT= Reference Dose (mg/kg-day)	4.3×10^{-6} mg/kg/d (RfD)
Receptor	Breast Fed Infant
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.011 ug/L or 11 PPT
Additional Information	
Reference	https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/Summary-of-Comments-Responses-with-Attachments.pdf

PFNA	
New Jersey	
Drinking Water Quality Institute	
Standard / Guidance	MCL
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.013 ug/L or 13 PPT
Key Study Information	
Critical Effect Key Study Reference	10% increase from the mean liver weight in the pregnant control mice pups Das KP, Grey BE, Rosen MB, et al. 2015. Developmental toxicity of perfluorononanoic acid in mice. Reproductive Toxicology 51:133- 144.
Species	Timed-pregnant CD-1
Study Exposure Duration (days)	17 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	"Because the half-life of long-chain PFCs such as PFNA is much longer in humans (several years) than in rats and mice, a given administered dose (mg/kg/day) results in a much greater internal dose (as indicated by serum level) in humans than in these animal species. Therefore, comparisons between effect levels in animal studies and human exposures were made on the basis of serum levels rather than administered dose"
Method to Derive Human Equivalent Dose	
Dose-Response	
Dose Response Modeling Method	BMDL
POD HED Units	4.9 mg/L
POD x DAF = HED	None derived
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	10
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	1000
Target Human Serum Level	4.9 x 10-3 mg/L or 4.9 x10-3 ug/mL target human serum level
Receptor	Lifetime
Exposure	
Ingestion Rate (L/day) Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Based on an assumed daily drinking water intake of 16 ml/kg/day (USEPA, 2011), the corresponding increase in daily dose of PFNA (ng/kg/day) that results in a 1 ng/ml increase in PFNA in blood serum is 0.08 ng/kg/day/(ng/ml). Based on an assumed daily drinking water intake of 16 ml/kg/day (USEPA, 2011), the corresponding increase in daily dose of PFNA (ng/kg/day) that results in a 1 ng/ml increase in PFNA in blood serum is 0.08 ng/kg/day/(ng/ml). Therefore, ongoing exposure to drinking water with 150 ng/L PFNA (the highest concentration reported in public drinking water in New Jersey or elsewhere) is estimated to increase PFNA serum levels, on average, by 30 ng/ml (µg/L; ppb) in serum. Based on the 200:1 ratio between PFNA serum levels and drinking water concentration, an increase in PFNA serum level of 2500 ng/L is expected to result from ongoing exposure to 12.5 ng/L
Relative Source Contribution	50 % RSC = 100 X (Target human serum level – 95th % NHANES serum level)/ Target Human Serum Level PFNA RSC = 100 x (4.9 ng/ml – 2.5 ng/ml) /4.9 ng/ml = 49.0% (rounded to 50%)
Threshold Level	0.013 ug/L or 13 PPT = 200 / 2.5 ng/mL rounded up
Additional Information	
Reference	https://www.nj.gov/dep/watersupply/pdf/pfna-health-effects.pdf

PFNA	
Vermont	
Department of Environmental Conservation / Department of Environmental Quality 2018	
Standard / Guidance	Maximum Allowable Concentration
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	0.000021 (2.1 x 10-5)
Receptor	Infant less than a year
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.175
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Additional Information	The 95th percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kgBW-d.
Reference	Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) July 2018 https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf

PFHxS

PFHxS	
Connecticut	
CT DPH 2016	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFHxS	
Maine	
DEP 2020	
Standard / Guidance	RAG
Media Type	DW
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Additional Information	
Reference	https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFHxS	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFHxS	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.051 ug/L or 51 PPT
Key Study Information	
Critical Effect Key Study Reference	decreased serum free thyroxin (T4) level NTP 2018 TOX-96: Toxicity Report Tables and Curves for Short-term Studies: Perfluorinated Compounds: Sulfonates and personal communication between MDH and NTP project manager Dr. Chad Blystone (as cited in the HRA Toxicology Review Worksheet for PFHxS, last revised 3/8/2019
Species	Sprague Dawley Rats
Study Exposure Duration (days)	28 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	A BMR of 20% was used in the BMD modeling based on clinical and toxicological knowledge regarding adverse outcomes associated with decreases in circulating thyroid hormones. MDH stated that 20% provided a more statistically reliable and biologically significant BMR. (MDH conducted Benchmark Dose modeling and provided modeling run data in the HRA Toxicology Review Worksheet for PFHxS, last revised 3/8/2019.
Method to Derive Human Equivalent Dose	The POD (32.4 mg/L) was multiplied by a toxicokinetic adjustment based on the chemical's specific clearance rate of 0.000090 L/kg-d (Vd = 0.25 L/kg [Sundstrom et al. [2012], half-life = 1935 days [Li et al. 2018]) for a human equivalent dose of 0.00292 mg/kg/day.
Dose-Response	
Dose Response Modeling Method	POD of 32.4 mg/L serum concentration for male rats based on BMDL20.
POD HED Units	32.4 mg/L
POD x DAF = HED	0.00292 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	9.7 ng/kg/day (9.7 x 10-6 mg/kg/day) which corresponds to a serum concentration of 0.11 µg/ml
Receptor	Breast fed infant
Exposure	
Ingestion Rate (L/day) Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Breast-fed infant, which is also protective of a formula-fed infant. Placental transfer = 0.8 Breastmilk transfer = 0.012 Half-life = 3100 days (ATSDR 2018: Olsen et al. 2007) Volume of distribution = 0.287 L/kg (ATSDR 2018) 95th percentile drinking water intake, consumers only, from birth to more than 21 years old (MDH 2017b: US EPA 2011) Upper percentile (mean plus two standard deviations) breast milk intake rate. Time-weighted average water ingestion rate from birth to 30-35 years of age (to calculate maternal serum concentration at delivery) Background Document: Toxicokinetic Model for PFOS and PFOA and Its Use in the Derivation of Human Health-based Water Guidance Values. Minnesota Department of Health.
Relative Source Contribution	50% Based on NHANES 95th percentiles for 3-11 (2013-2014) and over 12 years old (2015-2016) participants (CDC 2019)
Threshold value	0.051 ug/L or 51 PPT
Additional information	The Workgroup discussed the Goeden et al. (2019) model which considered full life stage exposure, from fetal exposure, to infant exposure through breastfeeding, and into adulthood. While the model was also developed for a formula-fed infant, the breastfed infant scenario is protective of a formula-fed infant.
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

PFHxS	
Minnesota	
DOH 2019	
Standard / Guidance	Health Based Guidance
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.047 ug/L or 47 PPT
Key Study Information	
Critical Effect Key Study Reference	NTP 2018 TOX-96: Toxicity Report Tables and Curves for Short-term Studies: Perfluorinated Compounds: sulfonates and personal communication between MDH and NTP project manager Dr. Chad Blystone (as cited in the HRA Toxicology Review Worksheet for PFHxS, last revised 3/8/2019) Critical effect: decreased serum free thyroxin (T4) levels was observed in adult male rats at the lowest PFHxS dose administered (0.625 mg/kg/day) Co-critical effects: decreased free and total T4, triiodothyronine (T3), and changes in cholesterol levels and increased hepatic focal necrosis https://tools.niehs.nih.gov/cebs3/views/?action=main.dataReview&bin_id=3874
Species	Adult Sprague Dawley rates
Study Exposure Duration (days)	
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	
Method to Derive Human Equivalent Dose	Toxicokinetic Adjustment based on Chemical-Specific Clearance Rate = Volume of Distribution (L/kg) x (Ln2/Half- life, days) = 0.25 L/kg x (0.693/1935 days) = 0.000090 L/kg- day. (Half-life from Li et al 2018)
Dose-Response	
Dose Response Modeling Method	MDH modeled BMDL20%
POD	32.4 µg/mL (or mg/L) serum concentration (male rats - NTP 2018, MDH modeled BMDL20%)
POD x DAF = HED mg/kg/day	POD x DAF = 32.4 mg/L x 0.000090 L/kg/d = 0.00292 mg/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	HED/Total UF = 0.00292/300 = 0.0000097 mg/kg-d (or 9.7 ng/kg-d)
Receptor	Infant exposure via breastmilk for 1 year, from mother chronically exposed via water, followed by lifetime of exposure via drinking water. Protective for short-term, subchronic and chronic.
Exposure	
Ingestion Rate (L/day)	The 95th percentile water intake rates (Table 3-1 and 3-3, USEPA 2011) or upper percentile breastmilk intake rates (Table 15-1, USEPA 2011) were used.
Body Weight (Kg) Normalized Drinking Water Intake (L/kg/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al. Placental transfer of 87% (MDH 2017). Breastmilk transfer of 5.2% (MDH 2017). Human Serum half-life of 840 days (Bartell et al. 2010) Volume of distribution of 0.17 L/kg (Thompson et al. [2010]) 95th percentile drinking water intake, consumers only, from birth to more than 21 years old (Goeden et al. [2019]) Upper percentile (mean plus two standard deviations) breast milk intake rate (Goeden et al. [2019]) Time-weighted average water ingestion rate from birth to 30-35 years of age (to calculate maternal serum concentration at delivery) (Goeden et al. [2019])
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.047 ug/L or 47 PPT
Additional Information	https://www.health.state.mn.us/communities/environment/risk/docs/guidance/gw/pfhxs.pdf

PFHxS	
New Hampshire	
NH Department of Environmental Services 2019	
Standard / Guidance	Proposed MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.018 ug/L or 18 PPT
Key Study Information	
Critical Effect Key Study Reference	Reduced litter size in mice following a 14 day prior to pregnancy oral exposure Chang S, et al. 2018. Reproductive and developmental toxicity of potassium perfluorohexanesulfonate in CD-1 mice. Reproductive Toxicology 78: 150-168.
Species	Adult CD-1 female mice
Study Exposure Duration (days)	14 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Serum concentrations on day 14
Method to Derive Human Equivalent Dose	Toxicokinetic Adjustment based on Chemical-Specific Clearance Rate = Volume of Distribution (L/kg) x (Ln2/Half- life, days) = 213 mL/kg x (Ln2/1716 days) = 8.61 x 10 -2 mL/kg/d
Dose-Response	
Dose Response Modeling Method	lower confidence limit on the BMD (BMDL)
POD HED Units	13.9 mg/L
POD x DAF = HED	4.3 x 10^{-6} mg/kg/d =134.9 mg/L x 8.61 x 10 -2 mL/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	3 (14 day exposure study)
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	4.0 x 10^{-6} mg/kg/d (RfD)
Receptor	Breast Fed Infant
Exposure	
Ingestion Rate (L/day)	Breast-fed infant, which is also protective of a formula-fed infant using Minnesota Department of Health Model based on Goeden et al.
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	
Relative Source Contribution	50%
Threshold Level (ug/L) or (PPT)	0.018 ug/L or 18 PPT
Additional Information	
Reference	https://www4.des.state.nh.us/nh-pfas-investigation/wp-content/uploads/Summary-of-Comments-Responses-with-Attachments.pdf

PFHxS	
Vermont	
Department of Environmental Conservation / Department of Environmental Quality 2018	
Standard / Guidance	Maximum Allowable Concentration
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	0.000021 (2.1 x 10-5)
Receptor	Infant less than a year
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.175
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Additional Information	The 95th percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kgBW-d.
Reference	Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) July 2018 https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf

PFHpA

PFHpA	
Connecticut	
CT DPH 2016	
Standard / Guidance	Action level
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.070 ug/L or 70 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA
Additional Information	
Reference	https://portal.ct.gov/DPH/Drinking-Water/DWS/Per--and-Polyfluoroalkyl-Substances

PFHpA	
Maine	
DEP 2020	
Standard / Guidance	RAG
Media Type	DW
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
HED/UFT= Reference Dose (mg/kg-day)	Based on EPA Health Advisories.
Receptor	Child (0-6 years) residential, non-cancer
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	sum of all PFAS exceeds 0.4 ug/L or 400 PPT
Additional Information	
Reference	https://www.maine.gov/pfastaskforce/materials/report/PFAS-Task-Force-Report-FINAL-Jan2020.pdf

PFHpA	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFHpA	
Vermont	
Department of Environmental Conservation / Department of Environmental Quality 2018	
Standard / Guidance	Maximum Allowable Concentration
Media Type	Ground Water and Drinking Water
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD	Based on EPA Health Advisories.
POD x DAF = HED	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	Based on EPA Health Advisories.
Animal to Human (UFA)	Based on EPA Health Advisories.
Subchronic to Chronic (UFS)	Based on EPA Health Advisories.
LOAEL to NOAEL (UFL)	Based on EPA Health Advisories.
Database (UFD)	Based on EPA Health Advisories.
Total Composite (UFT)	Based on EPA Health Advisories.
Toxicity Value RfD (mg/kg-day)	0.000021 (2.1 x 10-5)
Receptor	Infant less than a year
Exposure	
Ingestion Rate (L/day)	
Body Weight (Kg)	
Normalized Drinking Water Intake (L/kg/day)	0.175
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.020 ug/mL or 20 PPT applied individually to PFOA, PFOS, PFHxS, PFHpA and PFNA and their sum
Additional Information	The 95th percentile Body Weight Adjusted Water Intake Rate for the first year of life based on combined direct and indirect water intake from community water supplies for consumers only is 0.175 L/kgBW-d.
Reference	Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances) July 2018 https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_DW_PFAS_HealthAdvisory.pdf

PFDA

PFDA	
Massachusetts	
DEP 2019	
Standard / Guidance	MCL
Media Type	DW
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Key Study Information	
Critical Effect Key Study Reference	Based on EPA Health Advisories.
Species	Based on EPA Health Advisories.
Study Exposure Duration (days)	Based on EPA Health Advisories.
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Based on EPA Health Advisories.
Method to Derive Human Equivalent Dose	Based on EPA Health Advisories.
Dose-Response	
Dose Response Modeling Method	Based on EPA Health Advisories.
POD HED Units	Based on EPA Health Advisories.
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	10
Database (UFD)	1
Total Composite (UFT)	300 x 3 = 900
HED/UFT= Reference Dose (mg/kg-day)	5×10^{-6} (mg/kg-day)
Receptor	pregnant women, nursing mothers and infants
Exposure	
Ingestion Rate (L/day)	Based on EPA Health Advisories.
Body Weight (Kg)	Based on EPA Health Advisories.
Normalized Drinking Water Intake (L/kg/day)	Based on EPA Health Advisories.
Relative Source Contribution	Based on EPA Health Advisories.
Threshold Level (ug/L) or (PPT)	0.020 ug/L or 20 PPT total PFOA + PFOS + PFNA + PFHxS + PFHpA + PFDA
Additional Information	
Reference	https://www.mass.gov/doc/310-cmr-2200-pfas-amendments/download

PFBS

PFBS	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.420 ug/L or 420 PPT
Key Study Information	
Critical Effect Key Study Reference	decreased serum total thyroxine (T4) in newborn (PND 1) mice as this was protective of kidney effects as well Feng, X; Cao, X; Zhao, S; Wang, X; Hua, X; Chen, L; Chen, L. (2017). Exposure of pregnant mice to perfluorobutanesulfonate causes hypothyroxinemia and developmental abnormalities in female offspring. Toxicol Sci 155: 409-419. decreased serum total thyroxine (T_4) in newborn (PND 1) mice
Species	PND1 Newborn mice
Study Exposure Duration (days)	20 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	The USEPA PODHED of 4.2 was divided by 0.149 (USEPA example DAF) to obtain a BMDL20 of 28.19 mg/kg/day.
Method to Derive Human Equivalent Dose	The BMDL20 of 28.19 mg/kg/day was divided by the Dose Adjustment Factor of 316 (human serum half-life/female mouse serum half-life = 665 hours/2.1 hours = 316)
Dose-Response	
Dose Response Modeling Method	BMDL20
POD HED Units	28.19 mg/kg/day (BMDL20) for decreased serum total T4 in newborn (PND 1) mice
POD x DAF = HED	HED = 0.0892 mg/kg/day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	300 ng/kg/day (0.0003 mg/kg/day)
Receptor	infant
Exposure	
Ingestion Rate (L/day)	95^{th} percentile of water intake for consumers only (direct and indirect consumption) for infants (birth to <1 year old) of 1.106 L/day, per Table 3-1, USEPA Exposure Factors Handbook, 2019.
Body Weight (Kg)	An infant body weight of 7.8 kilograms was used and represents a time-weighted average for birth to 1 year old (Table 8-1, USEPA 2011).
Normalized Drinking Water Intake (L/kg-day)	0.142
Relative Source Contribution	20%
Threshold value	0.420 ug/L or 420 PPT
Additional information	As insufficient human serum data was available to assess the population's exposure to PFBS from sources other than drinking water, a default Relative Source Contribution of 20% was selected consistent with USEPA (2000) guidance
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

PFHxA

PFHxA	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	400 ug/L or 400,000 PPT
Key Study Information	
Critical Effect Key Study Reference	Critical effect renal tubular degeneration and renal papillary necrosis in female rats Klaunig, J.E., Shinohara, M., Iwai, H., Chengelis, C.P., Kirkpatrick, J.B., Wang, Z., Bruner, R.H., 2015. Evaluation of the chronic toxicity and carcinogenicity of perfluorohexanoic acid (PFHxA) in Sprague-Dawley rats. Toxicol. Pathol. 43 (2), 209–220. Luz, AL, Anderson, JK, Goodrum, P, Durda, J. (2019) Perfluorohexanoic acid toxicity, part I: Development of chronic human health toxicity value for use in risk assessment. Reg. Toxicol. Pharmacol. 103: 41-55.
Species	male and female Crl:CD rats
Study Exposure Duration (days)	104 weeks
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	BMDL10 = 90.4 mg/kg/day (Luz et al., 2019)
Method to Derive Human Equivalent Dose	BMD was adjusted by (80kg/0.45 kg)¼ = 3.65. The resulting PODHED (90.4 mg/kg/day divided by 3.65) = 24.8 mg/kg/day. (Luz et al., 2019)
Dose-Response	
Dose Response Modeling Method	BMDL10
POD HED Units	90.4 mg/kg/day (Luz et al., 2019).
POD x DAF = HED	HED 24.8 mg/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	1
LOAEL to NOAEL (UFL)	1
Database (UFD)	10
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	83,000 ng/kg/day (8.3 mg/kg/day)
Receptor	adult
Exposure	
Ingestion Rate (L/day)	95th percentile of water intake for consumers only (direct and indirect consumption) for adults > 21 years old 3.353 L/day
Body Weight (Kg)	80 kg
Normalized Drinking Water Intake (L/kg-day)	
Relative Source Contribution	20%
Additional Information	0.420 ug/L or 420 PPT
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

GenX

GenX	
Michigan	
Michigan Science Advisory Group 2019	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.370 ug/L or 370 PPT
Key Study Information	
Critical Effect Key Study Reference	Oral (Gavage) Reproduction/ Developmental Toxicity Study in Mice (OECD TG 421; modified according to the Consent Order) DuPont18405-1037 (2010) (also contains 90-day toxicity study information and outcomes - that information is not described here) (Adopted draft USEPA 2018 over North Caroline 2017)
Species	Crl:CD1(ICR) mice
Study Exposure Duration (days)	40 days
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	A candidate POD HED was derived from the BMDL10 for liver effects using a BW3/4 allometric scaling approach.
Method to Derive Human Equivalent Dose	DAF for the allometric scaling of doses from mice to humans is 0.15. Using the BMDL10 of 0.15 mg/kg/day to complete the calculation results in a PODHED for single-cell necrosis of the liver from DuPont18405-1037 (2010) of 0.023 mg/kg/day (USEPA 2018).
Dose-Response	
Dose Response Modeling Method	BMDL10
POD HED Units	
POD x DAF = HED	HED 24.8 mg/kg/d
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	3
Subchronic to Chronic (UFS)	3
LOAEL to NOAEL (UFL)	1
Database (UFD)	3
Total Composite (UFT)	300
HED/UFT= Reference Dose (mg/kg-day)	77 ng/kg/day (7.7 x10-5 mg/kg/day)
Receptor	adult
Exposure	
Ingestion Rate (L/day)	95th percentile of water intake for consumers only (direct and indirect consumption) for adults > 21 years old 3.353 L/day
Body Weight (Kg)	80 kg
Normalized Drinking Water Intake (L/kg-day)	
Relative Source Contribution	20%
Threshold value	0.370 ug/L or 370 PPT
Additional Information	Workgroup decided that the drinking water HBV below based on liver effects would be sufficiently conservative to be protective of infant exposure.
Reference	https://www.michigan.gov/documents/pfasresponse/Health-Based_Drinking_Water_Value_Recommendations_for_PFAS_in_Michigan_Report_659258_7.pdf

GenX	
North Carolina	
Standard / Guidance	Health Based Values
Media Type	Drinking Water
Threshold Level (ug/L) or (PPT)	0.140 ug/L or 140 PPT
Key Study Information	
Critical Effect Key Study Reference	liver toxicity endpoints from two sub-chronic studies provided by Chemours/DuPont during the U.S. EPA Toxic Substances Control Act
Species	mice
Study Exposure Duration (days)	mice (28-day study and a reproductive screen)
Kinetics	
Method of Administered Dose conversion to Internal Serum Level	Used UF adjustment
Method to Derive Human Equivalent Dose	Used UF adjustment
Dose-Response	
Dose Response Modeling Method	NOAEL
POD HED Units	0.1 mg/kg-day
POD x DAF = HED	0.1 mg/kg-day
Uncertainty Extrapolation	
Human Variability (UFH)	10
Animal to Human (UFA)	10
Subchronic to Chronic (UFS)	10
LOAEL to NOAEL (UFL)	1
Database (UFD)	1
Total Composite (UFT)	1000
HED/UFT= Reference Dose (mg/kg-day)	0.0001 mg/kg-day
Receptor	Bottle fed infant
Exposure	
Ingestion Rate (L/day)	1.1 liters per day = Intake rate of drinking water for a bottle-fed infant, 1.1 liters per day
Body Weight (Kg)	7.8 kg BW infant
Normalized Drinking Water Intake (L/kg-day)	
Relative Source Contribution	20%
Threshold Level (ug/L) or (PPT)	0.140 ug/L or 140 PPT
Additional Information	BMD modeling performed and determined to be statistically unreliable due to poor model fit and large confidence interval
Reference	https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/DEMLR/SAB-GenX-Report-FINAL-Appendices-10-30-2018.pdfdf

Appendix A: Abbreviations and Acronyms

Regulatory Agency
CDC = Center for Disease Control & Prevention
CEQ = Commission on Environmental Quality
DEC = Dept. of Environmental Conservation
DENR = Dept. of Environment and Natural Resources
DEP = Dept. of Environmental Protection
DEQ = Dept. of Environmental Quality
DES = Dept. of Environmental Services
DOH = Dept. of Health
DNR = Dept. of Natural Resources
DPH = Division of Public Health
EPA = Environmental Protection Agency

Standard or Guidance
AGQS = ambient groundwater quality standard
BCL = basic comparison level
CL = groundwater cleanup level
ES = environmental standard
GCC = Generic Cleanup Criteria (Part 201)
HA = lifetime health advisory
HNV = human non-cancer value for surface drinking water
HRL = health risk limit
ILR = initiation level
IMAC = interim maximum allowable standard
ISGWQC = interim specific groundwater quality criterion
MAC = maximum allowable concentration
MCL = maximum contaminant level
MEG = maximum exposure guideline
PCL = protective concentration level
PGWES = primary groundwater enforcement standard
PHG = public health goal
RAG = remedial action guideline
RL = reporting level

RSL = regional screening level (calculated)
Type of Medium
DW = drinking water
GW = groundwater
SW = surface water and/or effluent