

MassDEP (December 26, 2019) *Technical Support Document, Per- and Polyfluoroalkyl Substances (PFAS): An Updated Subgroup Approach to Groundwater and Drinking Water Values*. Massachusetts Department of Environmental Protection, Boston, MA.

MassDEP (January 27, 2020) *Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water: Questions and Answers for Consumers*. Massachusetts Department of Environmental Protection, Drinking Water Program, Boston, MA.

Michigan

MDHHS (February 22, 2019) *Public health drinking water screening levels for PFAS*. Michigan Department of Health and Human Services, Division of Environmental Health, Michigan PFAS Action Response Team Human Health Workgroup.

Michigan Science Advisory Workgroup (June 27, 2019) *Health-based Drinking Water Value Recommendations for PFAS in Michigan*.

Minnesota

MDOH (August 2018) *Toxicological Summary for Perfluorooctanoate*. Minnesota Department of Health, Health Based Guidance for Water, Health Risk Assessment Unit, Environmental Health Division.

MDOH (April 2019) *Toxicological Summary for Perfluorooctane sulfonate*. Minnesota Department of Health, Health Based Guidance for Water, Health Risk Assessment Unit, Environmental Health Division.

MDOH (April 2019) *Toxicological Summary for Perfluorohexane sulfonate*. Minnesota Department of Health, Health Based Guidance for Water, Health Risk Assessment Unit, Environmental Health Division.

Nevada

NDEP (July, 2017) *User's Guide and Background Technical Document for the Nevada Division of Environmental Protection (NDEP). Basic Comparison Levels (BCLs) for Human Health for the BMI Complex and Common Areas*. Nevada Division of Environmental Protection, Bureau of Corrective Action, Special Projects Branch, Las Vegas, NV

New Hampshire

NHDES (June 28, 2019) *Rules related to per- and polyfluoroalkyl substances (PFAS)*. New Hampshire Department of Environmental Services, Concord, NH.

NDES (June 1, 2019) *Technical Background for the June 2019 Proposed Maximum Contaminant Levels (MCLs) for Perfluorooctanoate (PFOA), Perfluorooctane sulfonate (PFOS), Perfluorononanoate (PFNA) and Pefluorohexane sulfonate (PFHxS)*. New Hampshire Department of Environmental Services, Concord, NH.

New Jersey

New Jersey Drinking Water Quality Institute (March 15, 2017) *Maximum Contaminant Level Recommendation for Perfluorooctanoic Acid in Drinking Water, Basis and Background*. New Jersey Drinking Water Quality Institute.

New Jersey Drinking Water Quality Institute (June 8, 2018) *Maximum Contaminant Level Recommendation for Perfluorooctane Sulfonate in Drinking Water, Basis and Background*. New Jersey Drinking Water Quality Institute.

New York

NYDOH (December 18, 2018) *Drinking Water Quality Council Meeting, December 18, 2018*. New York State Department of Health.
<https://totalwebcasting.com/view/?func=VOFF&id=nysdoh&date=2018-12-18&seq=1>

North Carolina

NCDEQ (August 2018) *Secretaries' Science Advisory Board Review of the North Carolina Drinking Water Provisional Health Goal for GenX*. North Carolina Department of Environmental Quality and North Carolina Department of Health and Human Services.

Ohio

Ohio EPA (December 2019) *Ohio Per- and Polyfluoroalkyl Substances (PFAS) Action Plan for Drinking Water*. Ohio Environmental Protection Agency and the Ohio Department of Health.

Vermont

VDOH (July 10, 2018) *Drinking Water Health Advisory for Five PFAS (per- and polyfluorinated alkyl substances)*. State of Vermont, Department of Health, Agency of Human Services.

Washington

WDOH (November, 2019) *Draft Recommended State Action Levels for Per- and Polyfluoroalkyl Substances (PFAS) in Drinking Water: Approach, Methods, and Supporting Information*. Washington Department of Health, Office of Environmental Public Health Services.

Wisconsin

WDOH (June 2019) *Perfluorooctanoic acid (PFOA), 2019 Cycle 10*. Wisconsin Department of Health Services.

Table 1. States that Use the EPA HALs for PFOA and PFOS*

State	Comment
Alaska	
Colorado	
Connecticut	Drinking Water Action Level is based upon the EPA HAL expanded to include the sum of PFOA, PFOS, PFNA, PFHxS, PFHpA.
Delaware	
Florida	Florida did not adopt the EPA HALs, but developed numbers that are numerically the same using the EPA reference doses for PFOA and PFOS
Maine	Remedial Action Guidelines listed as 0.4 µg/L for PFOA and PFOS in residential water, but recommends "that the EPA health advisory level be applied at sites where groundwater is currently being used, or may be used in the future, for human consumption."
Montana	
Ohio	

* 70 ng/L for PFOA, PFOS, and PFOA + PFOS

Table 2. ATSDR and State PFAS Drinking Water Criteria Not Based Upon USEPA HALs.

	PFOA	PFOS	PFNA	PFHxS	PFHpA	PFDA	PFBA	PFHxA	PFBS	GenX
ATSDR, adult	78	52	78	517						
child	21	14	21	140						
California ^b	5.1	6.5								
Florida	70	70								
Illinois ^c	21	14	21	140					140,000	
Massachusetts	20 ^a	20 ^a	20 ^a	20 ^a	20 ^a	20 ^a			2000	
Michigan	8	51	9	84				400,000	1000	370
Minnesota	35	15		47			7		2000	
Nevada	667	667							667,000	
New Hampshire	12	15	11	18						
New Jersey	14	13	13							
New York ^{c,d}	10	10								
North Carolina										140
Ohio			21	140					140,000	700
Vermont	20 ^a	20 ^a	20 ^a	20 ^a	20 ^a					
Washington ^c	10	15	14	70					1300	
Wisconsin	20 ^a	20 ^a								

All concentrations in ng/L

^a individually and as the sum of listed PFAS;

^b numbers listed are management values based upon detection limit. Non-cancer risk-based values for PFOA and PFOS are 2 and 7 ng/L and cancer risk-based values are 0.1 and 0.4 ng/L, respectively.

^c proposed

^d management values

Table 3. Critical Effects Used to Derive PFOA Reference Doses

	Critical Effect	Study
USEPA	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006
ATSDR	Neurodevelopmental and skeletal effects in mice	Koskela et al. 2016 Onishchenko et al. 2011
California	Increased oxidative DNA damage, changes in mitochondrial membrane potential, and increased biomarkers of apoptosis in the liver of female mice	Li et al., 2017
Florida*	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006
Massachusetts	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006
Michigan	Neurodevelopmental and skeletal effects in mice	Koskela et al. 2016 Onishchenko et al. 2011
Minnesota	Reduced ossification, accelerated puberty, trend for decreased pup body weight, increased maternal liver weight in mice	Lau et al. 2006
Nevada	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006
New Hampshire	Altered liver function	Loveless et al., 2006
New Jersey	Altered liver function	Loveless et al., 2006
Vermont	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006
Washington	Neurodevelopmental and skeletal effects in mice	Koskela et al. 2016 Onishchenko et al. 2011
Wisconsin	Reduced ossification of phalanges and accelerated puberty in mice	Lau et al. 2006

* Florida did not select this effect independently, but used the EPA reference dose that is based upon this critical effect.

Table 4. PFOA Reference Doses

	POD HED (mg/kg-d)	NOAEL/LOAEL	UF _H	UF _A	UF _S	UF _L	UF _D	Total UF	MF	RfD* (ng/kg-d)
USEPA	0.0053	LOAEL	10	3	1	10	1	300	--	20
ATSDR	0.000821	LOAEL	10	3	1	10	1	300	--	3
California	0.00014	LOAEL	10	3	1	3	3	300	--	0.45
Florida**	0.0053	LOAEL	10	3	1	10	1	300	--	20
Massachusetts	0.0053	LOAEL	10	3	1	10	3	1000	--	5.3
Michigan	0.001163	LOAEL	10	3	1	3	3	300	--	4
Minnesota	0.0053	LOAEL	10	3	1	3	3	300	--	18
Nevada	0.0053	LOAEL	10	3	1	10	1	300	--	20
New Hampshire	0.00061	NOAEL	10	3	1		3	100	--	6.1
New Jersey	0.00061	NOAEL	10	3	1	1	10	300	--	2
Vermont	0.0053	LOAEL	10	3	1	10	1	300	--	20
Washington	0.000821	LOAEL	10	3	1	1	1	300	--	3
Wisconsin	0.00054	LOAEL	10	3	1	10	1	300	--	2

POD = Point of Departure; HED = Human Equivalent Dose; NOAEL = no observable adverse effect level; LOAEL = lowest observable adverse effect level; UF_H = human variability uncertainty factor; UF_A = interspecies differences uncertainty factor; UF_S = duration of exposure uncertainty factor; UF_L = LOAEL to NOAEL uncertainty factor; UF_D = database uncertainty factor; MF = Modifying Factor

* ATSDR value is termed Minimal Risk Level, or MRL.

** Florida did not select these inputs independently, but used the EPA reference dose that is based upon these values.

Table 5. PFOA Exposure Assumptions

	Receptor	Ingest. Rate (L/d)	Body Wt. (kg)	Normalized Intake (L/kg-d)	RSC	Calculated Limit (ng/L)
USEPA	Lactating woman	--	--	0.054	0.2	70
ATSDR	Adult	3.092	80	--	1	78
	Child (0-1 yr)	1.113	7.8	--	1	21
California	Lifetime	--	--	0.053	0.2	2
Florida	Lactating woman	--	--	0.054	0.2	70
Massachusetts	Lactating woman	--	--	0.054	0.2	20
Michigan	Lifetime beginning at birth	Minnesota model			0.5	8
Minnesota	Lifetime beginning a birth	Modeled intake through breastmilk for 1 year followed by continuous direct exposure at 95 th percentile rate			0.5	35
Nevada*	Adult	2.5	70	--	1	667
New Hampshire	Lifetime beginning a birth	Minnesota model			0.5	12
New Jersey	Adult	2	70	--	0.2	14
Vermont	Infant (0- 1 yr)			0.175	0.2	20
Washington	Lifetime beginning a birth	Minnesota model			0.5	10
Wisconsin	Young child	1	10	--	1	20

* Nevada tap water formula is based on 26 years of exposure at 350 days per year, and includes an inhalation component

Table 6. Critical Effects Used to Derive PFOS Reference Doses

	Critical Effect	Study
USEPA	Reduced rat pup body weight	Luebker et al., 2005
ATSDR	Delayed eye opening and decreased rat pup weight	Luebker et al., 2005
California	Decreased plaque forming cell response	Dong et al., 2009
Florida*	Reduced rat pup body weight	Luebker et al., 2005
Massachusetts	Reduced rat pup body weight	Luebker et al., 2005
Michigan	Delayed eye opening and decreased rat pup weight	Luebker et al., 2005
Minnesota	Suppressed immune response in mice	Dong et al. 2011
Nevada	Reduced rat pup body weight	Luebker et al., 2005
New Hampshire	Suppressed immune response in mice	Dong et al. 2011
New Jersey	Suppressed immune response in mice	Dong et al., 2009
Vermont	Reduced rat pup body weight	Luebker et al., 2005
Washington	Suppressed immune response in mice	Dong et al. 2011
Wisconsin	Delayed eye opening and decreased rat pup weight	Luebker et al., 2005

* Florida did not select this effect independently, but used the EPA reference dose that is based upon this critical effect.

Table 7. PFOS Reference Doses

	POD HED (mg/kg-d)	NOAEL/LOAEL	UF _H	UF _A	UF _S	UF _L	UF _D	Total UF	MF	RfD* (ng/kg-d)
USEPA	0.00051	NOAEL	10	3	1	1	1	30	--	20
ATSDR	0.000515	NOAEL	10	3	1	1	1	30	10	2
California	0.0000546	NOAEL	10	3	1	1	1	30	--	1.8
Florida**	0.00051	NOAEL	10	3	1	1	1	30	--	20
Massachusetts	0.00051	NOAEL	10	3	1	1	1	100	--	5.1
Michigan	0.0000866	NOAEL	10	3	1	1	1	30	--	2.89
Minnesota	0.000307	NOAEL	10	3	1	1	3	100	--	3.1
Nevada	0.00051	NOAEL	10	3	1	1	1	30	--	20
New Hampshire	0.000302	NOAEL	10	3	1	1	3	100	--	3.0
New Jersey	0.000055	NOAEL	10	3	1	1	1	30	--	1.8
Vermont	0.00051	NOAEL	10	3	1	10	1	30	--	20
Washington	0.000302	NOAEL	10	3	1	1	3	100	--	3.0
Wisconsin	0.000515	NOAEL	10	3	1	1	1	30	10	2

POD = Point of Departure; HED = Human Equivalent Dose; NOAEL = no observable adverse effect level; LOAEL = lowest observable adverse effect level; UF_H = human variability uncertainty factor; UF_A = interspecies differences uncertainty factor; UF_S = duration of exposure uncertainty factor; UF_L = LOAEL to NOAEL uncertainty factor; UF_D = database uncertainty factor; MF = Modifying Factor

* ATSDR value is termed Minimal Risk Level, or MRL.

** Florida did not select these inputs independently, but used the EPA reference dose that is based upon these values.

Table 8. PFOS Exposure Assumptions

	Receptor	Ingest. Rate (L/d)	Body Wt. (kg)	Normalized Intake (L/kg-d)	RSC	Calculated Limit (ng/L)
USEPA	Lactating woman	--	--	0.054	0.2	70
ATSDR	Adult	3.092	80	--	1	52
	Child (0-1 yr)	1.113	7.8	--	1	14
California	Lifetime	--	--	0.053	0.2	7
Florida	Lactating woman	---	--	0.054	0.2	70
Massachusetts	Lactating woman	--	--	0.054	0.2	20
Michigan	Lifetime beginning a birth	Minnesota model			0.5	51
Minnesota	Lifetime beginning a birth	Modeled intake through breastmilk for 1 year followed by continuous direct exposure at 95 th percentile rate			0.5 infants and young children 0.2 older age groups	15
Nevada*	Adult	2.5	70	--	1	667
New Hampshire	Lifetime beginning a birth	Minnesota model			0.5	15
New Jersey	Adult	2	70	--	0.2	13
Vermont	Infant (0- 1 yr)			0.175	0.2	20
Washington	Lifetime beginning a birth	Minnesota model			0.5 infants and children 0.2 adults	15
Wisconsin	Young child	1	10		1	20

* Nevada tap water formula is based on 26 years of exposure at 350 days per year, and includes an inhalation component

Table 9. Critical Effects Used to Derive PFNA Reference Doses

	Critical Effect	Study
ATSDR	Reduced pup weight and developmental delays in mice.	Das et al., 2015
Florida	Not Applicable*	
Michigan	Reduced pup weight and developmental delays in mice.	Das et al., 2015
New Hampshire	Increased liver weight in pups with prenatal exposure	Das et al., 2015
New Jersey	Increased liver weight in pups with prenatal exposure	Das et al., 2015
Washington	Reduced pup weight and developmental delays in mice	Das et al., 2015

* Florida does not have a groundwater screening level for PFNA.

Table 10. PFNA Reference Doses

	POD HED (mg/kg-d)	Threshold	UF _H	UF _A	UF _S	UF _L	UF _D	Total UF	MF	RfD* (ng/kg-d)
ATSDR	0.001	NOAEL	10	3	1	1	10	300	--	3
Florida**	NA	NA	NA	NA	NA	NA	NA	NA		NA
Michigan	0.000665	NOAEL	10	3	1	1	1	300	--	2.2
New Hampshire	0.00043	BMDL ₁₀	10	3	1	1	3	100	--	4.3
New Jersey	0.00074	BMDL ₁₀	10	3	10	1	3	1000	--	0.74
Washington	0.001	NOAEL	10	3	1	1	10	300	--	3

POD = Point of Departure; HED = Human Equivalent Dose; NOAEL = no observable adverse effect level; LOAEL = lowest observable adverse effect level; UF_H = human variability uncertainty factor; UF_A = interspecies differences uncertainty factor; UF_S = duration of exposure uncertainty factor; UF_L = LOAEL to NOAEL uncertainty factor; UF_D = database uncertainty factor; MF = Modifying Factor; NA = Not applicable

* ATSDR value is termed Minimal Risk Level, or MRL.

* Florida does not have a groundwater screening level for PFNA.

Table 11. PFNA Exposure Assumptions

	Receptor	Ingest. Rate (L/d)	Body Wt. (kg)	Normalized Intake (L/kg-d)	RSC	Calculated Limit (ng/L)
ATSDR	Adult	3.092	80	--	1	78
	Child (0-1 yr)	1.113	7.8	--	1	21
Florida*	NA	NA			NA	NA
Michigan	Lifetime beginning at birth	Minnesota model			0.5	9
New Hampshire	Lifetime beginning a birth	Minnesota model			0.5	11
New Jersey	Adult	2	70	--	0.5	13
Washington	Lifetime beginning a birth	Minnesota model			0.5	14

NA = Not applicable

* Florida does not have a groundwater screening level for PFNA.

Table 12. Critical Effects Used to Derive PFHxS Reference Doses

	Critical Effect	Study
ATSDR	Thyroid follicular cell hypertrophy and hyperplasia in rats	Butenhoff et al. 2009; Hoberman and York, 2003
Florida	Not applicable*	
Michigan	Thyroid follicular cell hypertrophy and hyperplasia, and increased liver weight and centrilobular hepatocellular hypertrophy in rats	Butenhoff et al. 2009; Hoberman and York, 2003
Minnesota	Reduced serum thyroxine in rats	NTP, 2018
New Hampshire	Decreased litter size and reproductive toxicity in mice	Chang et al., 2018
Washington	Reduced serum thyroxine in rats	NTP, 2018

* Florida does not have a groundwater screening level for PFHxS.

Table 13. PFHxS Reference Doses

	POD HED (mg/kg-d)	Threshold	UF _H	UF _A	UF _S	UF _L	UF _D	Total UF	MF	RfD* (ng/kg-d)
ATSDR	0.0047	NOAEL	10	3	1	1	10	300	--	20
Florida**	NA	NA	NA	NA	NA	NA	NA	NA		NA
Michigan	0.00292	BMDL ₂₀	10	3	1	1	1	300	--	9.7
Minnesota	0.00292	BMDL ₂₀	10	3	1	1	10	300	--	9.7
New Hampshire	0.0012	BMDL	10	3	3	1	3	300	--	4
Washington	0.00292	BMDL ₂₀	10	3	1	1	10	300	--	9.7

POD = Point of Departure; HED = Human Equivalent Dose; NOAEL = no observable adverse effect level; LOAEL = lowest observable adverse effect level; UF_H = human variability uncertainty factor; UF_A = interspecies differences uncertainty factor; UF_S = duration of exposure uncertainty factor; UF_L = LOAEL to NOAEL uncertainty factor; UF_D = database uncertainty factor; MF = Modifying Factor; NA = not applicable

* ATSDR value is termed Minimal Risk Level, or MRL.

** Florida does not have a groundwater screening level for PFHxS.

Table 14. PFHxS Exposure Assumptions

	Receptor	Ingest. Rate (L/d)	Body Wt. (kg)	Normalized Intake (L/kg-d)	RSC	Calculated Limit (ng/L)
ATSDR	Adult	3.092	80	--	1	517
	Child (0-1 yr)	1.113	7.8	--	1	140
Florida*	NA	NA			NA	NA
Michigan	Lifetime beginning a birth	Minnesota model			0.5	84
Minnesota	Lifetime beginning a birth	Modeled intake through breastmilk for 1 year followed by continuous direct exposure at 95 th percentile rate			0.5	47
New Hampshire	Lifetime beginning a birth	Minnesota model			0.5	18
Washington	Lifetime beginning a birth	Minnesota model			0.5	70

NA = Not applicable

* Florida does not have a groundwater screening level for PFHxS.

Table 15. Critical Effects Used to Derive PFBS Reference Doses

	Critical Effect	Study
EPA	Reduction in thyroid hormones in newborn offspring of mice dosed during pregnancy.	Feng et al., 2017
Florida	Not applicable*	
Michigan	Increased incidence of kidney hyperplasia in rats.	Lieder et al., 2009b
Minnesota	Hyperplasia in kidney in parent and offspring in 2-gen study in rats	Lieder et al., 2009a
Nevada	Increased incidence of kidney hyperplasia	Lieder et al., 2009b
Washington	Reduction in thyroid hormones in newborn offspring of mice dosed during pregnancy.	Feng et al., 2017

* Florida does not have a groundwater screening level for PFBS.

Table 16. PFBS Reference Doses

	POD HED (mg/kg-d)	Threshold	UF _H	UF _A	UF _S	UF _L	UF _D	Total UF	MF	RfD (ng/kg-d)
EPA	4.2	BMDL ₂₀	10	3	1	1	10	300	--	10,000
Florida*	NA	NA	NA	NA	NA	NA	NA	NA		NA
Michigan	0.225	BMDL ₁₀	10	3	10	1	3	1000	--	230
Minnesota	0.129	BMDL ₁₀	10	3	3	1	3	300	--	430
Nevada**	18.9	BMDL ₁₀	10	3	10	1	3	1000	--	20,000
Washington	0.089	BMDL ₂₀	10	3	1	1	10	300	--	300

POD = Point of Departure; HED = Human Equivalent Dose; NOAEL = no observable adverse effect level; LOAEL = lowest observable adverse effect level; UF_H = human variability uncertainty factor; UF_A = interspecies differences uncertainty factor; UF_S = duration of exposure uncertainty factor; UF_L = LOAEL to NOAEL uncertainty factor; UF_D = database uncertainty factor; MF = Modifying Factor; NA = not applicable

* Florida does not have a groundwater screening level for PFBS.

** based upon EPA PPRTV value from 2014.

Table 17. PFBS Exposure Assumptions

	Receptor	Ingest. Rate (L/d)	Body Wt. (kg)	Normalized Intake (L/kg-d)	RSC	Calculated Limit (ng/L)
Florida*	NA	NA	NA	NA		NA
Michigan	Lifetime beginning at infancy	--	--	0.044	0.2	1000
Minnesota	Lifetime beginning at infancy	--	--	0.044	0.2	2000
Nevada	Adult	2.5	70	--	1	667,000
Washington	Lactating women	--	--	0.047	0.2	1300

NA = Not applicable

* Florida does not have a groundwater screening level for PFBS.