

MassDEP PFAS Drinking Water Standards

Town of Wayland

June 14, 2021

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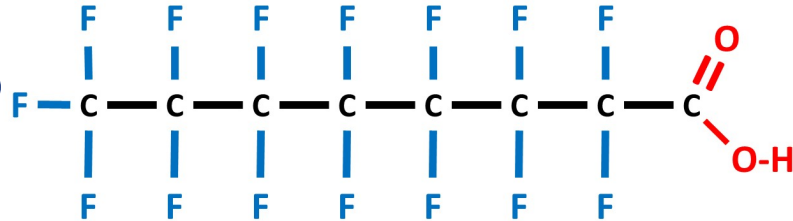
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What Are PFAS?



Poly- and perfluoroalkyl Substances

A family of thousand of compounds with varying structure

(e.g, carbon chain length)

- **Extremely stable** – Heat & Stain Resistant, Water repellent
- **“Forever chemicals”** - Very persistent, do not biodegrade
- **Water Soluble**
- **Some are very toxic**
 - Slowly excreted from the body – half lives of years (1-8+ for longer-chain)
 - Developmental risks to fetus/infants
 - Endocrine disruption, effects on immune system
 - Possibly cancers (kidney, teste, pancreas, liver)



Common Uses of PFAS Since the 1950s

- Textile treatments: stain resistance/ water repellency
- Paper coatings: grease resistant
- “Waxes”: some floor, car, ski
- “Waterproof” down
- Manufacturing
- Aqueous Film-Forming Foam (AFFF)



Most Americans are exposed to some levels of PFAS through use of consumer products

What Are Exposures of Concern for PFAS?

Sensitive groups

- *Pregnant women, nursing mothers and infants*
 - *Immunocompromised*
-

Water uses that pose (relatively) less concern include:

- Water use by someone not considered in a “sensitive group”
- Non-residential water use – *restaurants, workplace*
- Water use for other purposes – *bathing, washing vegetables*

Ways people may reduce potential exposure:

- Drink and cook with bottled water
- Use a home water treatment system (NSF certification not yet available)



WHAT IS MASSDEP DOING ABOUT PFAS?

Developed Drinking
Water and Cleanup
Standards

Technical Assistance,
Education, Outreach,
Coordination,
Learning, Training

Firefighting Foam
Take-Back Program

Working to Identify
Sources & Releases
to the Environment

Sampling & Analyses
for Public Water
Systems and Private
Wells





BASIS OF MASSDEP DRINKING WATER VALUES FOR SIX PFAS




MassDEP Approach

- Addressed as a subclass
- Basis of selection?
 - Considered EPA Method 537.1 analytes (14) – Drinking water data available
 - Focused on longer-chain PFAS
 - More toxic and persistent in human body
 - Subclass with very similar chemical structures
 - +/- 2 carbons from PFOS/PFOA
 - Same functional groups
 - PFOA and PFOS as surrogates: best studied
 - 7 compounds in subgroup: PFNA; PFHxS; PFHpA; PFHxA; PFDA; PFOS; PFOA
 - PFHxA (C6) much less toxic/shorter half life
 - Final subclass includes the remaining 6 compounds



FINAL SUBCLASS OF LONGER CHAIN PFAS REGULATED BY MASSDEP



# Carbons	EPA Method 537 Analytes	
4	PFBS	Perfluorobutanesulfonic acid
6	PFHxA	Perfluorohexanoic acid
6	PFHxS	Perfluorohexanesulfonic acid
7	PFHpA	Perfluoroheptanoic acid
8	PFOA	Perfluorooctanoic acid
8	PFOS	Perfluorooctanesulfonic acid
9	PFNA	Perfluorononanoic acid
10	PFDA	Perfluorodecanoic acid
11	NMeFOSAA	2-(N-Methylperfluorooctanesulfonamido)acetic acid
11	PFUnA	Perfluoroundecanoic acid
12	NEtFOSAA	2-(N-Ethylperfluorooctanesulfonamido)acetic acid
12	PFDoA	Perfluorododecanoic acid
13	PFTTrDA	Perfluorotridecanoic acid
14	PFTA	Perfluorotetradecanoic acid



BASIS OF DRINKING WATER VALUES

Animal Toxicology
Human Epidemiology

TOXICITY
INFORMATION

-> Review studies
-> Evaluate dose-response info
-> Identify study with relevant effect at lowest doses:
Point of Departure (POD)
-> Extrapolate to human equivalent dose
-> Account for limitations with uncertainty factors
= Toxicity value – daily acceptable dose mg per kg
body weight per day (mg/kg bw/day) **Reference
Dose (RfD)**

TOXICITY
VALUES

Apply exposure parameters considering:
-> Sensitive population's water consumption
-> Potential for other sources of exposure
= health-based guideline

DW CONC.



DERIVATION OF MA PFAS STANDARDS FOR DRINKING WATER

- MOST ELEMENTS CONSISTENT WITH USEPA PFOA/PFOS DRINKING WATER HEALTH ADVISORIES
- THESE INCLUDE:
 - EXPOSURE PARAMETERS – NURSING MOTHER
 - RELATIVE SOURCE CONTRIBUTION FACTOR – 20%
 - ACCOUNTS FOR OTHER EXPOSURES
 - SUMMING CONCENTRATIONS ACROSS CATEGORY



MASSDEP TOOK MORE HEALTH PROTECTIVE APPROACH VS. USEPA

- REVISED RFD FOR PFOA AND PFOS
 - LOWER (MORE TOXIC) VS. EPA VALUE
- ADDED FOUR ADDITIONAL CLOSELY RELATED PFAS
 - PFOA/PFOS USED AS SURROGATES BASED ON SIMILARITIES IN CHEMICAL STRUCTURES; HALF LIVES; AND EFFECTS
 - ALSO INFORMED BY RELATIVE POTENCY ASSESSMENT
- REVIEWED AND ENDORSED BY MASSDEP HEALTH EFFECTS ADVISORY COMMITTEE



WHY DID MASSDEP REVISE THE REFERENCE DOSE?

- ATSDR DRAFT TOXICITY VALUES LOWER
- EFFECTS IN MULTIPLE ANIMAL STUDIES AT LOWER EXPOSURE LEVELS THAN USED IN EPA'S ASSESSMENT
 - THYROID; LIVER; DEVELOPMENTAL (MAMMARY GLAND, LIVER, SKELETAL); IMMUNOTOXICITY
- TAKEN TOGETHER THESE RAISED COMPELLING CONCERNS
- HOWEVER, BECAUSE THE INDIVIDUAL STUDIES HAVE LIMITATIONS, ALTERNATIVE SINGLE STUDY TOXICITY DATA NOT USED AS POD



UPDATED REFERENCE DOSE

- TO ACCOUNT FOR MORE SENSITIVE EFFECTS A DATABASE UF (UF_D) WAS APPLIED
 - ESTABLISHED APPROACH
 - USED BY ATSDR AND SEVERAL OTHER STATES IN PFAS ASSESSMENTS
- UF_D OF $10^{1/2}$ SELECTED
 - COMPARISONS OF SERUM LEVELS AT ALTERNATIVE PODS: 2 TO 5-FOLD LOWER
- REVISED RFD = 5×10^{-6} MG/KG-DAY (VS. EPA PFOA AND PFOS RFD OF 2×10^{-5})



WHAT ABOUT THE OTHERS IN THE SUBCLASS?

- MUCH LESS DATA
- LOOK TO SIMILAR SURROGATE CHEMICALS WITH MORE EXTENSIVE TOXICITY DATA: IN THIS CASE PFOA AND PFOS
- “SIMILARITY” BASED ON
 - CHEMICAL STRUCTURES
 - TOXICITY PROFILES
 - HALF-LIVES
 - COMPARATIVE POTENCY EVALUATION – WHERE DATA ALLOWS



SUBCLASS CHARACTERISTICS

- SHARE SIMILAR TOXICITY PROFILES
 - LIVER
 - THYROID
 - DEVELOPMENT
 - IMMUNE SYSTEM
- CAUSE ADVERSE EFFECTS AT SIMILAR DOSES
 - OVERLAPPING SERUM CONCENTRATION AND HUMAN EQUIVALENT DOSE RANGES AT ADVERSE EFFECT LEVELS
 - MASSDEP COMPARATIVE POTENCY ASSESSMENT OF NATIONAL TOXICOLOGY PROGRAM (NTP) STUDY DATA



NTP PFAS TOXICITY STUDY

- NATIONAL TOXICOLOGY PROGRAM (NTP) (2018)
 - 28-DAY TOX STUDIES FOR 7 PFAS; DATA ON MULTIPLE ENDPTS
 - BEST AVAILABLE COMPARATIVE POTENCY STUDY

# Carbons	Sulfonates	Carboxylates
4	PFBS	
6	PFHxS	PFHxA
8	PFOS	PFOA
9		PFNA
10		PFDA

PFHpA was not included in NTP study



POTENCY COMPARISONS BASED ON NTP 28-DAY STUDY

- RELATIVE POTENCIES COMPARED FOR MOST SENSITIVE BENCHMARK RESPONSES
 - FREE THYROXINE CONCENTRATION
 - RELATIVE LIVER WEIGHT
- DOSES ASSOCIATED WITH BENCHMARKS CALCULATED
 - FOR BOTH RESPONSES USING TWO MEASURES OF DOSE
 - BASED ON MULTIPLE DOSE RESPONSE MODELS AVERAGED USING BAYESIAN BENCHMARK DOSE (BBMD) APPROACH



Bayesian Benchmark Dose BBMD (Shao and Shapiro 2018)

<https://benchmarkdose.org/>

POTENCIES RELATIVE TO PFOA

NTP (2018) 28-day male rat bioassay data

End Point	Free T4	Relative Liver Wt	Free T4	Relative Liver Wt
Exposure Metric	Serum (mg/L)		HED (mg/kg-day) ^a	
BMR	20%	5%	20%	5%
PFOA	1	1	1	1
PFOS	3	1	4	1
PFNA	3	0.9	2	0.6
PFHxS	0.5	0.2	0.8	0.2
PFDA	1	2	2	2

- All RPs within factor of five (5)
- Most within factor of two (2)



CONCLUSIONS: RP EVALUATION NTP STUDY

- ALL FIVE LONGER-CHAIN PFAS CAUSED DOSE-DEPENDENT EFFECTS IN THE LIVER AND THYROID
- POTENCIES MOSTLY WITHIN 1 TO 2-FOLD OF PFOA, ALL WITHIN 5-FOLD AND OVERLAP ACROSS ENDPOINTS AND DOSE METRICS
 - **SUPPORTS SIMILARITY OF POTENCIES**
- REVISED RFD FOR PFOS AND PFOA APPLIED TO SUBCLASS



OVERALL CONCLUSIONS

- The MMCL of 20 ppt (ng/L) is applicable to each PFAS individually and the sum of 6 PFAS
- The MMCL is health-based and protective of the most sensitive population
- The regulations require that, every 3 years MassDEP, perform a review for relevant developments in the science, assessment and regulation of PFAS in drinking water
 - Revisions and possible consideration of additional PFAS is possible
- MA's standards in line with those of other states



Comparison of Drinking Water Values for PFAS (ppt)

as of Jan. 2020	PFOS	PFOA	PFNA	PFHxS	PFHpA	PFDA
USEPA Health Advisories	70 Sum of two		NA	NA	NA	NA
MA MCL, GW standard	70 (2018 ORSG) → 20 (MCL; MCP GW standard) Sum of five → Sum of six (adds PFDA)					
VT MCL	20 Sum of five					NA
CT Action Levels	70 Sum of five					NA
WI Recommended GW standard	20					
ATSDR draft ATSDR toxicity values and EPA exposure parameters	7	11	10	70	NA	NA
NY MCL	10	10	NA	NA	NA	NA
NJ MCL	13	14	13	NA	NA	NA
CA Notification levels (Response levels)	6.5 (40)	5.1 (10)	NA	NA	NA	NA
MI MCL	16	8	6	51	NA	PFNA value recomm ended
MN guidelines	15	35	NA	47	NA	NA
NH MCL	15	12	11	18	NA	NA
Most other states (EPA value by default)	70		NA	NA	NA	NA



ACKNOWLEDGEMENTS

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

- OFFICE OF RESEARCH AND STANDARDS

DR. SANDRA BAIRD

DR. TSEDASH ZEWDIE

- DRINKING WATER PROGRAM



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