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CQC (AA-EQS) and AQC (MAC-EQS) – Proposal by the Ecotox Centre for:

Trifluoroacetic Acid (TFA)

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Authors

Dr. Breanne Holmes, Swiss Centre for Applied Ecotoxicology

Scientific Support

Karen Duis, ECT Oekotoxikologie GmbH, Böttgerstraβe 2-14, 65439 Flörsheim/Main, Germany

Please note that the suggested EQS and contents of this dossier do not necessarily reflect the opinion of the external reviewer.

Contact

Breanne Holmes: Breanne.holmes@oekotoxzentrum.ch
Marion Junghans: marion.junghans@oekotoxzentrum.ch

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Executive summary

CQC (AA-EQS): 0.016 mg/L

AQC (MAC-EQS): No proposed value. See section 6.1.

The chronic quality criterion (CQC) and the acute quality criterion (AQC) were derived according to the TGD for EQS of the European Commission (EC 2018a). In order to ensure that the dossiers are internationally comparable, the English terminology of the TGD will be used in the remainder of the dossier. The AQC corresponds to the MAC-EQS ("maximum allowable concentration environmental quality standard") and the CQC corresponds to the AA-EQS ("annual average environmental quality standard"). According to the Swiss Water Protection Ordinance (The Swiss Federal Council 2020), the CQC should not be compared with an annual average value but with the averaged concentration over two weeks.

Zusammenfassung

CQK (AA-EQS): 0.016 mg/L

AQK (MAC-EQS): Kein vorgeschlagener Wert. Siehe Abschnitt 6.1.

Das chronische Qualitätskriterium (CQK) und das akute Qualitätskriterium (AQK) wurden nach dem TGD for EQS der Europäischen Kommission (EC 2018a) hergeleitet. Damit die Dossiers international vergleichbar sind, wird im Weiteren die englische Terminologie des TGD verwendet. Der AQK entspricht dabei dem MAC-EQS (“maximum allowable concentration environmental quality standard”) und der CQK entspricht in der Herleitung dem AA-EQS (“annual average environmental quality standard”) soll aber gemäss Schweizer Gewässerschutzverordnung (Der Schweizerische Bundesrat 2020) nicht mit einem Jahresmittelwert sondern mit der gemittelten Konzentration über 2 Wochen verglichen werden.

Résumé

CQC (AA-EQS) : 0.016 mg/L

CQA (MAC-EQS) : Aucune valeur proposée. Voir rubrique 6.1.

Le critère de qualité chronique (CQC) et le critère de qualité aiguë (AQC) ont été dérivés selon le TGD for EQS de la Commission européenne (EC 2018a). Afin que les dossiers soient comparables au niveau international, la terminologie anglaise du TGD est utilisée ci dessous. La CQA correspond à la MAC-EQS (“maximum allowable concentration environmental quality standard”) ou NQE-CMA ("norme de qualité environnementale de la concentration maximale admissible") et la CQC correspond à la AA-

EQS ("annual average environmental quality standard") ou NQE-MA ("norme de qualité environnementale de la moyenne annuelle"). Selon l'ordonnance suisse sur la protection des eaux (Le Conseil fédéral suisse 2020), la CQC ne doit cependant pas être comparée à une valeur moyenne annuelle, mais à la concentration moyenne sur deux semaines.

Sommario

CQC (AA-EQS) : 0.016 mg/L

CQA (MAC-EQS) : Nessun valore proposto. Vedere la sezione 6.1.

Il criterio di qualità cronica (CQC) e il criterio di qualità acuta (CQA) sono stati derivati secondo il TGD for TGD della Commissione Europea (EC 2018a). Per garantire che i dossier siano comparabili a livello internazionale, viene utilizzata la terminologia inglese del TGD. Il CQA corrisponde al MAC-EQS ("maximum allowable concentration environmental quality standard") oppure SQA-CMA ("standard di qualità ambientale a concentrazione massima ammissibile") e il CQC corrisponde al AA-EQS ("annual average environmental quality standard") oppure SQA-MA ("standard di qualità ambientale medio annuo"). Secondo l'ordinanza svizzera sulla protezione delle acque (Il Consiglio federale svizzero 2020), tuttavia, il CQC non deve essere confrontato con un valore medio annuo, ma con la concentrazione media su due settimane.

Table of content

1 General Information

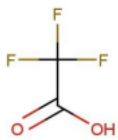
Selected information on the compound trifluoracetic acid (TFA) relevant for the aquatic environment is presented in this chapter. Registration information and risk assessments referred to are:

- ECHA (2024) Trifluoroacetic acid REACH Dossier (https://chem.echa.europa.eu/100.000.846/dossier-view/60cec416-2eda-4340-98bb-abde81256cda/IUC5-4926a2f7-5e9e-470f-8dcc-29a80dcebfb5_6b1ce3c3-d70e-49a1-9a3a-bbb1985a6946?searchText=trifluoroacetic%20acid)
- German Environment Agency (2023) Trifluoroacetate (TFA): Laying the foundations for effective mitigation – Spatial analysis of the input pathways into the water cycle.
- EFSA (2024) Draft Renewal Assessment Report – Flufenacet. RMS: Poland, Co-RMS: France, 1-9.
- EFSA (2017) Updated peer review of the pesticide risk assessment of the active substance flurtamone.

1.1 Identity and physico-chemical properties

Table 1 summarizes identity and physico-chemical and environmental fate parameters for TFA required for EQS derivation according to the EU TGD for EQS (EC 2018a). Where available, experimentally collected data is identified as (exp.) and estimated data as (est.). When not identified, no indication is available in the cited literature.

Table 1 Information required for EQS derivation according to the EU TGD for EQS (EC 2018a).

Characteristics	Values	References
Common name	Trifluoroacetic acid (TFA)	
IUPAC name	2,2,2-trifluoroacetic acid	UBA 2020
Chemical group	PFAS	UBA 2020
Structural formula		UBA 2020
Molecular formula	C2HF3O2	UBA 2020
CAS	76-05-1	UBA 2020
EC Number	200-929-3	UBA 2020
SMILES code	CF3COOH	ECHA 2024
Molecular weight [g/mol]	114.0233	UBA 2020
Melting point [°C]	-15.2 (exp. EU Method A.1)	ECHA 2024
Boiling point [°C]	72.2 (exp. EU Method A.2)	ECHA 2024
Vapour pressure [Pa]	12400 at 20 °C (exp. EU Method A.4)	ECHA 2024
Henry's law constant [$Pa \cdot m^3 \cdot mol^{-1}$]	0.009 at 20 °C 5800 ± 700 mol dm^{-3} atm^{-1} at 20 °C	ECHA 2024 Kutsana et al. 2008
Water solubility [$g \cdot l^{-1}$]	1520 at 20 °C (exp. visual examination)	ECHA 2024
Dissociation constant (pK_a)	0.43 at 20 °C (est.)	ECHA 2024

Characteristics	Values	References
Octanol-water partition coefficient (log K_{ow})	0.79 at 25 °C (est. QSAR)	ECHA 2024
Soil-water partition coefficient (log K_{oc} or K_p)	6.22 at 20 °C (K_{OC}) (OECD Guideline 106) 0.94 at 25 °C (log K_P)	ECHA 2024
Sediment adsorption coefficient (K_d [l/kg])	0.17 – 20 for organic and mineral soils 0.94 (SD = 4.86, n = 20) Geometric mean	ECHA 2024
Aqueous hydrolysis DT_{50}	TFA is stable; not listed.	
Aqueous photolysis DT_{50}	TFA is stable; not listed.	
Biodegradation in aqueous environment DT_{50} [d]	TFA is stable; not biodegradable.	ECHA 2024
Biodegradation in sediment DT_{50} [d]	TFA is stable; no degradation in the time scale of the laboratory (2880h) and field (up to 1 year) experiments.	ECHA 2024
Biodegradation in soil DT_{50} [d]	TFA is stable; not listed.	

1.2 Regulatory context and environmental limits

Table 2 summarizes existing regulation and environmental limits in Switzerland, Europe and elsewhere for TFA. Existing PNEC/Environmental quality standards are listed in Table 3. Please note that the information provided in Table 2 and 3 may have changed since finalization of this dossier.

Table 2 Existing regulation and environmental limits for TFA in Switzerland and Europe.

Europe	
EU Priority substance list	Included as a PFOS derivative, 2013
EU Water Framework Directive	Included in EQS for surface waters for summed weighted concentrations for 25 PFAS of 4.4 ng/L (relative potency factor 0.002)
REACH	Authorized ≥ 100 to < 1000 tonnes per annum
ECHA Classification and Labelling	Acute Toxicity Hazard Inhalation Category 4(H332) Skin Corrosion/Irritation 1A (H314) Hazard to the Aquatic Environment Chronic Category 3 (H412)
OSPAR list of substances for priority action (SVHC)	Included as of 15.11.2024
vPvM	Qualified for classification as very persistent and very mobile (UBA 2017, 2021)
BfR	Category 1B Toxic to Reproduction
Switzerland	
PSMV	Not listed.
International	
UN risk class (ref, UN2015)	8 Corrosive

Table 3 PNEC/quality standards available from authorities and reported in the literature.

Description	Value [mg/L]	Development method	References
Ad hoc MTR	0.0022	Indicative drinking water guideline value	RIVM report 2023
Drinking water limit	9	Quality requirement for consumer taps (DK)	BEK nr 1023 29/06/2023
JD-$QS_{fw, eco}$ (DE)	0.021	Quality target for surface waters (UBA) (draft proposal)	Umweltbundesamt 2020
Drinking water limit	0.010*	Non-relevant metabolite (UBA)	UBA 2020
Drinking water limit	0.060	Quality target (DE)	Umweltbundesamt 2020
PNEC (freshwater)	0.56	Hazard for aquatic organisms (REACH)	ECHA 2024

*Non-relevant metabolites were suggested to have a value of 10 ug/L but this no longer valid because TFA is now deemed a relevant metabolite.

1.3 Use and emissions

The PFOS-derivative, trifluoroacetic acid (TFA), is a short-chain perfluorocarboxylic acid and a member of the broader class of perfluorinated and polyfluorinated alkyl substances (PFAS). It is the degradation product of many fluorinated plant protection products (PPPs) and PFAS compounds, so it is ubiquitous in the environment. In part, its widespread detection is the result of the atmospheric degradation of replacement compounds for chlorofluorocarbons (CFCs), including hydrofluorocarbons (HFCs), hydrochlorofluorocarbons (HCFCs), and hydrofluoroolefins (HFOs) (Jagani et al. 2025).

Since TFA is also very stable, it is the most abundantly found PFAS, with concentrations at 100 to 1000 times higher than other PFAS in groundwater in Switzerland (BAFU, 2024). TFA concentrations in the environment vary considerably, but several values have been reported. In Germany, it was detected in precipitation up to 0.21 µg/L, in drinking water up to 1.5 µg/L, and in surface waters up to 30 µg/L (Sturm et al. 2023). In California, concentrations in rain and fog were found up to 3.779 µg/L, while in Switzerland TFA was found in rain up to 1.550 µg/L and up to 0.350 µg/L in rain in Canada (Solomon et al. 2016). Additionally, the OECD identified TFA as a high production volume (HPV) chemical (OECD 2025).

In Switzerland, 28 authorized active substances are approved for use as PPPs include at least one CF group. In 2022, over 40 tonnes of these PPPs were sold in Switzerland, of which 10 tonnes were flufenacet and 10 tonnes were fluazinam (BAFU, 2024). In the European Economic Area, TFA is manufactured and/or imported at ≥ 100 to < 1000 tonnes per annum (ECHA, 2025). In a 2024 study, 560 out of 564 drinking water samples in Switzerland had detectable levels of TFA (Meier, S. et al.).

1.4 Mode of action

TFA is a member of the ultrashort-chain PFAS class of compounds. It has been identified as the final compound in the degradation process of many chemicals, particularly plant protection products (PPPs). TFA has also been identified as acutely toxic, causing severe skin burns, eye damage, is corrosive to metals, harmful if swallowed, and is suspected to be a reproductive toxicant (ECHA, 2024). Despite its abundance in the environment and the identified classification and labeling hazards, little is known about its mode of action in either humans or environmental species. This is largely due to its prominence as a degradation product and not an active substance.

While acute toxicity tests have shown very low activity for both aquatic organisms and mammals, the liver was identified as a target organ in repeated oral dose studies in rats. In that study, mild liver hypertrophy was the lead effect, specifically, with slight effects on peroxisome proliferator receptors (Dekant and Dekant 2023). The oral LD_{50} for rats was found to be above 500 mg/kg body weight and no mortality was shown at a single oral dose of 2000 mg/kg bw, affirming that there is low lethal acute toxicity (Dekant and Dekant 2023). In a chronic study in which TFA-spiked drinking water was administered to rats, a highly conservative NOEL of 1.8 mg/kg bw/day (30 ppm) was established based on changes in the liver enzyme ALT.

In a fact sheet on endocrine disruptors (Bundesamt für Gesundheit 2019), the authors, a group of experts of Swiss BAG, BAFU, BLV, BLW, SECO, Swissmedic and Suva, refer to the WHO definition (Damstra *et al.* 2002) adapted from EC/Weybridge UK (1996):

“An endocrine disruptor is an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations.”

According to the ED criteria as defined in Commission Regulation (EU) 2018/605 of 19 April 2018 (EC 2018b) and referred to in ECHA/EFSA/JRC *et al.* (2018),

“a substance shall be considered as having ED properties if it meets all of the following criteria:

a. it shows an adverse effect in [an intact organism or its progeny]/[non-target organisms], which is a change in the morphology, physiology, growth, development, reproduction or life span of an organism, system or (sub)population* that results in an impairment of functional capacity, an impairment of the capacity to compensate for additional stress or an increase in susceptibility to other influences;

b. it has an endocrine mode of action, i.e. it alters the function(s) of the endocrine system;

c. the adverse effect is a consequence of the endocrine mode of action.”

The EFSA “Guidance for the identification of endocrine disruptors […]” specifies that “It should be highlighted that the ‘endocrine mode of action’ as stated in point (b) should be interpreted as ‘endocrine activity’ while the term ‘endocrine mode of action’ in point (c) covers the link between the adverse effect and the endocrine activity identified in points a) and b), respectively.” (ECHA/EFSA/JRC *et al.* 2018)

TFA is considered a potential developmental and reproductive toxicant, based on embryo-fetal developmental toxicity in rabbits (ECHA 2024), so further studies on its potential to be an endocrine disruptor are still needed, especially since its mode of action is unknown. The German Environment Agency also listed TFA as Toxic to Reproduction, Category 1B (BfR 2025).

2 Environmental fate

2.1 Stability and degradation products

TFA is formed as a degradation product from a wide number of compounds used in a variety of settings, including at least 45 plant protection products, 6 biocides, 51 human pharmaceuticals, 8 veterinary medicines, as well as industrial chemicals, and gaseous refrigerants and propellants (Umweltbundesamt 2021). When released into the atmosphere, it binds to moisture and transfers to soils and surface waters through subsequent precipitation (e.g. rain, snow, fog, and dew). Since it has a low log Kp (0.94) and low log Kow (0.79), as shown in Table 1, it is highly mobile in soils and, once deposited, quickly moves to groundwater and ultimately drinking water sources (Scheurer et al. 2017). Ultimately, it is not degraded, and since it is the final degradation products of many other compounds and extremely persistent, it accumulates significantly in the environment and particularly in aquatic environments (UBA 2021, Hanson et al. 2024). This high mobility and persistence, along with constant release from multiple sources, has led to a constant increase in the environment (Scheurer et al. 2017, Arp et al. 2024).

2.2 Bioavailability

Bioavailability is a complex process which depends on many factors including the sorption capacity of the dissolved organic carbon (DOC) in the water phase and of the sediment in the water-sediment system (e.g. OC content), the hydrophobicity of the compound, and the physiology, feeding behaviour and activity of the organism considered (Warren *et al.* 2003).

As stated in the EU TGD for EQS, total and dissolved concentrations of very hydrophobic substances with Kp values above 10000 L/kg or K_{oc} values for linear partitioning into amorphous organic matter above 100000 L/kg, may differ. Thus, for compounds with log K_p <4 or, if this value is not available, log K_{ow} <6, the $EQS_{water,\ total}$ is equivalent to the $EQS_{water,dissolved}$ (EC 2018a). TFA, with a log K_{ow} of 0.79, does not sorb to organic carbon but does accumulate in plants and in water sources. In water sources this is due to the high mobility and persistence of TFA coupled to constant input. In plants, short-chain PFAS like TFA are more likely to transport from soil by transpiration and then to accumulate in strongly transpiring plant parts such as the leaves (Blaine et al. 2014, Krippner et al. 2014).

2.3 Bioaccumulation and biomagnification

A limited dataset is available for TFA, which does not include studies on bioaccumulation, for example there was no study done under OECD TG 305. Furthermore, for TFA, the log K_{ow} is less than 3 (0.79). Since it is also highly soluble in water and shows volatility (according to Directive 1999/13/EC criteria), it is not considered bioaccumulative (Arp et al. 2024, ECHA 2024). In field samples, however, TFA was detected in plants in the vicinity of fluorochemical plants with an average field bioaccumulation factor of 13,000 (Chen et al. 2018). It has also been demonstrated that TFA bioaccumulates in terrestrial plants grown in aqueous concentrations ranging from 100 to 1,000 mg/L TFA (Boutonnet et al. 1999). A study by Standley and Bott showed that TFA salts could bind to proteins in plants and aquatic species, but the work wasn't replicated and since the binding was based on incorporation into biomolecules through covalent binding, TFA would then be released during digestion and biomagnification wouldn't subsequently occur (1998; Solomon et al. 2016). While TFA was also detected in zebra mussels, herring gull eggs, and human serum, no bioaccumulation studies were done to formally address the risk (Rupp et al. 2025).

3 Analytics

TFA, as with all ultra-short-chain PFAS, is particularly difficult to measure analytically. Its high polarity and low molecular weight make it difficult to retain using traditional reversed-phase liquid chromatography and, therefore, advanced methods including ion-exchange chromatography, direct-injection, and supercritical fluid chromatography have been developed to improve detection (Jagani et al. 2025). While gas chromatography (GC) allows for increased performance, you need to derivatize the sample so liquid chromatography is primarily used (Björnsdotter et al. 2019).

Table 4 Methods for TFA analysis in water and corresponding limits of detection (LOD) and limits of quantification (LOQ) (µg/L). N.A. means not reported.

LOD (ng/L)	LOQ (ng/L)	Analytical method	Reference
N.A.	300	LC-MS/MS	Dorgerloh et al. 2025
3.5	N.A.	Hybrid HILIC/ion-exchange column LC-MS/MS	Liang, S.H. et al. 2024
N.A.	25	Ion-exchange LC-MS/MS	Freeling, F. et al. 2020
N.A.	0.5	Ion-exchange LC-MS/MS	Taniyasu et al. 2008
3.3	36	GC-ECD	Wujcik et al. 1998
N.A.	0.2	Supercritical fluid chromatography (SFC)-MS/MS	Yeung et al. 2017
34	N.A.	Supercritical fluid chromatography (SFC)-MS/MS	Björnsdotter et al. 2019

4 Effect data

A literature search was performed using Scopus on May 19, 2025 for all available documents using search terms including trifluoroacetic acid and ecotoxicity, ecotoxicology, and aquatic organisms resulting in 19, 10, and 19 results, respectively. A search using TFA and ecotoxicity, ecotoxicology, and aquatic organisms was run and resulted in 15, 6, and 20 hits, respectively. However, a search of just trifluoroacetic acid on Scopus resulted in over 16,000 articles, emphasizing its presence in a number of chemical fields outside of environmental science.

While there were several review studies which emphasized the limited dataset for TFA and the growing concern as it accumulates in the environment (Arp et al. 2024), there were limited studies testing TFA with relevant organisms. Most studies were relevant to environmental fate (Brunn et al. 2023, Zhao et al. 2022) or ecosystem impacts (Benesch et al. 2002). In the article by Benesch et al., it was shown that microbial communities were unable to degrade TFA in vernal pool and agricultural soils up to 10 mg/L after incubation of up to 3 months. Furthermore, accumulation occurred in wetland species, which is consistent with other studies showing terrestrial plant accumulation of TFA (Benesch et al. 2001, Boutonnet et al. 1999). No exposures effects were observed in the plants despite the accumulation of TFA. Ultimately, the publications and the available PPP degradation product information indicate a need for further testing and emphasize the limited information on the potential toxicity of TFA.

Only reliable and relevant data should be used for EQS derivation (EC 2018a). These data are often referred to as "valid". Different approaches to assessment and classification of (eco)toxicological data have been published. An established method introduced by Klimisch *et al.* (1997) uses four levels of validity: (1) reliable, (2) reliable with restrictions, (3) not reliable, (4) not assessable. The CRED approach published by (Moermond *et al.* 2016) is based on a similar classification scheme but additionally takes into account the relevance of test results for the derivation of quality standards. Both methods are recommended in the EU TGD for EQS (EC 2018a).

Studies considered as acceptable in the EU DRAR were adopted as valid/Klimisch 1 without additional assessment (face value). Studies on mixtures were considered as irrelevant due to the potential effects of other compounds on the endpoints of the test. When selecting effect concentrations from algae growth inhibition tests, growth rate is preferred over growth, biomass, and cell density according to (EC 2018a), therefore values other than growth rate are in grey in Table 5. Values that were not deemed relevant and/or reliable for this EQS derivation are in grey. In studies where sodium TFA was tested, the TFA active endpoint was used for the evaluation and the sodium TFA endpoint was listed for completeness. In instances where ECHA found a study to have a reliability of 2 but noted that deviations in the study made it not relevant and/or reliable for current assessments, for example due to insufficient controls or high variability, they were listed as validity 3* in Table 5 based on the severity of the insufficiency. Endpoints that were valid but which had unbounded values were not included in geometric mean calculations.

Table 5 Aquatic effect data collection for Trifluoroacetic acid in mg/L. Data were evaluated for relevance and reliability according to the CRED criteria (Moermond *et al.* 2016) in case they had not been previously evaluated. Data assessed as not relevant and not reliable is in grey font. Data where the validity deviated from the ECHA conclusion on reliability are denoted with an *. Data used for QS derivation is underlined. Abbreviations: NA = not available.

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
Acute Freshwater												
cyanobacteria	*Microcystis aeruginosa*	OECD TG 201 (1984)	growth rate	144h	ErC50	>	97	nom (TFA)	static	NA	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 012
cyanobacteria	*Anabaena flos-alquae*	OECD TG 201 (1984)	growth rate	120h	ErC50	>	1997	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 014
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	ErC50	=	192.48	nom-i (NaTFA)	static	99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.410 Anon. 1992
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	ErC50	=	<u>160.24</u>	nom-i (TFA)	static	99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.410 Anon. 1992
green algae	*Raphidocelis subcapitata*	OECD TG 201 (1984)	yield	72h	EyC50	=	4.19	nom-i (NaTFA)	static	99	1	EC 2024 cited in Peer review assessment

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
	(Selenastrum capricornutum)											report 2024 Vol. 3 B9 p.410 Anon. 1992
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (1984)	growth rate	72h	ErC50	=	6.4	nom (TFA)	static	99	3*	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 003
green algae	*Chlorella vulgaris*	OECD TG 201 (1984)	growth rate	72h	ErC50	>	999	nom (TFA)	static	NA	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 009
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (1984)	growth rate	72h	ErC50	=	11.4	nom (TFA)	static	NA	3*	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 008
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	ErC50	>	1.2	nom-i (NaTFA)	static	>99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.413 Anon. 1993
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	ErC50	>	0.999	nom-i (TFA)	static	>99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.413 Anon. 1993

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
green algae	*Desmodesmus subspicatus*	OECD TG 201 (1984)	growth rate	72h	ErC50	>	99.9	nom (TFA)	static	NA	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 010
green algae	*Chlamydomonas reinhardtii*	OECD TG 201 (1984)	growth rate	72h	ErC50	>	99.9	nom (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 011
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (1984)	growth rate	72h	ErC50	=	<u>133</u>	nom-i (TFA)	static	NA	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 005
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (2006)	growth rate	72h	ErC50	=	<u>237.07</u>	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 001
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	NF-EN-ISO 8692 (2005)	growth rate	72h	ErC50	=	<u>145</u>	nom (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 002
green algae	*Raphidocelis subcapitata*		growth rate	72h	ErC50	=	<u>164.5</u>	Geometric mean (n=4)				

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
diatom algae	*Navicula pelliculosa*	OECD TG 201 (1984)	growth rate	144h	ErC50	=	499	nom-i (TFA)	static	NA	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 013
aquatic plant (monocotyledons)	*Lemna gibba*	ASTM (1991)	frond no.	7d	ErC50	=	1990	nom-i (NaTFA)	static	99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p501 Anon. 1993
aquatic plant (monocotyledons)	*Lemna gibba*	ASTM (1991)	frond no.	7d	EC50	=	915	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.6 - 001
crustaceans	*Daphnia magna*	OECD TG 202 (1984)	immobilisation	48h	LC50	>	1200	nom-i (NaTFA)	static	99	1	REACH Dossier 2024 Full Joint Submission Section 6.1.3 - 001
crustaceans	*Daphnia magna*	OECD TG 202 (1984)	immobilisation	48h	EC50	>	999	nom-i (TFA)	static	99	1	REACH Dossier 2024 Full Joint Submission Section 6.1.3 - 001
fish	*Danio rerio (Brachydanio rerio)*	OECD TG 203 (1984)	mortality	96h	LC50	>	1200	nom-i (NaTFA)	static	99	1	REACH Dossier 2024 Full Joint Submission

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
												Section 6.1.1 - 001
fish	*Danio rerio (Brachydanio rerio)*	OECD TG 203	mortality	96h	LC50	>	999	nom-i (TFA)	static	99	1	REACH Dossier 2024 Full Joint Submission Section 6.1.1 - 001
fish embryo test	*Danio rerio embryo*	NA	morphology	144h	EC50	=	700	nom-i (TFA)	static	NA	3	Carlsson, G., Norrgren, L., Orn, S., Ulhaq, M. (2013): Comparison of Developmental Toxicity of Seven Perfluoroalkyl acids to Zebrafish Embryos. Environ Tox and Pharmacol. 36 (2) 423-426.
Chronic freshwater												
Cyanobacteria	*Anabaena flos-alquae*	OECD TG 201 (1984)	growth rate	120h	NOEC	=	499	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 014

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	NOEC	=	0.36	nom-i (NaTFA)	static	99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.410 Anon. 1992
green algae	*Raphidocelis subcapitata (Selenastrum capricornutum)*	OECD TG 201 (1984)	growth rate	72h	NOEC	=	0.30	nom-i (TFA)	static	99	1	EC 2024 cited in Peer review assessment report 2024 Vol. 3 B9 p.410 Anon. 1992
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (2006)	growth rate	72h	NOEC	=	2.5	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission - Section 6.1.5 - 001
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (2006)	growth rate	72h	EC10	=	5.6	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 001
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	OECD TG 201 (1984)	growth rate	72h	NOEC	=	0.12	nom-i (NaTFA)	static	>99	2	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 004
green algae	*Raphidocelis subcapitata*	OECD TG 201 (1984)	growth rate	72h	NOEC	=	0.1	nom-i (TFA)	static	>99	2	REACH Dossier 2024 Full Joint Submission

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
	(Pseudokirchneriella subcapitata)											Section 6.1.5 - 004
green algae	*Raphidocelis subcapitata (Pseudokirchneriella subcapitata)*	NF-EN-ISO 8692 (2005)	growth rate	72h	NOEC	=	6	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 002
green algae	*Raphidocelis subcapitata*		Growth rate	72h	NOEC	=	0.819	Geometric mean (n=4)				
crustaceans	*Daphnia magna*	OECD TG 211 (2008)	reproduction rate	21d	NOEC	≥	100	nom-i (NaTFA)	semi-static	30% w/w NaTFA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.4 - 001
crustaceans	*Daphnia magna*	OECD TG 211 (2008)	reproduction rate	21d	NOEC	≥	25	nom-i (TFA)	semi-static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.4 - 001
aquatic plant (monocotyledons)	*Lemna gibba*	ASTM 1991	frond no	7d	NOErC	=	300	nom-i (NaTFA)	static	99	1	REACH Dossier 2024 Full Joint Submission Section 6.1.6 - 001
aquatic plant (monocotyledons)	*Lemna gibba*	ASTM 1991	frond no	7d	NOErC	=	250	nom-i (TFA)	static	99	1	REACH Dossier 2024 Full Joint Submission

Group	Species	Guideline	Endpoint	Duration	Parameter		Value (mg/L)	Analytics	Exposure	Purity (%)	Validity	Reference
												Section 6.1.6 - 001
Chronic Saltwater												
green algae	*Dunalielia tertiolecta*	OECD TG 201 (1984)	growth rate	72h	EC50	>	103 (TFA)	nom-i	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 015
diatom algae	*Phaeodactylum tricornutum*	OECD TG 201 (1984)	growth rate	72h	EC50	>	97	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 016
diatom algae	*Skeletonema costatum*	OECD TG 201 (1984)	growth rate	72h	EC50	>	1997	nom-i (TFA)	static	NA	1	REACH Dossier 2024 Full Joint Submission Section 6.1.5 - 017

Legend

Chemical analitycs

m-gm based on mean measured concentrations (geometric mean)
nom based on nominal concentration; without analytical verification
nom-i based on nominal concentrations ; concentrations were measured and in case recovery was 80-120 %, nominal effect concentrations are regarded as valid and reported.

Exposure

S static
R semi-static
T flow-through

4.1 Graphic representation of effect data

All available data have been plotted independently of their relevance and reliability (Figure 1).

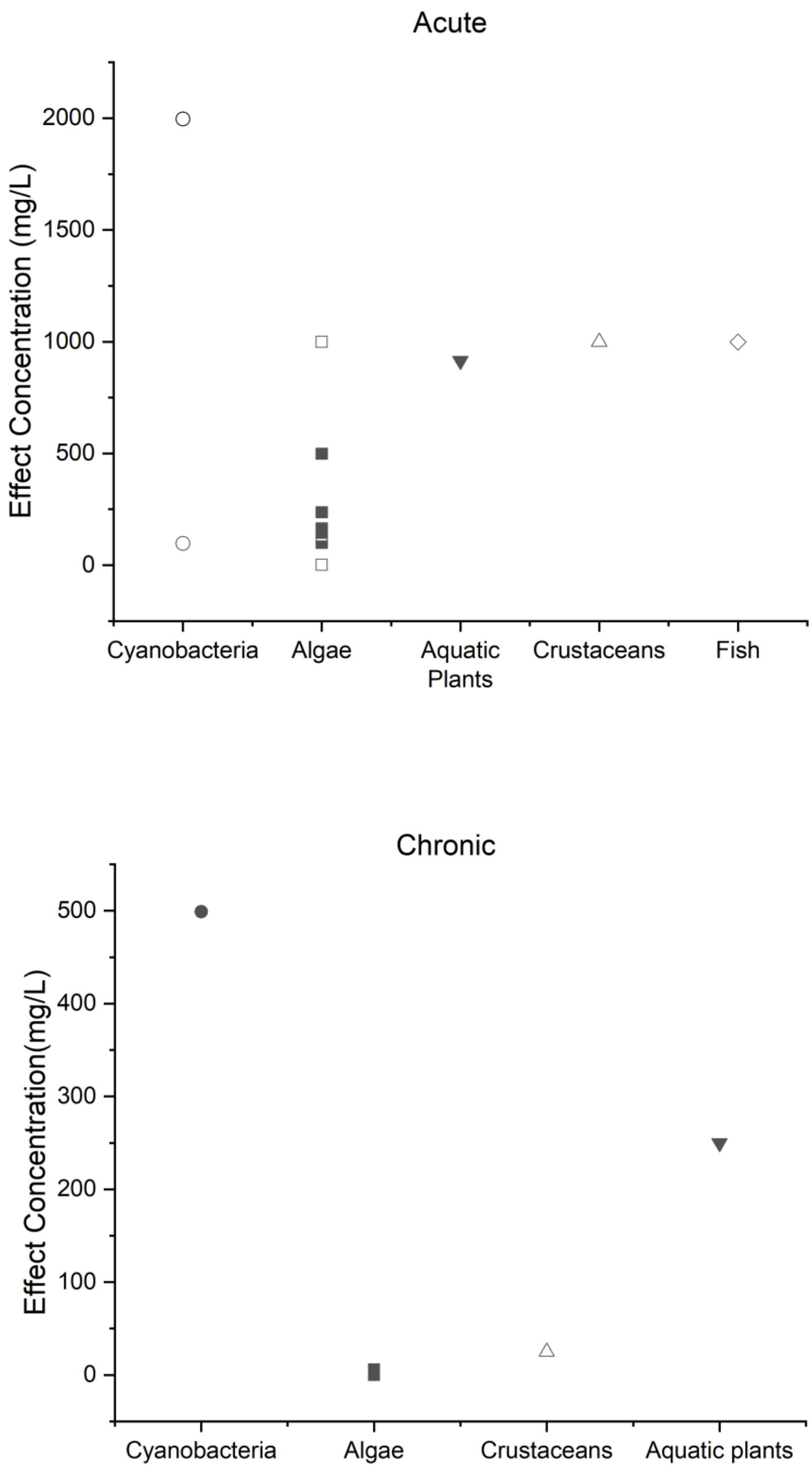
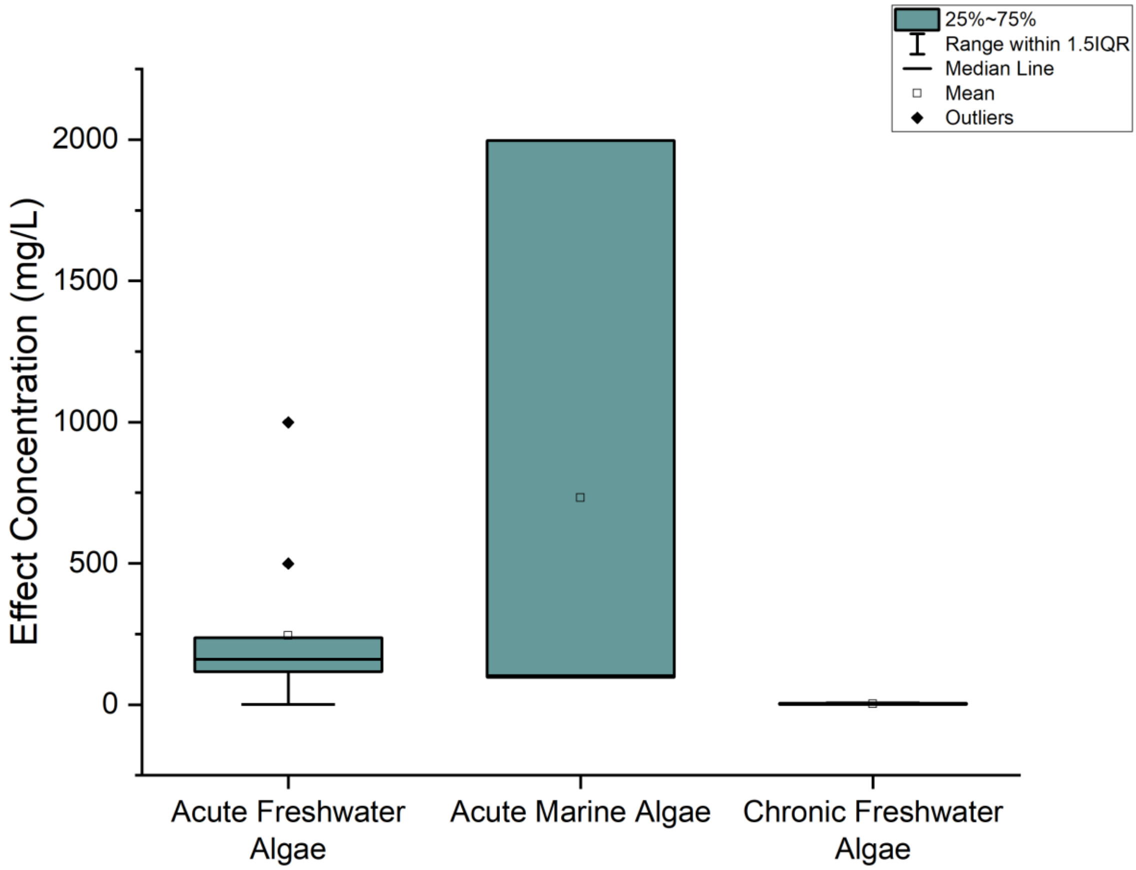


Figure 1 Graphical representation of acute and chronic effect data from aquatic toxicity tests with TFA. Data are not normalized for OC.

4.2 Comparison between marine and freshwater species

As suggested by the EU TGD for EQS (EC 2018a), for statistical comparison of marine and freshwater species, one value per species is selected, all effect data are log-transformed, and the two datasets are compared for significant differences. For TFA, however, the only marine species tested was marine algae, including: green algae (*Dunalielia tertiolecta), and diatoms (Phaeodactylum tricornutum,* and *Skeletonema costatum).* The extremely limited marine species dataset means a meaningful comparison to freshwater species is not possible. For an informal comparison, the marine species had EC50 values of 97-1997 mg/L, with a geometric mean of 271 mg/L, compared to the freshwater geometric mean of 0.819 mg/L indicating that more studies are required for aquatic organisms to get a better scope on the risk to this compartment.



5 Chronic toxicity

5.1 Derivation of CQC (AA-EQS) using the Assessment Factor (AF) method

The derivation of a CQC_{AF} ($AA\text{-}EQS_{AF}$) is based on applying an assessment factor (AF) to the lowest credible datum from long-term toxicity tests.

The lowest long-term effect datum available for TFA is the NOEC of 0.819 mg/L (Table 6) for the geometric mean growth rate of *R. subcapitata*.

Table 6 Most sensitive relevant and reliable chronic data summarized from Table 5.

Group	Species	Duration	Effect concentration	Value [mg/L]	Reference
Basic data					
Algae	*R. subcapitata (Geometric mean, n=4)*	72h	NOEC	0.819	EC 2024 cited in Peer review assessment report 2024, ECHA 2024
Crustaceans	*Daphnia magna*	25d	NOEC	≥ 25	REACH Dossier 2022 Full Joint Submission Section 6.1.4 - 001
Fish	*Not tested*				

In case of long term tests (NOEC or EC_{10}) being available for three species representing different living and feeding conditions, the EU TGD for EQS recommends the application of an assessment factor of 10 on the lowest credible datum (Table 3 in EC (2018a)). However, for TFA, data is only available for two trophic levels (algae and Daphnia).

The suggested assessment factor is thus 50 in accordance with EU TGD for EQS:

$$\mathrm{CQC}_{AF}\ (\mathrm{AA}-\mathrm{EQS}_{AF}) = \frac{lowest\ EC_{10}\ or\ NOEC}{AF}$$

$$\mathrm{CQC}_{AF}\ (\mathrm{AA}-\mathrm{EQS}_{AF}) = \frac{0.819\left(\frac{mg}{L}\right)}{50} = 0.016\ \left(\frac{mg}{L}\right)$$

Since TFA has a very low log Kow (0.79) and is not expected to bind to particulate matter, a correction for the OC content is not required.

The application of an AF of 50 to the lowest credible chronic datum results in a **CQC_{AF} (AA-EQS_{AF}) = 0.016 mg/L or 16 µg/L**.

5.2 Derivation of CQC (AA-EQS) using the species sensitivity distribution (SSD) method

The minimum data requirements recommended for the application of the SSD approach for EQS water derivation is preferably more than 15, but at least 10 NOEC/EC_{10}, from different species covering at least eight taxonomic groups (EC (2018a), p. 43).

In this case, not enough data are available for applying the SSD approach and therefore this could not be calculated.

5.3 Determination of CQC (AA-EQS) according to mesocosm/field data

No field or mesocosm studies that provide effect concentrations are available, thus, no CQC (AA-EQS) based on field data or mesocosm data has been derived.

6 Acute toxicity

6.1 Derivation of AQC (MAC-EQS) using the Assessment Factor (AF) method

The derivation of an AQC_{AF} ($MAC\text{-}EQS_{AF}$) is based on applying an assessment factor (AF) to the lowest credible datum from short-term toxicity tests.

The lowest short-term effect datum available for TFA is the ErC_{50} of 164.5 mg/L (Table 7) for the geometric mean of the growth rate of *R. subcapitata*.

Table 7 Most sensitive relevant and reliable acute data summarized from Table 5

Group	Species	Duration	Effect concentration	Value [mg/L]	Reference
Basic data					
Algae	*R. subcapitata (Geometric mean, n=4)*	72h	ErC50	164.5	EC 2024 cited in Peer review assessment report 2024, ECHA 2024
Crustaceans	*Daphnia magna*	48h	EC50	>999	REACH Dossier 2024 Full Joint Submission Section 6.1.3 - 001
Fish	*Danio rerio*	96h	LC50	>999	REACH Dossier 2024 Full Joint Submission Section 6.1.1 - 001
Additional data					
Aquatic plants	*Lemna gibba*	7d	ErC50	915	REACH Dossier 2024 Full Joint Submission Section 6.1.6 - 001

In case of short term tests being available for three species representing different living and feeding conditions, the EU TGD for EQS recommends the application of an assessment factor of 100 on the lowest credible datum (Table 5 in EC (2018a)). It can be reduced to 10 in case acute toxicity data for different species do not have a higher standard deviation than a factor of 3 in both directions (i.e., if the standard deviation of the log10 transformed L(E)C50 values is < 0.5, an assessment factor of 10 could be applied) or known mode of toxic action and representative species for the most sensitive taxonomic group included in the data set.

Since the endpoints for both crustaceans and fish are unbounded values, a log10 transformed value cannot be accurately calculated. Additionally, since the mode of action for TFA is unknown, the AF cannot be reduced.

The suggested assessment factor is thus 100 in accordance with EU TGD for EQS:

$$\mathrm{AQC}_{AF}\ (\mathrm{MAC}-\mathrm{EQS}_{AF}) = \frac{lowest\ LC\ or\ EC_{50}}{AF}$$

$$\mathrm{AQC}_{AF}\ (\mathrm{MAC}-\mathrm{EQS}_{AF}) = \frac{164.5\left(\frac{mg}{L}\right)}{100} = 1.65\ \left(\frac{mg}{L}\right)$$

According to the EU TGD for EQS, in case of substantial levels of suspended particulate matter in the test system, the effect concentration is regarded as $c_{test\ water,total}$ and needs to be corrected for OC concentration to yield $c_{water,dissolved}$.

The critical acute toxicity study on *P. subcapitata* was performed according to OECD 201 without feeding and sediment, thus OC concentrations can be assumed to have been negligible. In this case, “the concentration [of the test substances] is assumed to be fully dissolved” (EC 2018a) and the derived AQC (MAC-EQS) does not need to be corrected for OC concentration in the test system. Furthermore, TFA has a low log Kow and is unlikely to be lost to OC so no correction is needed.

While the MAC-EQS value was calculated according to the EU TGD, the persistence of TFA in the environment and its complete lack of degradation, which results in accumulation over time, do not support the use of a MAC-EQS for regulatory purposes. Additionally, the sensitivity of chronic studies compared to acute endpoints supports only the use of an AA-EQS. Therefore, the application of an AF of 100 to the lowest credible acute datum results in a **AQC (MAC-EQS$_{AF}$) = 1.65 mg/L or 1650 µg/L**, but this should not be used for regulatory purposes.

6.2 Derivation of AQC (MAC-EQS) using the species sensitivity distribution (SSD) method

The minimum data requirements recommended for the application of the SSD approach for EQS water derivation is preferably more than 15, but at least 10 EC_{50}, from different species covering at least eight taxonomic groups (EC (2018a), p. 43).

In this case, not enough data are available for applying the SSD approach.

6.3 Derivation of MAC-EQS according to mesocosm/field data

No field or mesocosm studies that provide effect concentrations of TFA are available, thus, no AQC (MAC-EQS) based on field data or mesocosm data has been derived.

7 Derivation of a biota standard to protect wildlife from secondary poisoning (QS$_{biota,\ sec\ pois,\ fw}$)

Derivation of a $QS_{biota,\ sec\ pois,\ fw}$ is not necessary as discussed in section 2. Since the log K_{ow} is < 3, and it is assumed that the risk of bioaccumulation is negligible, no assessment of secondary poisoning is required. Additionally, low toxicity was shown for the bird species tested, including an LD50 of greater than 2000 mg TFA/kg bw/d and a chronic NOAEL of 84 mg TFA/kg bw for Bobwhite quail (EFSA 2024).

8 Toxicity of transformation products

Trifluoroacetic acid is the final degradation product for plant protection products, pharmaceuticals, flame retardants, and industrial chemicals. Furthermore, it does not freely degrade because of its highly stable C-F bonds. Considering the stability of TFA, and its existence as a ubiquitous final degradation product, no further degradation products need to be considered.

9 Proposed CQC (AA-EQS) and AQC (MAC-EQS) to protect aquatic species

The QS value for each derivation method included in the EU TGD for EQS are summarized in Table 8. According to the EU TGD for EQS, the most reliable extrapolation method for each substance should be used (EC 2018a).

Table 8 QS derived according to the EU TGD for EQS and their corresponding AF. All concentrations expressed as mg/L. Proposed EQS are in bold letters/numbers. N.A. means not applicable.

	Value	AF
CQC_{AF} (AA-EQS_{AF})	**0.016**	50
AQC_{AF} (MAC-EQS_{AF})	N.A.	N.A.

A **CQC (AA-EQS) of 0.016 mg/L** including the application of an AF of 50 is thus suggested. The AQC (MAC-EQS) of 1.65 mg/L (AF of 100) for TFA is not recommended for regulatory use, as noted in 6.1. The extremely high persistence of TFA and its notably stronger chronic toxicity compared to acute toxicity make the implementation of a MAC-EQS inadvisable.

10 Protection of aquatic organisms and uncertainty analysis

The assessment factor method was used to derive the CQC value for TFA, based on assessment factor of 50. Since TFA is a compound of growing concern that is the degradation product of so many widely used chemicals, there are several limitations to the current data set. Among them, developmental toxicity of TFA has been suspected for humans (ECHA 2024) and this has prompted a re-evaluation of its presence as a degradation product from several plant protection products (AGES 2024). Additionally, the lack of chronic data for fish is a data gap that needs to be addressed considering the stability of the compound and the continuous release of TFA into the environment through multiple sources. Differences between marine and freshwater species should also be explored as TFA is found globally, including in precipitation, and there is currently limited information on its toxicity in a marine environment. Analytical limitations also exist regarding the measurement of TFA in relation to the broader group of PFAS compounds, as they are often found in the same environmental compartments and separation can be difficult. The CQC derived is assumed to be protective for surface waters based on the available information, but more studies are needed to fully understand its behavior and risks.

11 References

AGES (2024). RelMet2: Extended assessmetn of metabolites of PPP active substances with regard to their biological and human toxicological relevance/non-relevance and derivation of toxicologically tolerable concentrations in groundwater and drinking water. RelMet2: Erweiterte Bewertung von Metaboliten von PSM-Wirkstoffen hinsichtlich ihrer biologischen und humantoxikologischen Relevanz/Nichtrelevanz und Ableitung humantoxikologisch tolerierbarer Konzentrationen im Grund- und Trinkwasser - BMLUK DaFNE

Arp, H.P.H., Gredelj, A., Glüge, J., Scheringer, M., and Cousins, I.T. (2024) The Global Threat from the Irreversible Accumulation of Trilfuoroacetic Acid (TFA). ES&T. 58(45), p19925-19935.

Benesch, J.A., Gustin, M.S., Cramer, G.R., Cahill, T.M. (2002) Investigation of effects of trifluoroacetic acid on vernal pool ecosystems. Environmental Toxicology and Chemistry. 21(3), p640-647.

BfR (German Federal Institute for Risk Assessment) (2025) Trifluoroacetic acid (TFA): Assessment for classification in new hazard classes submitted. https://www.bfr.bund.de/en/press-release/trifluoroacetic-acid-tfa-assessment-for-classification-in-new-hazard-classes-submitted/ Accessed 28.08.2025.

Björnsdotter, M.K., Yeung, L.W.Y., Kärrman, A., Ericson, J.I. (2019) Ultra-short-chain perfluoroalkyl acids including trifluoromethane sulfonic acid in water connected to known and suspected point sources in Sweden. Environ Sci Technol. 53, p11093-11101.

Blaine, A.C., Rich, C.D., Sedlacko, E.M., Hundal, L.S., Kumar, K., Lau, C., Mills, M.A., Harris, K.M., and Higgins, C.P. (2014) Perfluoroalkyl Acid distribution in various plant compartmetns of edible crops grown in biosolids-amended soils. ES&T. 48(14), p7858-7865.

Boutonnet, J.C., Bingham, P., Calamari, D., de Rooij, C., Franklin, J., Kawano, T., Libre, J-M., McCullock, A., Malinverno, G., Odom, J.M., Rusch, G.M., Smythe, K., Sobolev, I., Thompson, R., Tiedje, J.M. (1999) Envrionmental Risk Assessment of Trifluoroacetic Acid. Human and Ecol. Risk Assess. 5, 59-124.

Brunn, H., Arnold, G., Körner, W., Rippen, G., Steinhäuser, K.G., Valentin, I. (2023) PFAS: forever chemicals - persistent, bioaccumulative and mobile. Revieweing the status and the need for their phase out and remediation of contaminated sites. Environmental Sciences Europe, 35(1).

Bundesamt für Gesundheit (2019) Endokrine Disruptoren. Bundesamt für Gesundheit BAG, B.f.U.B., Bundesamt für Lebensmittelsicherheit und Veterinärwesen BLV, Bundesamt für Landwirtschaft BLW, Staatssekretariat für Wirtschaft SECO, Swissmedic, Suva (ed).

Carlsson, G., Norrgren, L., Orn, S., Ulhaq, M. (2013) Comparison of Developmental Toxicity of Seven Perfluoroalkyl acids to Zebrafish Embryos. Environ Tox and Pharmacol. 36 (2), p423-426.

Chen, H., Yao, Y., Zhao, Z., Wang, Y., Wang, Q., Ren, C., Wang, B., Sun, H., Alder, A.C., and Kannan, K. (2018) Multimedia Distribution and Transfer of Per- and Polyfluoroalkyl Substances (PFAS) Surrounding Two Fluorochemical Manufacturing Facilities in Fuxin, China. ES&T. 52(15), p8263-8271.

Damstra, T., Barlow, S., Bergman, A., Kavlock, R. and Van Der Kraak, G. (2002) Global Assessment of the State-of-the-Science of Endocrine Disruptors.

Dekant, W., and Dekant, R. (2023) Mammalian toxicity of trifluoroacetate and assessment of human health risks due to environmental exposures. Arch of Tox. 97, p1069-1077.

Der Schweizerische Bundesrat (2020) Gewässerschutzverordnung (GSchV) vom 28. Oktober 1998 (Stand am 1. April 2020).

Dorgerloh, U., Becker, R., Freeling, F., Scheurer, M., Gokce, E., Strack, K., Sommerfeld, T., Sauer, A., Schneider, J., Hartel, C., Valkov, V., Moser, L., Geiβ, S., Junginger, S., Schlittenbauer, L., Seuss, E., and Ruth, K. (2025) Standardising the quantification of trifluoroacetic acid in water: interlaboratory validation trial using liquid chromatography-mass spectrometric detection (LC-MS/MS). Accreditation and Quality Assurance 30: 473-376.

EC (2017) Updated peer review of the pesticide risk assessment of the active substance flurtamone. 15(8): 4976.

EC (2018a) Technical Guidance for Deriving Environmental Quality Standards Environment, Guidance Document No. 27, Updated version 2018, Document endorsed by EU Water Directors at their meeting in Sofia on 11-12 June 2018.

EC (2018b) Commission Regulation (EU) 2018/605 of 19 April 2018 amending Annex II to Regulation (EC) No 1107/2009 by setting out scientific criteria for the determination of endocrine disrupting properties

EC (2024) Draft Renewal Assessment Report prepared according to the Commission Regultion (EU) No 1107/2009- Flufenacet.

EC (2025) Directive of the European Parliament and of the council amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy - Analysis of the final compromise text with a view to agreement. 13706/25.

EC/Weybridge UK (1996) European workshop on the impact of endocrine disruptors on human health and wildlife.

ECHA (2007) Information from the Existing Substances Regulation. https://echa.europa.eu/de/information-on-chemicals/information-from-existing-substances-regulation

ECHA (2017) Guidance on Information Requirements and Chemical Safety Assessment Chapter R . 7b : Endpoint specific guidance.

ECHA/EFSA/JRC, Andersson, N., Arena, M., Auteri, D., Barmaz, S., Grignard, E., Kienzler, A., Lepper, P., Lostia, A.M., Munn, S., Parra Morte, J.M., Pellizzato, F., Tarazona, J., Terron, A. and Van der Linden, S. (2018) Guidance for the identification of endocrine disruptors in the context of Regulations (EU) No 528/2012 and (EC) No 1107/2009, European Chemical Agency (ECHA) and European Food Safety Authority (EFSA) with the technical support of the Joint Research Centre (JRC). EFSA Journal 16(6), e05311.

ECHA (2024) REACH Dossier Full Joint Submission - Trifluoroacetic acid. Trifluoroacetic acid 100.000.846 | 60cec416-2eda-4340-98bb-abde81256cda - ECHA CHEM

Freeling, F., Behringer, D., Heydel, F., Scheurer, M., Ternes, T.A., and Nodler, K. (2020) Trifluoroacetate in Precipitation: Deriving a Benchmark Data Set. ES&T. 54, p11210-11219.

Federal Office for the Environment (FOEN) (Accessed 2025) TFA in groundwater. TFA in groundwater

Hanson, M.L., Sibley, P.K., Mabury, S.A., Solomon, K.R., and Muir, D.C.G. (2002) Trichloroacetic acid (TCA) and trifluoroacetic acid (TFA) mixture toxicity to the macrophytes *Myriophyllum spicatum* and *Myriophyllum sibiricum* in aquatic microcosms. Science of the Total Environment 285, p 247-259.

Il Consiglio federale svizzero (2020) Ordinanza sulla protezione delle acque (OPAc) del 28 ottobre 1998 (Stato 1° aprile 2020).

Jagani, R., Chovatiya, J., Patel, H., and Andra, S.S. (2025) Trifluoroacetic Acid: An Ultra-Short PFAS with Emerging Environmental and Public Health Concerns. ES&T. Water 5, p3533-3537.

Klimisch, H.J., Andreae, M. and Tillmann, U. (1997) A systematic approach for evaluating the quality of experimental toxicological and ecotoxicological data. Regulatory Toxicology and Pharmacology. 25, p1-5.

Krippner, J., Brunn., H., Falk, S., Georgii, S., Schubert, S., Stahl, T. (2014) Effects of chain length and pH on the uptake and distribution of perfluoroalkyl substances in maize (Zea mays). Chemosphere. 94, p85-90.

Kutsuna, S., Hari, H. (2008) Experimental determination of Henry's law constants of trifluoroacetic acid at 278 - 298 K. Atmospheric Environment 42(7), p1399-1412.

Le Conseil fédéral suisse (2020) Ordonnance sur la protection des eaux (OEaux) du 28 octobre 1998 (Etat le 1er avril 2020).

Liang, S.H., Chakraborty, M., Steimling, J.A. (2024) Incorporating ultrashort-chain compounds into the comprehensive analysis of per-and polyfluorinated substances in potable and non-potable water by LC-MS/MS. J. of Chromatography Open 6.

Meier, S., Brodmann, P., Weber, S., Moschet, C., Gelmi, T., Lacour, W., Steinmann, J. (2024) Trinkwasserqualität bezüglich der PFAS-Rückstände. Aqua & Gas. 3, p22-27.

Moermond, C.T.A., Kase, R., Korkaric, M. and Ågerstrand, M. (2016) CRED: Criteria for reporting and evaluating ecotoxicity data. Environmental Toxicology and Chemistry. 35(5), p1297-1309.

OECD (2006) Test No. 221: Lemna sp. Growth Inhibition Test

OECD (2011) Test No. 201: Freshwater Alga and Cyanobacteria, Growth Inhibition Test.

OECD (accessed 01.07.2025) OECD Existing Chemicals Database. https://hpvchemicals.oecd.org/ui/AllChemicals.aspx

RIVM (2023) Opinion indicative drinking water guideline value for substance trifluoroacetic acid (TFA, CAS No. 76-05-1)

Rupp, J., Guckert, M., Berger, U., Fu, Q., Nödler, K., Nürenberg, G., Koschorreck, J., Schulze, J., and Reemtsma, T. (2025) Long Term Trends of Legacy Per- and Polyfluoroalkyl Substances (PFAS), Their Substitutes and Precursors in Archived Wildlife Samples from the German Environmental Specimen Bank. Envr Intl. 201, 109592.

Scheurer, M., Nödler, K., Freeling, F., Janda, J., Happel, O., Riegel, M., Müller, U., Storck, F.R., Fleig, M., Lange, F.T., Brunsch, A., Brauch, H-J. (2017) Small, mobile, persistent: Trifluoroacetate in the water cycle - Overlooked sources, pathways, and consequences for drinking water supply. Water Research. 126, p460-471.

Solomon, K.R., Velders, G.J.M., Wilson, S.R., Madronich, S., Longstreth, J., Aucamp, P.J., Bornman, J.F. (2016) Sources, fates, toxicity, and risks of trifluoroacetic acid and its salts: Relevance to substances regulated under the Montreal and Kyoto Protocols. J Toxicol Environ Health B Crit Rev. 19(7), p 289-304.

Sturm, S., Freeling, F., Bauer, F., Vollmer, T., aus der Beek, T., Karges, U. (2023) Trifluoroacetate (TFA): Laying the foundations for effective mitigation - Spatial analysis of the input pathways into the water cycle. Unweltbundesamt (German Environment Agency) 167.

Taniyasu, S., Kannan, K., Yeung, L.W.Y., Kwok, K.Y., Lam, P.K.S., Yamashita, N. (2008) Analysis of trifluoroacetic acid and other short-chain perfluorinated acids (C2-C4) in preciptation by liquid chromatography-tandem mass spectrometry: comparison to patterns of long-chain perfluorinated acids (C5-C8). Anal Chim Acta. 619, p221-230.

The Swiss Federal Council (2020) Waters Protection Ordinance (WPO) of 28 October 1998 (Status as of 1 April 2020).

Umweltbundesamt (UBA, German Environment Agency) (2020) Trifluoressigsäure (TFA) - Gewässerschutz im Spannungsfeld von toxikologischem Leitwert, Trinkwasserhygiene und Eintragsminimierung.

Umweltbundesamt (UBA, German Environment Agency) (2020) UQN Vorschlag TFA.

Umweltbundesamt (UBA, German Environment Agency) (2021) Reducing the input of chemicals into waters: trifluoroacetate (TFA) as a persistent and mobile substance with many sources.

US EPA (2004) Overview of the Ecological Risk Assessment Processin the Office of Pesticide Programs, U.S. Environmental Protection Agency: Endangered and Threatened Species Effects Determinations.

van Vlaardingen, P.L.A., Traas, T.P., Wintersen, A.M. and Aldenberg, T. (2005) ETX 2.0. A program to calculate harzardous concentrations and fraction affected, based on normally distributed toxicity Data.

Warren, N., Allan, I.J., Carter, J.E., House, W.A. and Parker, A. (2003) Pesticides and other micro-organic contaminants in freshwater sedimentary environments—a review. Applied Geochemistry. 18(2), p159-194.

Wujcik, C.E., Cahill, T.M., Seiber, J.N. (1998) Extraction and analysis of trifluoroacetic acid in environmental waters. Anal Chem. 70, p4074-4080.

Yeung, L.W.Y., Stadey, C., Mabury, S.A. (2017) Simlutaneous analysis of perfluoroalkyl and polyfluoroalkyl substances including ultrashort convergence chromatography. J Chromatogr A. 1522, p78-85.

Zhao, H., Yang, L., Yang, X., Zhao, S. (2022) Behaviors of 6:2 fluorotelomer sulfonamide alkylbetaine (6:2 FTAB) in wheat sseedlings: Bioaccumulation, biotransformation and ecotoxicity. Ecotoxicology and Enviornmental Safety, 238.