Australian Government
Department of Health and Aged Care
Australian Industrial Chemicals Introduction Scheme

# Ethylenediaminetetraacetic acid (EDTA) and its salts and complexes

## Evaluation statement

31 March 2025

Draft

# Table of contents

## Contents

# AICIS evaluation statement

## Subject of the evaluation

Ethylenediaminetetraacetic acid (EDTA) and its salts and complexes

## Chemicals in this evaluation

| Name | CAS registry number |
|---|---|
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)- | 60-00-4 |
| Calciate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, disodium, (OC-6-21)- | 62-33-9 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tetrasodium salt | 64-02-8 |
| Glycine, N,N′-1,2-ethanediylbis[N-(carboxymethyl)-, sodium salt (1:2) | 139-33-3 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, trisodium salt | 150-38-9 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, dipotassium salt | 2001-94-7 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tetrapotassium salt | 5964-35-2 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, disodium salt, dihydrate | 6381-92-6 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, potassium salt | 7379-27-3 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, sodium salt | 7379-28-4 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tetrasodium salt, dihydrate | 10378-23-1 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tetrasodium salt, tetrahydrate | 13235-36-4 |
| Magnesate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, disodium, (OC-6-21)- | 14402-88-1 |
| Ferrate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, disodium, (OC-6-21)- | 14729-89-6 |
| Ferrate(1-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, sodium, (OC-6-21)- | 15708-41-5 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, triammonium salt | 15934-01-7 |
| Ferrate(1-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, hydrogen, (OC-6-21)- | 17099-81-9 |

| Name | CAS registry number |
|---|---|
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, monosodium salt | 17421-79-3 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tripotassium salt | 17572-97-3 |
| Ferrate(1-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, sodium, trihydrate, (OC-6-21)- | 18154-32-0 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, diammonium salt | 20824-56-0 |
| Ferrate(1-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, ammonium, (OC-6-21)- | 21265-50-9 |
| Ferrate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, dihydrogen, (OC-6-21)- | 21393-59-9 |
| Ferrate(1-), aqua[[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, sodium, (PB-7-11'-121'3'3)- | 21626-24-4 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, tetraammonium salt | 22473-78-5 |
| Glycine, N,N'-1,2-ethanediylbis[N-(carboxymethyl)-, dipotassium salt, dihydrate | 25102-12-9 |
| Magnesate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, magnesium(2+) (1:1), (OC-6-21)- | 39377-66-7 |
| Ferrate(1-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']-, potassium, (OC-6-21)- | 54959-35-2 |
| Ferrate(2-), [[N,N'-1,2-ethanediylbis[N-(carboxymethyl)glycinato]](4-)-N,N',O,O',ON,ON']hydroxy-, diammonium | 68413-60-5 |
| Iron, EDTA ammonium complexes | 111030-92-3 |

## Reason for the evaluation

Evaluation Selection Analysis indicated a potential environmental risk.

## Parameters of evaluation

This evaluation considers the environmental risks associated with the industrial uses of ethylenediaminetetraacetic acid (EDTA) and its salts and complexes with calcium, sodium, potassium, magnesium and iron.

Chemicals in this group have been assessed for their risks to the environment according to the following parameters:

- A cumulative volume of <3,000 tonnes/year for all chemicals in this group, predicted based on reported Australian and international introduction volumes.
- Industrial uses listed in the ‘Summary of use’ section.
- Expected emission to surface waters via domestic and commercial wastewaters and to soils by direct application.
- Release primarily to the water compartment as a result of their industrial uses.

Chemicals in this group also have reported non-industrial uses in pharmaceuticals, food and pesticides and that are not considered in this AICIS evaluation.

# Summary of evaluation

## Summary of introduction, use and end use

No specific Australian use information has been identified for the chemicals in this group.

Based on international data, chemicals in this evaluation are used as chelating agents in the following products:

- adhesive and sealant products
- arts, crafts and hobby products
- lubricant and grease products
- tattoo ink products
- paint and coating products
- plastic and polymer products
- construction products
- fabric, textile and leather products
- electronic products
- ink, toner and colourant products
- automotive care products
- cleaning and furniture care products
- laundry and dishwashing products
- paper products
- personal care products (cosmetics)
- photographic products
- water treatment products
- fertilisers.

They are also used as chelating agents, chemical reaction regulators, oxidising agents and absorbents in industry processes.

Use of these chemicals in mining and oil extraction and processing have not been assessed in this evaluation.

Reported information from Australia indicates that several chemicals in this group are introduced into Australia in volumes of up to 1,000 tonnes per year. Reported information from international jurisdictions indicate high volumes of use, with nine chemicals having reported volumes in the range 1,000–100,000 tonnes per year.

# Environment

### Summary of environmental hazard characteristics

Based on the information presented in this evaluation and according to the environmental hazard thresholds stated in the Australian Environmental Criteria for Persistent, Bioaccumulative and/or Toxic Chemicals, these chemicals are:

- Persistent (P)
- Not Bioaccumulative (Not B)
- Not Toxic (Not T)

### Environmental hazard classification

Based on the ecotoxicological data presented in this evaluation, chemicals in this group are not expected to be harmful to aquatic organisms. Therefore, these chemicals do not satisfy the criteria for classification for acute or chronic aquatic hazard under the Globally Harmonised System of Classification and Labelling of Chemicals (UNECE 2017).

### Summary of environmental risk

These chemicals are expected to be found in a range of household and commercial products available for use in Australia and widely used in industry processes. These chemicals will be released to surface waters via domestic and commercial wastewaters and to soils by direct application in soil amendments. They are expected to be released to surface waters and soils in forms that remain dissolved or mobile.

The chemicals are persistent (P), not bioaccumulative (Not B) and not toxic (Not T). The industrial use of these chemicals in Australia is not expected to pose a significant risk to the environment as the RQ values are below the level of concern (<1).

# Conclusions

The Executive Director proposes to be satisfied that the identified risks to the environment from the introduction and use of the industrial chemicals can be managed.

Note:

1. Obligations to report additional information about hazards under *Section 100* of the *Industrial Chemicals Act 2019* apply.
2. You should be aware of your obligations under environmental, workplace health and safety and poisons legislation as adopted by the relevant state or territory.

# Supporting information

## Rationale

This evaluation considers the environmental risks associated with the industrial uses of ethylenediaminetetraacetic acid (EDTA) and its salts and complexes with sodium, potassium, ammonium, calcium, magnesium and iron. These 30 chemicals are being assessed as a group because they are expected to form the same or interchangeable species in the environment.

The evaluation selection analysis indicated potential risk to aquatic and terrestrial life based on high environmental concentrations in international surface waters, high use volumes and expected high release pathways to soils.

## Chemical identity

EDTA is a synthetic aminopolycarboxylic acid derived from glycine. It contains four carboxylic acid groups and can form conjugate base anions with charges ranging from –1 to –4. The term EDTA is used to refer to both the protonated and deprotonated forms.

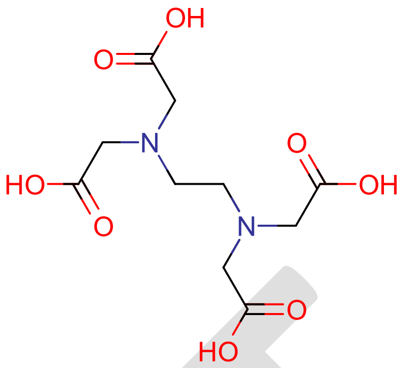
The dissociated anion, EDTA(4–), forms complexes with metal ions through multiple bonds, and the resulting heteroatomic rings are called chelates (Hart 2011). EDTA can coordinate to metal ions through six donor atoms, forming up to five chelate rings (Bucheli-Witschel and Egli 2001). It forms chelate complexes with di- and trivalent cations including calcium(2+), magnesium(2+) and iron(3+).

The term ‘salt of EDTA’ is used to refer to a compound consisting of a cation and anionic form of EDTA. Complex salts are ionic compounds consisting of a cation and an anionic metal-EDTA complex. Complex salts will be referred to by the formula [salt cation] [complex cation] EDTA, e.g. sodium iron(3+) EDTA (a sodium salt of the iron(3+) EDTA complex).

The chemicals in this evaluation include the fully protonated EDTA (referred to as the free acid), salts of EDTA anions, metal-EDTA chelate complexes, and salts of metal-EDTA complexes (complex salts) with sodium, potassium, ammonium, calcium, magnesium or iron cations.

Chemical identity details are given in the tables below for EDTA, a representative salt and a representative complex salt.

| | |
|---|---|
| **CAS number** | 60-00-4 |
| **CAS name** | Glycine, *N*,*N*'-1,2-ethanediylbis[*N*-(carboxymethyl)- |
| **Molecular formula** | $C_{10}H_{16}N_2O_8$ |
| **Associated names** | EDTA<br>Ethylenediaminetetraacetic acid<br>Edetic acid |

| | |
|---|---|
| **Molecular weight (g/mol)** | 292.24 |
| **SMILES (canonical)** | O=C(O)CN(CC(=O)O)CCN(CC(=O)O)CC(=O)O |
| **Structural formula** |  |

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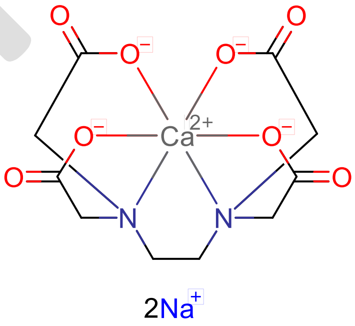
| | |
|---|---|
| **CAS number** | 62-33-9 |
| **CAS name** | Calciate(2-), [[*N*,*N′*-1,2-ethanediylbis[*N*-[(carboxy-.kappa.*O*)methyl]glycinato-.kappa.*N*,.kappa.*O*]](4-)]-, sodium (1:2), (*OC*-6-21)- |
| **Molecular formula** | $C_{10}H_{12}CaN_2O_8.2Na$ |
| **Associated names** | Disodium calcium EDTA<br>Disodium [(ethylenedinitrilo)tetraacetato]calciate |
| **Molecular weight (g/mol)** | 374.27 |
| **SMILES (canonical)** | [Na+].O=C1[O-][Ca+2]2345[O-]C(=O)C[N]5(C1)CC[N]4(CC(=O)[O-]2)CC(=O)[O-]3 |
| **Structural formula** |  |

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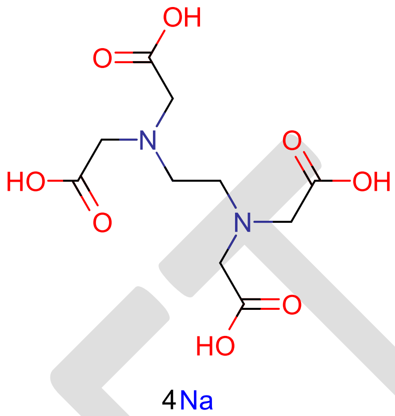
| | |
|---|---|
| **CAS number** | 64-02-8 |
| **CAS name** | Glycine, *N*,*N′*-1,2-ethanediylbis[*N*-(carboxymethyl)-, sodium salt (1:4) |

| | |
|---|---|
| **Molecular formula*** | $C_{10}H_{16}N_2O_8.4Na$ |
| **Associated names** | Tetrasodium EDTA |
| **Molecular weight (g/mol)*** | 384.20 |
| **SMILES (canonical)*** | [Na].O=C(O)CN(CC(=O)O)CCN(CC(=O)O)CC(=O)O |
| **Representative structure*** |  |

**Additional chemical identity information**

* This chemical is a salt and has been represented according to CAS nomenclature/identity conventions.

## Relevant physical and chemical properties

The chemical EDTA is a colourless solid at room temperature and thermally decomposes before melting (EC 2004). In water at neutral pH, it is expected to form a zwitterion with fully deprotonated carboxylic acid groups, given pKa values of −0.12 to 2.7 for the carboxylic acid groups and 6.07 to 10.44 for the amines (REACH n.d.-a).

All the other chemicals in this group are ionic and are also expected to be solids under ambient conditions. All chemicals are expected to have very low volatility and lipophilicity due to their ionic nature. In the environment, the free acid and salt forms of EDTA are expected to dissolve and dissociate into the same anionic EDTA species. Salts of EDTA complexes of calcium, magnesium and iron will dissolve and dissociate to form the corresponding anionic metal-EDTA complexes.

The chemical EDTA forms water-soluble complexes with metal ions (Bucheli-Witschel and Egli 2001). Water solubility data for selected chemicals are given in the table below, representing the different degrees of ionisation and chelate complexes present in chemicals in this group. The free acid is moderately soluble in water, and the selected salts and complexes are readily soluble. Data are from (Hart 2011) or (REACH n.d.-a; REACH n.d.-d; REACH n.d.-e; REACH n.d.-g).

| **Chemical** | **Water solubility (mg/L)** |
|---|---|
| EDTA | 100 |
| Disodium EDTA | 105,000 |

| | |
|---|---|
| Tetrasodium EDTA | 500,000 |
| Dipotassium EDTA | 681,000 |
| Disodium calcium EDTA | 336,000 |
| Sodium iron(3+) EDTA | 72,000 |
| Disodium magnesium EDTA | 370,000 |

The other EDTA salts and complexes in this evaluation are also expected to be readily soluble.

# Introduction and use

## Australia

Based on information reported to the former National Industrial Chemicals Notification and Assessment Scheme (NICNAS) under previous mandatory and/or voluntary calls for information, the annual introduction volumes of the following chemicals are each in the range of 100–1,000 tonnes:

- EDTA (CAS RN 60-00-4)
- disodium calcium EDTA (CAS RN 62-33-9)
- tetrasodium EDTA (CAS RN 64-02-8)
- disodium EDTA (CAS RN 139-33-3)
- sodium iron(3+) EDTA (CAS RN 15708-41-5)
- ammonium iron(3+) EDTA (CAS RN 21265-50-9).

No Australian introduction volume information have been identified for the other chemicals in this group.

No specific Australian use information has been identified for the chemicals in this group.

## International

The chemicals in this group are used to bind metal ions in a wide range of domestic and commercial products and processes to promote dissolution or mobility, prevent certain reactions, and facilitate other reactions. They have high reported international volumes, with nine chemicals having reported volumes in the range 1,000–100,000 t/year.

Synthetic aminopolycarboxylic acids are widely used for their ability to form stable, water-soluble chelate complexes with metal ions. They are referred to as chelating agents. EDTA is the most common aminopolycarboxylic acid chelating agent (Bucheli-Witschel and Egli 2001; Hart 2011). Since EDTA and its salts will dissociate to the same anionic species before complexing metal ions, the uses of chemicals in this evaluation are expected to overlap.

The chemical EDTA is mainly used to prevent inorganic precipitation, to prevent undesirable metal-catalysed reactions and to remove metal ions and inorganic deposits (Bucheli-Witschel and Egli 2001; Hart 2011). Along with its salts and some complexes, it is used for these purposes in:

- dishwashing and laundry detergents,
- cleaning products (including automotive cleaning products),
- personal care products (cosmetics),
- boiler water,
- textile dyeing and finishing,
- photographic industry,
- metal plating of components for electronic products,
- pulp and paper bleaching,
- fume desulfuration at power and waste incineration plants.

(Bucheli-Witschel and Egli 2001; EC 2004; n.d.; Hart 2011; US EPA 2004; US EPA 2020).

It also reportedly used in building and construction materials, adhesives, paints and coatings, printing inks, tattoo inks and lubricants (EC 2004; Government of Canada 2018; US EPA 2020).

The chemical EDTA is added to fertilisers in metal-chelate form to increase availability of complexed metal ions to plants by increasing their mobility and preventing precipitation reactions (Bucheli-Witschel and Egli 2001; Hart 2011). EDTA and sodium and ammonium salts of EDTA, iron(3+) EDTA, calcium EDTA and magnesium EDTA are reportedly used in fertilisers (US EPA 2020).

The chemical EDTA is also used for extracting heavy metals from contaminated soils either by assisted phytoextraction, in which metal-chelate complexes are taken up by plants, or by soil washing, in which soluble metal-EDTA complexes are removed from soil in solution (Leštan et al. 2008; Shahid et al. 2014).

Iron-EDTA complexes are used to promote or perform desirable reactions. EDTA is used together with iron ions to initiate polymerisation in the production of styrene-butadiene rubber (EC 2004; Hart 2011). Ammonium iron(3+) EDTA is used to oxidise silver in photographic processing (Bucheli-Witschel and Egli 2001; EC 2004). Iron chelates are also used to treat gaseous emissions, removing hydrogen sulfide by catalysing oxidation to elemental sulfur and nitrogen oxide by absorption (Hart 2011).

Uses of chemicals in this group in resource extraction (including oil and gas production, and mining) are not considered in this evaluation. Uses of chemicals in this group in pharmaceuticals, food and pesticides are not considered to be industrial uses under the *Industrial Chemicals Act 2019*. Therefore they are not included in the parameters of AICIS evaluations.

In Europe, the reported Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) Total Tonnage Band is highest for tetrasodium EDTA at 10,000–100,000 t/year (REACH n.d.-e). Volumes of 1,000–10,000 t/year are reported for EDTA, disodium calcium EDTA, disodium EDTA, sodium iron(3+) EDTA and diammonium hydroxy iron(3+) EDTA. The remaining chemicals in this group have reported volumes under 1,000 t/year or no reported volumes (ECHA n.d.).

In the United States of America (USA), the highest volume of up to 113,000 t/year is reported for tetrasodium EDTA, followed by up to 45,400 t/year for EDTA (US EPA 2020). Volumes of up to 9,070 t/year are reported for diammonium EDTA, ammonium iron(3+) EDTA and diammonium hydroxy iron(3+) EDTA, and volumes of up to 4,540 t/year for disodium calcium EDTA, disodium EDTA, sodium iron(3+) EDTA and tetraammonium EDTA. The remaining chemicals in this group have reported volumes under 1,000 t/year or no reported volumes.

In Canada, import volumes for tetrasodium EDTA and EDTA of 1,000–10,000 t and 100–1,000 t, respectively, were reported in 2013 (Government of Canada 2018). Ammonium iron(3+) EDTA and sodium iron(3+) EDTA had reported import volumes under 100 t.

# Existing Australian regulatory controls

## Environment

The Australian Drinking Water Guidelines specify a health guideline value for EDTA in drinking water of 0.25 mg/L (NHMRC 2011).

In Australia, the Australia New Zealand Guidelines for Fresh and Marine Water Quality (ANZ Water Quality Guidelines) provide default guideline values for various metals and metalloids in fresh and marine water. These values represent a starting point for assessing water quality and are recommended for generic applications in the absence of more relevant guideline values. No default guideline values for iron in fresh and marine water have been derived, due to lack of data, and the ANZ Water Quality Guidelines suggest an interim indicative working level of 300 µg Fe/L, based on the Canadian guideline level (ANZG 2000).

# International regulatory status

## United Nations

The chemicals in this group are not currently identified as a Persistent Organic Pollutant (POP) (UNEP 2001), ozone depleting substance (UNEP 1987), or hazardous substance for the purpose of international trade (UNEP & FAO 1998).

## OECD

The chemical EDTA was sponsored by Germany under the Cooperative Chemicals Assessment Programme (CoCAP). The 18th Screening Information Data Set (SIDS) Initial Meeting Assessment (SIAM 18) in 2004 agreed that the chemical was a candidate for further work (OECD n.d.). Although EDTA was not found to possess properties indicating a hazard for the environment, a risk assessment performed in the context of the EU Existing Substances Regulation identified a risk for the following scenarios based on very high releases of the substance:

- for the use of EDTA in industrial detergents by large sites within dairy and beverage industry where no effective wastewater treatment is applied
- for paper pulp mills where no effective wastewater treatment is applied
- for metal plating (circuit board production)
- for releases at waste disposal sites.

Countries were invited to perform an exposure assessment to identify possible risks to the aquatic environment caused by the use of EDTA as complexing agent.

# Environmental exposure

In Australia, EDTA and its salts and complexes are expected to be widely used in industrial processes and found in a range of domestic and commercial products. These chemicals will be released to surface waters via domestic and industrial wastewaters. EDTA will be released to soils by direct application of some products to soils.

Chemicals used in dishwashing, laundry, cleaning and personal care products are usually released to wastewater. Studies indicate that EDTA concentrations are not significantly reduced by typical wastewater treatment (Bucheli-Witschel and Egli 2001). These chemicals are, therefore, expected to remain in treated wastewater effluent that is released to surface waters. Products going into stormwater, such as DIY automotive cleaning products, are expected to be released directly to surface waters without treatment.

Chemicals used in commercial applications can enter surface waters via wastewater disposal. EDTA-containing wastewater is expected to be generated from several major industries as follows (EC 2004; OECD 2004c):

- EDTA added to boiler water will mostly be recirculated within a closed system but will be discharged during routine maintenance such as flushing or cleaning of the system
- In pulp and paper bleaching, EDTA is not fixed into the paper and will remain in effluent.
- EDTA used in metal plating may be recycled into the process but is ultimately expected to be disposed of in wastewater.
- EDTA-containing chemicals used in photographic industry may be disposed of by incineration, evaporation and disposal of the solid residue, or emission to wastewater. This information comes from reports published in the early 2000s, and contributions from photographic industry are expected to have decreased substantially over the past 20 years.
- EDTA-containing chemicals used in industrial cleaning, textile manufacture and rubber production are expected to be released in effluent.

Effluents from these processes may, in some cases, be treated on-site before release to surface waters (EC 2004; OECD 2004a; 2004b; 2009). They may also be discharged to sewers and undergo standard sewage treatment. On-site industrial wastewater treatment may degrade EDTA more effectively than typical sewage treatment (EC 2004), but this will depend on the facility. Some proportion of EDTA is expected to remain in all treated effluent released to surface waters.

Chemicals containing EDTA used for fume desulfuration are often not emitted to wastewater, but rather circulated through a closed system, the waste from which is incinerated (EC 2004). Iron-EDTA complexes used to treat gaseous emissions are expected to have similarly low environmental release.

Chemicals in this group are expected to be applied directly to soils when used in fertilisers and soil remediation. EDTA-containing fertilisers are applied in solution via spraying or through irrigation systems (Agricrop Nutrition n.d.; Optifert n.d.; RapiSol n.d.; Valagro n.d.). Soil remediation is expected to be applied to contaminated sites and environmental exposure to EDTA managed on a site-by-site basis. Available information indicates that significant amounts of EDTA may be applied, much of which can remain in soils after metals of concern have been removed. This remaining EDTA can then leach to water (Nowack et al. 2006). In soil-washing, up to 64% of applied EDTA may be retained in remediated soils (Jez and Lestan 2016). Soil-washing also produces wastewater containing metal-chelate complexes, which will be treated to remove heavy metals, although it is unclear to what extent the chelating agent is removed (Leštan et al. 2008). When soil is remediated by EDTA-assisted phytoextraction, calculations suggest that at least 90% of the chelating agent applied to the soil will remain in the soil solution (Nowack et al. 2006). The plant mass that has accumulated metal-EDTA complexes is expected to be disposed of in landfill or by incineration.

Chemicals used in building and construction materials, adhesives, paints and coatings, inks and lubricants may be released by abrasion, flaking, spills and leakage. These can result in diffuse emissions to soil and to waters via urban runoff. These emissions are expected to be minor compared to discharge of EDTA to domestic and commercial wastewaters and intentional application to soils.

## Environmental fate

### Speciation, partitioning and mobility

The chemicals in this group are expected to be released to surface waters and soils in forms that remain dissolved or mobile. In surface waters, these chemicals are expected to exist mainly as dissolved metal-EDTA complexes, a major form being the iron(3+) complex. Other metal-EDTA complexes will be present depending on water chemistry, the form in which EDTA is released, relative stabilities of the complexes and the rate of ligand exchange. In soils, EDTA will also form soluble metal complexes that diffuse readily, with the iron(3+) complex expected to be dominant in acidic soils and the calcium complex prevalent in alkaline soils.

In water, the free acid and salt forms of EDTA are expected to dissociate into the same anionic EDTA species. However, as the EDTA anion tends to chelate metal cations and is widely used as either a chelating agent or a metal-chelate complex, it will exist mostly as soluble metal-EDTA complexes (EC 2004). For example, the Fe(3+)EDTA complex anion is a major form of EDTA released to surface waters due to the use of iron salts during wastewater treatment to precipitate phosphates and use of iron-EDTA complexes in the rubber production and, to a lesser extent, photographic industries (Bucheli-Witschel and Egli 2001; EC 2004). This species constitutes 20–90% of total EDTA in wastewater effluents (Nowack 2002).

In surface waters, remaining free EDTA ions are expected to form metal complexes by chelating to naturally occurring metal cations (Bucheli-Witschel and Egli 2001). The distribution of different metal-EDTA complexes will depend on:

- water chemistry parameters including abundance of cations and competing ligands (e.g. hydroxide anions and humic acids),
- the form in which EDTA is released to the environment (e.g. the free anion or a metal-EDTA complex),
- reaction parameters including the rate of ligand exchange (i.e. how quickly EDTA ions dissociate from one metal ion and chelate another), and the stabilities of the metal-EDTA complexes themselves.

In particular, significant concentrations of Fe(3+)EDTA in surface waters are expected due to the slow rate of EDTA ligand exchange between Fe(3+) and other metals (Bucheli-Witschel and Egli 2001; EC 2004). Fe(3+)EDTA is expected to be continuously released to the environment and have a half-life of about 20 days in river waters. When ligand exchange does occur, it will release free Fe(3+) into the water compartment.

EDTA-containing species in surface waters are expected to remain mostly dissolved and not partition significantly to sediments. Adsorption of free EDTA to the organic fraction of sediments is not expected (EC 2004), and level III fugacity modelling predicts 99% of EDTA emitted to water will remain in the water compartment (US EPA 2017). Negatively charged metal-EDTA complexes will sometimes adsorb to positively charged solids such as aluminium and iron(3+) (hydr)oxides and manganese (3+,4+)oxides (Bucheli-Witschel and Egli 2001; Nowack 2002).

Some literature reports have identified concerns about the ability of chelating agents to remobilise metals in sediments. However, reviews suggest that this will not be significant at typical environmental concentrations and will only occur when unusually high EDTA loadings are released in wastewater and some proportion of EDTA remains free (i.e. not chelated with a metal) (Bucheli-Witschel and Egli 2001; EC 2004).

In soils, EDTA-containing species are expected to be mobile. Free EDTA is expected to adsorb only slightly (EC 2004) but precipitate under very acidic conditions (Jez and Lestan 2016). Fugacity modelling suggests that approximately half of EDTA applied in fertilisers will remain in soil in the porewater fraction, the rest partitioning to surface waters via runoff or groundwater via leaching. Free EDTA will complex metals present in soil particles, such as iron and manganese in oxides and metals bound to sulfides and organic material (Shahid et al. 2014). Modelling suggests that, at equilibrium, the iron(3+) complex will be dominant in soils at pH ≤ 7 while calcium complexes become prevalent in alkaline soils (Nowack et al. 2006). However, the abundance of Fe(3+)EDTA will also depend on time and the type of iron oxides in the soil, as conversion of iron oxides to chelate complexes can be slow due to slow mineral dissolution. Metal-EDTA complexes are expected to diffuse readily and leach into groundwater (Nowack et al. 2006; Shahid et al. 2014). However, metal-EDTA complexes may be increasingly adsorbed onto mineral surfaces under acidic conditions (Jez and Lestan 2016).

### Degradation

The chemical EDTA is not readily or inherently biodegradable. EDTA will be photolysed in surface waters when complexed to Fe(3+), and its photolysis products are more readily biodegradable. The extent of degradation will depend on light conditions and EDTA speciation. While a significant portion of EDTA in Australian waters is likely to degrade rapidly, degradation may not be complete. In soils and sediments, EDTA may persist for over six months.

The chemical EDTA is recalcitrant to biodegradation in wastewater treatment plants and the environment. It does not pass OECD ready biodegradation tests, and inherent biodegradability studies give mixed results (EC 2004). EDTA can be biodegraded under certain conditions, but these conditions are not typical during standard wastewater treatment.

In soils and sediments, some studies have found no biodegradation, whereas others have found slow microbial decomposition under aerobic conditions (Bucheli-Witschel and Egli 2001; EC 2004). EDTA has been reported to persist in soil for over six months (Shahid et al. 2014) and the European Union estimated half-lives of approximately ten months (EC 2004). No biodegradation has been observed under anaerobic conditions.

The major degradation pathway for EDTA in the environment is via photolysis when bound to iron(3+) (Bucheli-Witschel and Egli 2001; EC 2004). Ultimate degradation of Fe(3+)EDTA is expected to occur via a combination of photolysis and biodegradation under certain conditions, releasing Fe(3+) as the ligand is mineralised. This occurs in surface waters when Fe(3+)EDTA is exposed to the fraction of sunlight below 400nm (violet light). EDTA may also be photodegraded in natural waters when adsorbed to iron oxide (Nowack 2002). Most other environmentally relevant EDTA species and free EDTA do not photolyse under environmental conditions (Bucheli-Witschel and Egli 2001). Considering the prevalence of Fe(3+)EDTA and iron oxide in the environment, a considerable amount of EDTA in surface waters should be degraded by photolysis.

For Fe(3+)EDTA, calculated photolysis half-lives range from 11 min to 20 days, depending on light conditions (Bucheli-Witschel and Egli 2001; EC 2004). Most studies have been tailored to light conditions in central and northern Europe. In Australia, stronger sunlight with higher UV levels would likely accelerate photolysis. In a field study in a Swiss river, Fe(3+)EDTA was eliminated within approximately 1 day.

When bound to Fe(3+), EDTA photolysis proceeds via successive decarboxylation, generating first ethylenediaminetriacetate (ED3A), then ethylenediaminediacetate (EDDA), then ethylenediaminemonoacetate (EDMA) (Nowack 2002). EDMA does not photodegrade further under these conditions. ED3A may cyclise to form ketopiperazinediacetate (KPDA) in the environment. Other degradation products include iminodiacetate (IDA), formaldehyde, carbon dioxide and glycine (EC 2004).

These photodegradation products biodegrade more readily than EDTA. In a modified OECD 302B test (inherent biodegradability), photolysis metabolites were incubated with activated sludge over 4 weeks, and mineralisation measured by carbonate titration. Mineralisation was 50% when the metabolites were mainly ED3A, EDDA and EDMA, and 93% when metabolites were mainly EDDA and EDMA. This result indicated inherent primary biodegradation of all the metabolites and ultimate biodegradation of EDDA and EDMA (Bucheli-Witschel and Egli 2001; EC 2004). In an OECD 301D closed bottle (ready biodegradability) test of KPDA, 92% biodegradation was observed after 4 weeks, but 60% degradation was not observed during the 10-day window. This result indicated ultimate but not ready biodegradation (EC 2004). These studies suggest that the photodegradation product ED3A may be persistent, but EDDA, EDMA and KDPA are probably not. However, as discussed above, ED3A is readily photodegraded to EDDA and EDMA in the presence of iron and sunlight.

Other abiotic degradation reactions of EDTA, such as hydrolysis or reaction with OH radicals, are slow or insignificant compared to photodegradation (EC 2004).

### Bioaccumulation

The chemical EDTA has low bioaccumulation potential. Due to the ionic nature of EDTA and EDTA complexes in solution, EDTA species in the environment are expected to have low lipophilicity. EDTA has a calculated BCF of 0.893 L/kg (US EPA 2017), and reported bioaccumulation endpoints for fish (*Lepomis macrochirus*) from experimental studies indicate minimal bioaccumulation of EDTA (EC 2004).

Metal-EDTA complexes are easily taken up by most plant species (Shahid et al. 2014). In phytoremediation, EDTA is added to soils to chelate metals and induce their accumulation in the harvestable parts of plants (Nowack et al. 2006), which is intended for disposal. High concentrations of chelating agent must be applied to the soil to achieve the desired accumulation and may kill the plant after some time. This scenario is unlikely to occur outside of intentional application of EDTA for the remediation of soils that are heavily contaminated by metals.

### Environmental transport

These chemicals may be transported long distances in natural water bodies due to their environmental persistence and tendency to remain dissolved.

## Predicted environmental concentration (PEC)

Calculated PEC values in surface waters and soils were derived for chemicals in this group. The PEC for EDTA in surface waters is 1,147 µg/L and was predicted based on standard exposure modelling and an estimated combined volume. The PEC for iron ions released from these chemicals is 51.2 µg Fe/L. The PEC in soils is 0.67 mg/kg dry weight (dw) for EDTA and 0.84 mg/kg dw for sodium iron(3+) EDTA and was based on recommended chemical application rates for EDTA-based fertilisers to agricultural land and fugacity modelling.

In surface waters, the calculated PEC for EDTA was considered more representative than concentrations from available monitoring data. Australian monitoring data is limited, and international environmental concentrations vary widely. The monitoring data does, however, support the calculated PEC as a reasonable worst-case estimate.

A PEC of 1,147 µg/L was calculated for EDTA using standard exposure modelling for release to surface waters via STP effluents (EPHC 2009; Struijs 1996). This was based on a reasonable worst-case estimate of the total Australian use volume of the chemicals in this evaluation. The combined volume is derived from reported Australian and international introduction volumes and is <3,000 tonnes/year. The model also conservatively assumes that 100% of the volume is released to sewers, and that no biodegradation occurs during treatment.

In Australia, some information indicates that EDTA has been detected in sewage treatment plant (STP) effluent in concentrations ranging from 0.7 to 210 µg/L (EPHC, NHMRC, NRMMC, 2008; NEPC 2008). It is unclear how representative these concentrations might be, as no details about STP locations or sampling strategies were provided. No Australian monitoring data was identified for surface waters or soils.

International monitoring data is mainly from lakes and rivers. In Europe, EDTA has been identified at higher concentrations in surface waters than any other man-made organic compound (Nowack and VanBriesen 2005). Reported concentrations in Europe vary widely and concentrations above 1,000 µg/L have been detected in several countries. Concentration ranges are summarised below for European countries with the highest reported EDTA levels. These are compiled from several reviews, as indicated. Note that values ≥ 2,000 µg/L in Germany and Spain were only detected in one sample per country.

| Country | Concentrations (µg/L) | Water body types | Reference |
|---|---|---|---|
| Germany | <1–2,000 | Rivers, creeks | (EC 2004) |
| Switzerland | 1–200 | Rivers, lakes | (Bucheli-Witschel and Egli 2001; EC 2004) |
| Spain | 599–2,460 | River | (EC 2004) |
| England | 14–1,120 | River | (Oviedo and Rodríguez 2003) |

In the USA, concentrations of EDTA in several rivers were 0–153 µg/L (Jiann et al. 2013; Nowack and VanBriesen 2005). In New Zealand, concentrations in dairy effluents discharged into a river were 72–261 µg/L. At a point 60 metres downstream, this was diluted to 2.7 µg/L (Xie et al. 2010).

As the calculated freshwater PEC is larger than the measured concentrations in Australia and most concentrations measured internationally it is expected to be protective.

A PEC of 51.2 µg/L was calculated for iron ions that may be released from iron-containing chemicals in this group in surface waters, using the same standard STP exposure model as above and an estimated combined volume. The model calculates a PEC in rivers of 332 µg/L for the chemicals, equivalent to approximately 51.2 µg Fe/L. It should be noted that iron is an essential and abundant trace element, and significant background concentrations are expected in natural waters. Typical concentrations in Australian drinking water are around 0.1 mg/L and up to 1 mg/L in uncontaminated surface waters (NHMRC 2011).

In soils, studies monitoring EDTA concentrations are limited, despite the use of EDTA-containing chemicals in fertilisers and soil remediation. Fertilisers are expected to be the most widespread source of EDTA in soils, as soil remediation is likely to be limited to contaminated sites. No studies were identified of soil concentrations resulting from typical fertiliser application.

Fertilisers containing EDTA are applied to crops in solution. As the chemicals are used deliberately to support plant health, the rate and frequency of application is expected to be moderated by impacts of these chemicals on the crops.

A soil PEC of 0.67 mg EDTA/kg dw was calculated based on chemical application rates of 5.4 kg EDTA/ha and a level III fugacity model modified for fertiliser application to agricultural soils. The equivalent soil PEC for sodium iron(3+) ETDA, a form in which EDTA is commonly applied, is 0.84 mg/kg dw. EDTA complexes of iron, magnesium and calcium are distributed in Australia with recommended maximum application rates of 3-10 kg per hectare of land (Agricrop Nutrition n.d.; Optifert n.d.; RapiSol n.d.; Valagro n.d.). The equivalent mass of EDTA for the average maximum application rate is 5.4 kg/ha. The model is based on a soil type with high porewater fraction (sand) and accounts for losses from rainwater and irrigation runoff and leaching to groundwater.

As EDTA-containing chemicals are highly soluble and partition readily to water, concentrations are not expected to build up in soils. Because of their mobility, EDTA-containing chemicals in applied fertilisers are likely to enter surrounding soils and waterways via runoff and leaching. As the above calculation is a worst-case concentration of EDTA at the time of application, the concentration of EDTA in surrounding soils can be expected to be lower. Contributions of soil leaching to EDTA surface water concentrations are expected to be reflected in the previously discussed monitoring data.

One study has investigated EDTA concentrations in soils from New Zealand farms irrigated with EDTA-rich dairy wastewater. This found concentrations of <0.15–0.93 mg EDTA/kg in topsoils, compared to <0.15 mg/kg in topsoil at sites that had not been irrigated (Xie 2009). While there is no evidence of such discharge of dairy wastewater occurring in Australia, the application of EDTA to agricultural land through irrigation systems is similar to methods of applying EDTA-containing fertilisers. Results from the same New Zealand study demonstrated leaching of EDTA to groundwater, with groundwater concentrations of 10.1–627 µg/L detected at irrigated sites, compared to <2–38 µg/L at non-irrigated sites (Xie 2009). The highest of these exceeds the Australian drinking water health guideline of

250 µg/L. The study also indicated that cadmium, copper, iron and zinc had been transported from soil to groundwater at farms irrigated with EDTA-rich wastewater.

# Environmental effects

## Effects on aquatic life

The EU Risk Assessment Report of EDTA contains a detailed review of aquatic ecotoxicity tests of free EDTA, tetrasodium EDTA and EDTA complexes of calcium, magnesium, iron, manganese, copper and zinc (EC 2004). The current REACH dossiers for EDTA-containing chemicals present some relevant studies that have become available since the EU report was published in 2004 (REACH n.d.-a; n.d.-c). While many aquatic endpoints for EDTA-containing chemicals have been reported more broadly, this evaluation considers the EU report and current REACH dossiers to have adequately summarised endpoints appropriate for environmental risk assessment while taking into consideration some factors that may influence test results, as described below.

Aquatic toxicity of EDTA is believed to be caused by disturbances in metal metabolism (EC 2004). EDTA occurs as a mixture of different EDTA-metal complexes in surface waters and its speciation influences ecotoxicity. Ecotoxicity assessment of EDTA should therefore consider tests with free EDTA, EDTA salts and metal-EDTA complexes.

In standard test media, free EDTA will form complexes with metals present as trace nutrients, unless it is added in concentrations exceeding stoichiometric amounts. Metal-EDTA complexes with metals that are not toxic to aquatic life, such as calcium and magnesium, tend to be considerably less toxic than the free EDTA anion. However, complexes with toxic metals such as copper and zinc show similar toxicity to the free anion, and the toxicity of the free metal ion is expected to contribute to the effects. This evaluation only considers EDTA complexes of calcium, magnesium and iron.

In closed systems, concentrations of EDTA exceeding concentrations of trace metals may cause nutrient deficiency to test organisms, leading to toxic effects. Furthermore, adding the protonated form of EDTA to test media may decrease pH to a degree that is detrimental to test organisms. Both effects are considered unlikely to occur in environmental waters due to dilution and the continuous supply of trace metals. Endpoints that may have been influenced by such effects have been discounted.

EDTA toxicity is also influenced by water hardness and pH. For example, free EDTA is more toxic to fish in soft water than hard water, as conversion to the calcium complex decreases toxicity.

### Acute toxicity

The following acute median lethal concentrations (LC50) and median effective concentrations (EC50) for model organisms across three trophic levels are the lowest reliable endpoints from the EU Risk Assessment Report (EC 2004) the REACH dossiers for EDTA-containing chemicals (LMC 2023; REACH n.d.-a; n.d.-c). Concentrations are of the specified test substance. Water hardness and pH are indicated, where available. Water hardness is the sum of Ca(2+) and Mg(2+) ions but is expressed in units of milligrams of calcium carbonate per litre (mg $CaCO_3$/L):

| Taxon | Endpoint | Method |
|---|---|---|
| **Fish** | 96 h LC50 = 157 mg/L | Test species: tetrasodium EDTA<br>*Lepomis macrochirus* (bluegill)<br>Static conditions<br>Hardness = 10–13 mg $CaCO_3$/L<br>pH = 7.0–7.7 |
| **Invertebrate** | 48 h EC50 = 101 mg/L | Test species: sodium iron(3+) EDTA<br>*Daphnia magna* (water flea)<br>Immobilisation<br>Static conditions, nominal concentration<br>OECD TG 202<br>pH = 7.7–8.5 |
| **Algae** | 72 h EC50 > 71 mg/L | Test species: iron(3+) EDTA<br>*Raphidocelis subcapitata* (green alga)<br>Growth rate<br>Static conditions, measured concentration<br>OECD TG 201 |

Note that in the studies on algae, no adverse effects on growth were observed at the highest test concentrations, provided sufficient trace metals were available in the test media.

### Chronic toxicity

The following chronic no observed effect concentrations (NOEC) for model organisms across three trophic levels are the lowest reliable endpoints from the EU Risk Assessment Report (EC 2004) and the REACH dossiers for EDTA-containing chemicals (LMC 2023; REACH n.d.-a). Concentrations are of the specified test substance. Water hardness and pH are indicated, where available:

| Taxon | Endpoint | Method |
|---|---|---|
| **Fish** | 35 d NOEC >36.9 mg/L | Test species: disodium calcium EDTA<br>*Danio rerio* (zebrafish)<br>Mortality and growth inhibition<br>Flow-through conditions, measured concentration<br>OECD TG 210<br>Hardness = 90–100 mg $CaCO_3$/L<br>pH = 7.9–8.2 |
| **Invertebrates** | 21 d NOEC = 25 mg/L | Test species: disodium EDTA<br>*Daphnia magna* (water flea)<br>Reproduction<br>Semi-static conditions, nominal concentration<br>OECD TG 211<br>Hardness = 220–320 mg $CaCO_3$/L<br>pH = 7.3–8.5 |
| **Algae** | 72 h NOEC = 57.0 mg/L | Test species: iron(3+) EDTA<br>*Raphidocelis subcapitata* (green alga)<br>Growth rate<br>Static conditions, measured concentration<br>OECD TG 201 |

## Effects on terrestrial life

The chemicals EDTA and sodium iron(3+) EDTA can have toxic effects on earthworms and plants via soil exposure (Edwards et al. 2009; REACH n.d.-b; n.d.-f). The toxicity of EDTA in soils is complicated by its interactions with metals. EDTA is added to soils to increase the mobility and bioavailability of metals to plants, which may also increase their toxicity to plants and other biota. The combination of iron phosphate and EDTA was found to be more toxic to earthworms than EDTA alone (Edwards et al. 2009). The addition of EDTA to soils contaminated with metals such as lead, zinc and cadmium was shown to increase metal uptake in and adverse effects on plants, soil micro-organisms and earthworms (Evangelou et al. 2007; Grčman et al. 2001; Jones et al. 2007).

The following ecotoxicity endpoints for soil exposure to earthworms and plants and dietary exposure to birds were obtained from the REACH dossiers for EDTA-containing chemicals (REACH n.d.-a; n.d.-f; n.d.-h) and the literature (Edwards et al. 2009). Separate endpoints are given for free EDTA and sodium iron(3+) EDTA, where available, due to the evidence that iron may contribute to the toxic effect. Concentrations are of the specified test substance:

| Taxon | Endpoint(s) | Method |
|---|---|---|
| **Soil-dwelling invertebrates** | 14 d LC50 = 156.5 mg/kg soil dw (EDTA)<br>14 d LC50 = 133 mg/kg soil dw (sodium iron(3+) EDTA) | *Eisenia fetida* (earthworm)<br>Nominal concentrations<br>OECD TG 207 |
| **Terrestrial plants** | 21 d EC50 = 714 mg/kg soil dw<br>21 d NOEC = 111 mg/kg soil dw | Test substance: sodium iron(3+) EDTA<br>*Glycine max* (soybean)<br>Growth inhibition<br>Nominal concentrations<br>OECD TG 208 |
| **Birds** | 14 d LC50 > 5000 mg/kg diet | Test substance: sodium iron(3+) EDTA<br>*Colinus virginianus* (bobwhite quail)<br>Nominal concentrations<br>OECD TG 205 |

These data indicate that these chemicals are harmful to earthworms and some terrestrial plants, and practically nontoxic to birds (UN SCEGHS 2006; US EPA n.d.).

## Effects on sediment dwelling life

There is limited available information on the ecotoxicity of EDTA-containing chemicals to sediment dwelling life. This is presumably because EDTA-containing species in surface waters are expected to remain mostly dissolved and not partition significantly to sediments. One non-guideline study on *tubifex tubifex* (sludge worm) found the 24 hour absolute lethal concentrations (LC100) for EDTA and disodium EDTA to be 380 mg/L and 2000 mg/L, respectively (REACH n.d.-a).

## Endocrine effects/activity

No evidence of endocrine effects or activity have been identified.

## Predicted no-effect concentration (PNEC)

An aquatic PNEC for the chemicals in this group of 2.2 mg/L (2,200 µg/L) was derived from the measured invertebrate chronic toxicity endpoint, using an assessment factor of 10. The 21 d NOEC for disodium EDTA (25 mg/L) was converted to the equivalent concentration of EDTA (22 mg/L) for the derivation. The assessment factor of 10 was selected as reliable chronic ecotoxicity data are available over three trophic levels (EPHC 2009).

A terrestrial PNEC for sodium iron(3+) EDTA of 1.1 mg/kg soil dw was derived from the measured plant toxicity endpoint (21 d NOEC = 111 mg/kg soil dw), using an assessment factor of 100. This assessment factor was selected as long-term toxicity data was available for one species (EPHC 2009). As the combination of iron and EDTA is expected to be more toxic to terrestrial life than EDTA alone, this PNEC is considered to be conservative for other chemicals in this group.

# Categorisation of environmental hazard

The categorisation of the environmental hazards of the assessed chemical according to domestic environmental hazard thresholds is presented below:

## Persistence

Persistent (P). Based on low biodegradability in experimental studies and the potential for incomplete abiotic degradation under environmental conditions, EDTA-containing chemicals are categorised as Persistent in environmental waters and soils.

## Bioaccumulation

Not Bioaccumulative (Not B). Based on low measured BCFs in fish and low lipophilicity in the environment, EDTA-containing chemicals are categorised as Not Bioaccumulative.

## Toxicity

Not Toxic (Not T). Based on available ecotoxicity values above 1 mg/L and evidence of low chronic toxicity, EDTA-containing chemicals are categorised as Not Toxic.

# Environmental risk characterisation

Based on the PEC and PNEC values determined above, the following Risk Quotients (RQ = PEC ÷ PNEC) have been calculated for release of the chemicals in this group into surface waters and soils. Concentrations in water are in terms of free EDTA, and concentrations in soils are in terms of sodium iron(3+) EDTA:

| Compartment | PEC | PNEC | RQ |
|---|---|---|---|
| Water | 1,147 µg/L | 2,200 µg/L | 0.52 |
| Soils | 0.84 mg/kg dw | 1.1 mg/kg dw | 0.76 |

For both the water and soil compartments, RQ values less than 1 indicate that the chemicals in this group are not expected to pose a significant risk to the environment based on estimated emissions, as environmental concentrations are below levels likely to cause harmful effects.

The PEC for iron ions that may be released from these chemicals into surface waters is 51.2 µg Fe/L. This is well below the interim working level of 300 µg/L suggested by the ANZ Water Quality Guidelines and below typical background concentrations. Iron ions resulting from the release of chemicals in this group to surface waters are not expected to pose a significant risk to the environment.

### Uncertainty

This evaluation was conducted based on information that may be incomplete or limited in scope. Some relatively common data limitations can be addressed through use of conservative assumptions (OECD 2019) or quantitative adjustments such as assessment factors (OECD 1995). Others must be addressed qualitatively, or on a case-by-case basis (OECD 2019).

The most consequential areas of uncertainty for this evaluation are:

- Limited data are available on EDTA concentrations in soils, and no studies were identified on concentrations resulting from typical fertiliser application or its migration to the surrounding environment. Should data become available indicating that environmental soil concentrations are concerningly high, the outcome of this evaluation may change.
- No Australian monitoring data were identified for EDTA in surface waters. Should information become available indicating that aquatic concentrations of EDTA in Australia are higher than the predicted concentration, the outcome of this evaluation may change.

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