Australian Government
Department of Health, Disability and Ageing
Australian Industrial Chemicals Introduction Scheme

Alkyl and alkenyl betaines and amido betaines

Evaluation statement (EVA00195)

1 April 2026

Draft

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AICIS evaluation statement (EVA00195)

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Reason for the evaluation

Evaluation Selection Analysis (ESA) indicated a potential environmental risk.

Parameters of evaluation

This evaluation considers a group of structurally similar, alkyl and alkenyl betaine and amido betaines with chain lengths varying from C8─C22, that are listed on the Australian Inventory of Industrial Chemicals (the Inventory). This group of chemicals belongs to a widely used class of zwitterionic surfactants.

This evaluation is an environmental risk assessment of identified industrial uses of the chemicals in Australia.

These chemicals have been assessed as a group as they have similar use patterns, exposures and behaviours when released to the environment.

The risks posed to the environment associated with the industrial uses of these chemicals have been evaluated according to the following parameters:

- total introduction to Australia at up to 1,000 tonnes/year
- expected release into sewage treatment plants (STPs) due to consumer and commercial use.

In this evaluation, chemical names have been abbreviated to describe chain length and indicate functional groups present.

As examples, for alkyl and alkenyl betaines:

Abbreviation	Chemical Name
C18 AB	1-Octadecanaminium, *N*-(carboxymethyl)-*N,N*-dimethyl-, inner salt
C18 AB (unsaturated)	9-Octadecen-1-aminium, *N*-(carboxymethyl)-*N,N*-dimethyl-, inner salt, (9*Z*)-
C12-14 AB	Betaines, C12-14-alkyldimethyl
C18 AEB (C18 ethoxy betaine)	1-Octadecanaminium, *N*-(carboxymethyl)-*N,N*-bis(2-hydroxyethyl)-, inner salt

As examples, for amido propyl betaines:

Abbreviation	Chemical Name
C14 APB	1-Propanaminium, *N*-(carboxymethyl)-*N,N*-dimethyl-3-[(1-oxotetradecyl)amino]-, inner salt
Coco APB	1-Propanaminium, 3-amino-*N*-(carboxymethyl)-*N,N*-dimethyl-, N-coco acyl derivs., inner salts

Summary of evaluation

Summary of introduction, use and end use

Alkyl and alkenyl betaines and amido betaines have functional uses as surfactants in a wide variety of consumer and commercial products. Available data indicates that these chemicals are used in high volumes worldwide (up to 59,000 tonnes per year) (OECD 2006). Most of these volumes are used in domestic cleaning products, laundry and dishwashing products and personal care products (cosmetics).

The chemicals in this evaluation may have Australian uses in:

- automotive care products
- cleaning and furniture care products
- laundry and dishwashing products
- lubricant and grease products
- personal care products (cosmetics).

International end uses of the chemicals that may be relevant to Australia include:

- air care products
- fabric, textile and leather products
- firefighting foams
- fuel additives
- ink, toner and colourant products
- manufacture of paper products
- oil or gas extraction
- paints and coatings products
- water treatment products.

Environment

Summary of environmental hazard characteristics

According to domestic environmental hazard thresholds (DCCEEW 2022) and based on the available data, the C22 betaine (CAS RN 26920-62-7) is:

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

All other chemicals in this evaluation are:

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

Environmental hazard classification

Most of the chemicals in this evaluation satisfy the criteria for environmental hazards classification according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) (UNECE 2017). This evaluation does not consider classification of physical hazards.

Many chemicals in this evaluation are UVCBs (unknown or variable composition, complex reaction products or of biological origin) comprising homologues with different alkyl chain lengths. The hazards of these chemicals will depend on the composition, which may differ between different introducers.

Classifications were primarily based on available experimental ecotoxicity information. Some of the proposed hazard classifications are based on read across principles (see **Supporting information**).

Classifications were assigned to chemicals by their CAS Registry Number (RN). The proposed default classification for a CAS RN is based on the most conservative ecotoxicological data available for the chemical.

Default classifications for the chemicals are recommended as below. As classifications for chemicals that are UVCBs can change with composition, the classification and labelling entries for these chemicals should be appended with the following note:

'The chemical is a substance of unknown or variable composition, complex reaction product, or biological material (UVCB). The hazards of the chemical may depend on the composition. For more information refer to the assessment report published on the website of the Australian Industrial Chemicals Introduction Scheme.'

If empirical data are available for a specific chemical, for example to justify a lower classification, then this data may be used to amend the default classification for that chemical.

The following chemical is classified according to the table below:

- C22 AB (CAS RN 26920-62-7)

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short-term)	Aquatic Acute 1	H400: Very Toxic to aquatic life

The following chemicals are classified according to the table below:

- C12 AB (CAS RN 683-10-3; 11140-78-6)
- C12 APB (CAS RN 4292-10-8; 86438-78-0)
- C14 APB (CAS RN 59272-84-3)
- C16 AB (CAS RN 693-33-4)
- C16 APB (CAS RN 32954-43-1)
- C18 AB (CAS RN 820-66-6)
- C18 (unsaturated) APB (CAS RN 25054-76-6)

- C18 (unsaturated) AB (CAS RN 871-37-4)
- C18 AEB (CAS RN 24170-14-7)
- C18 APB (CAS RN 6179-44-8)
- Castor oil APB (CAS RN 86089-12-5)
- Coco APB (CAS RN 61789-39-7; 61789-40-0)
- Coco AB (CAS RN 68424-94-2)
- Tallow AEB (CAS RN 70750-46-8)
- Tallow APB (CAS RN 91783-17-4)
- C12-14 AB (CAS RN 66455-29-6).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short-term)	Aquatic Acute 2	H401: Toxic to aquatic life
Hazardous to the aquatic environment (long-term)	Aquatic Chronic 3	H412: Harmful to aquatic life with long lasting effects

Due to a lack of experimental ecotoxicity data or read across data, it is not possible to classify the following chemical for long term (chronic) toxicity:

- C22 AB (CAS RN 26920-62-7)

Due to a lack of experimental ecotoxicity data and alkyl chain length distribution data, it is not possible to classify the following chemical for short term (acute toxicity) and long term (chronic) toxicity:

- C8-22 APB (CAS RN 84082-44-0).

Summary of environmental risk

Based on available Australian and international use information, chemicals in this evaluation are expected to be introduced into Australia in high volumes. These chemicals are used as surfactants in a wide range of consumer and commercial products. They are primarily released to wastewater as a normal part of their use pattern.

According to Australian thresholds (DCCEEW 2022), all chemicals in this evaluation are not persistent and not bioaccumulative, as they pass ready biodegradation tests and have estimated bioaccumulation factors below 2,000 L/kg. C22 betaine is toxic with acute endpoints less than or equal to 1 mg/L. The remaining chemicals in this evaluation are not toxic with endpoints above 1 mg/L.

Based on modelled domestic concentrations in sewage treatment plant (STP) effluent, the chemicals in this evaluation are predicted to be present in Australian surface waters at concentrations below the level of concern.

The calculated risk quotient (RQ) obtained for alkyl and alkenyl betaines and amido betaines in surface water is less than 1. Therefore, the current industrial use of these chemicals in Australia is not expected to pose a significant risk to the environment.

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. A person introducing these chemicals should be aware of their obligations under environmental, workplace health and safety and poisons legislation as adopted by the relevant state or territory.

Supporting information

Grouping rationale

This evaluation considers the environmental risks associated with industrial uses of a group of 21 alkyl and alkenyl betaines and amido betaines. Chemicals in this evaluation are used in high volumes worldwide and were selected for evaluation because the ESA indicated a potential risk to the environment. These chemicals have been assessed as a group as they have similar chemical structures, industrial uses and environmental release patterns, and are expected to have similar environmental effects.

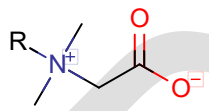
Some chemicals in this evaluation do not have confirmed use in Australia. They were included in the evaluation group as the environmental risk outcomes will be protective for the potential Australian use of the chemicals.

Chemical identity

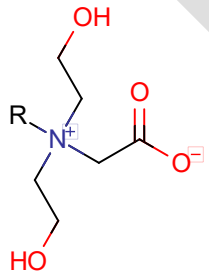
Chemicals in this evaluation are structurally similar zwitterionic surfactants. They consist of an alkyl, alkyl-propanamide or alkenyl aliphatic chain (R group), and a betaine moiety comprising a quaternary ammonium cation and a carboxylate anion. The quaternary ammonium nitrogen is bonded to the R group, the carboxylate-bearing carbon, and either 2 methyl groups or 2 ethoxy groups. The alkyl or alkenyl chain lengths range from C8 to C22.

Each chemical in this evaluation falls into one of 3 groups.

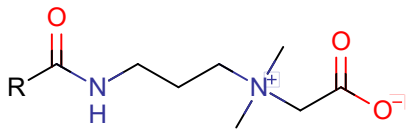
Alkyl betaines (ABs) with the generic formula of $R–N^+(CH_3)_2–CH_2–COO^-$ and a representative structure of:



Alkyl ethoxy betaines (AEBs) with the generic formula of $R–O–(CH_2CH(OH))–N^+(CH_3)_2–CH_2–COO^-$ and a representative structure of:



Alkyl amido propyl betaines (APBs) with the generic formula of R–CO–NH–$(CH_2)_3$–$N^+(CH_3)_2$–CH_2–COO^- and a representative structure of:



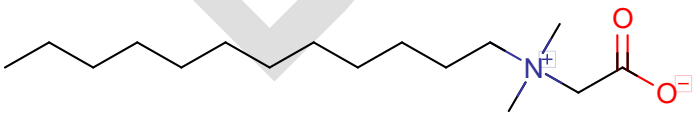
These chemicals are manufactured by reacting a fatty acid or a fatty alcohol with a tertiary amine to form an amine or an amide intermediate. This intermediate is then reacted with a carboxylate acid or its salt to introduce a carboxylate anion into the head group to form the zwitterionic betaine structure. The alkyl chain of the chemicals in this group can be derived from a vegetable or animal source (Burnette 2018).

Some of the chemicals in the evaluation are UVCBs (unknown or variable composition, complex reaction products or of biological origin) comprising of homologues with different chain lengths. Typical chain length information is limited for most chemicals in this evaluation. However, some information is available for the chemicals in this evaluation derived from vegetable or animal sources (OECD 2006; Thomas et al. 2015)

Information for representative chemicals in the evaluation is tabulated below.

CAS number	683-10-3
CAS name	1-Dodecanaminium, *N*-(carboxymethyl)-*N*,*N*-dimethyl-, inner salt
Molecular formula	$C_{16}H_{33}NO_2$
Associated names	Lauryl betaine
Molecular weight (g/mol)	271.44
SMILES (canonical)	O=C([O-])C[N+](C)(C)CCCCCCCCCCCC

Structural formula

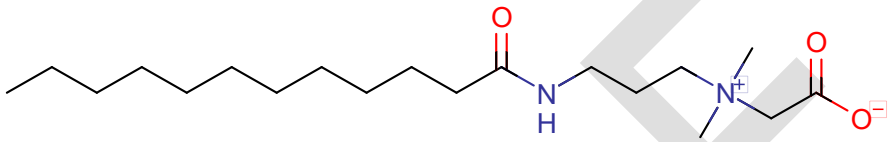


Additional chemical identity information

This is an example of an alkyl betaine.

CAS number	4292-10-8
CAS name	1-Propanaminium, *N*-(carboxymethyl)-*N*,*N*-dimethyl-3-[(1-oxododecyl)amino]-, inner salt
Molecular formula	$C_{19}H_{38}N_2O_3$
Associated names	Lauramidopropyl betaine
Molecular weight (g/mol)	342.52
SMILES (canonical)	O=C([O-])C[N+](C)(C)CCCNC(=O)CCCCCCCCCCC

Structural formula

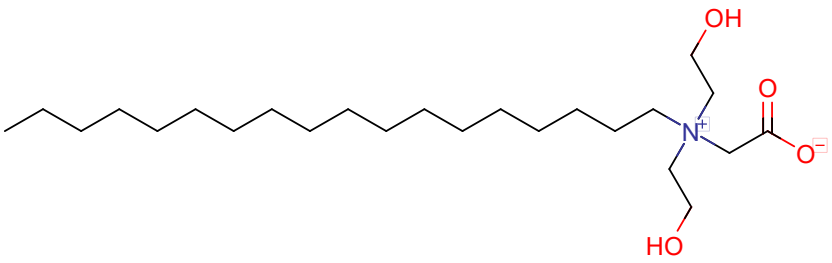


Additional chemical identity information

This is an example of an alkyl amido propyl betaine

CAS number	24170-14-7
CAS name	1-Octadecanaminium, *N*-(carboxymethyl)-*N*,*N*-bis(2-hydroxyethyl)-, inner salt
Molecular formula	$C_{24}H_{49}NO_4$
Associated names	1-Octadecanaminium, *N*-(carboxymethyl)-*N*,*N*-bis(2-hydroxyethyl)-, hydroxide, inner salt
Molecular weight (g/mol)	415.65
SMILES (canonical)	O=C([O-])C[N+](CCO)(CCO)CCCCCCCCCCCCCCCCCC

Structural formula



Additional chemical identity information

This is an example of an alkyl hydroxy ethyl betaine.

Relevant physical and chemical properties

Measured physical and chemical properties for chemicals in this evaluation were retrieved from the registration dossier for the chemical submitted under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation in the European Union (EU) and other scientific literature (El-Dossoki et al. 2020; Haftka et al. 2016; Yarveicy and Javaheri 2019).

Chemical name	C12 AB	Coco APB	C12 APB
Physical form	Solid	Solid	Solid
Melting point	-35.5°C	260–320°C (calc.)*	283°C (calc.)*
Boiling point	155–176°C	600–730°C (calc.)*	651°C (calc.)*
Critical micelle concentration (CMC)	320–376 mg/L	100–1,062 mg/L	200 mg/L
Ionisable in the environment?	Yes	Yes	Yes
log K_{oc}	-	2.3–3.5	2.3
log K_{ow}	0.07	-1.28–3.63	3.54 (calc)*

All values are experimental unless otherwise specified.

* calculated values (calc.) as reported in the OECD SIDS initial assessment report for alkylamidopropyl betaines (OECD 2006).

Chemicals in this evaluation have a polar head group containing a quaternary ammonium moiety and a carboxylic acid. The carboxylic acid has estimated pKa = 2.62 (US EPA n.d). The quaternary ammonium moiety contains a permanent cation and will remain positively charged across environmental pH.

The chemicals in this evaluation are surfactants; therefore, the critical micelle concentration (CMC) of selected chemicals has been reported instead of water solubility.

Chemicals in this evaluation exhibit a range of aqueous solubilities. CMC tends to decrease as the number of carbon atoms in the alkyl chain increases. Reported CMC values for alkyl betaines include 376 mg/L for C12 AB, 56 mg/L for C14 AB and 1.6 mg/L for C16 AB (Haftka et al. 2016).

Experimental log K_{OW} values are available for some of the chemicals in this evaluation. However, they are not a good descriptor of hydrophobicity as surfactants tend to concentrate between phase boundaries instead of equilibrating between the phases (Haftka et al. 2016).

Introduction and use

Australia

Not all chemicals in this evaluation are confirmed to have active Australian use.

According to volume information provided to the former National Industrial Chemicals Notification and Assessment Scheme (NICNAS) under previous calls for information, chemicals in this evaluation may be used in Australia up to 1,000 tonnes per year.

According to information available to AICIS, chemicals in this evaluation may have uses in:

- personal care products (cosmetics)
- cleaning and furniture care products
- laundry and dishwashing products
- automotive care products
- lubricant and grease products.

Coco APB has reported uses in shampoos, shower gels, and bubble bath formulations (NICNAS 2016). Recent information provided to AICIS as part of this evaluation confirms the use of Coco APB at concentrations up to 0.02% in automotive care products and 1.1% in cleaning products.

Internationally, the chemicals have been identified as used in offshore oil/gas production. Available information indicates that any Australian use of these chemicals will be for 'in well' applications. The chemicals will be pumped into the oil or gas well. The chemicals will then either be pumped out with the oil or gas or remain in the well. Some proportion of the chemicals may also be present in the oil or gas before it is refined. Available information indicates that process wastes (slops) containing the chemicals will be stored and transported onshore for disposal.

International

Available information for chemicals in this evaluation indicates they are used as surfactants in a range of products and applications worldwide. Many of the identified uses overlap with known uses in Australia (HERA 2005; OECD 2006; REACH n.d.-a; REACH n.d.-b; REACH n.d.-c; REACH n.d.-d; REACH n.d.-e; REACH n.d.-f; US EPA 2016; US EPA 2020).

The following additional end uses have been identified:

- firefighting foams
- paints and coatings products
- fuel additives
- fabric, textile and leather products
- ink, toner and colourant products
- air care products
- oil and gas extraction
- manufacture of paper products

- water treatment products.

Available data from international regions indicate high use volumes of alkyl and alkenyl betaines and APBs worldwide.

In Europe, multiple APBs are registered under ECHA, reporting production volumes ranging up to 100,000 tonnes per year for APBs (REACH n.d.-a; REACH n.d.-h; REACH n.d.-l) and up to 10,000 tonnes per year for alkyl betaines (REACH n.d.-g).

In 2002, reported production volumes of APBs in Western Europe were 59,000 tonnes (HERA 2005).

In the USA, a production volume of 18,000 tonnes of APBs was reported for the year 2003 (OECD 2006). More recent volumes of use for the year 2019 include 22,700–45,400 tonnes for Coco APB with multiple other APBs reportedly used at up to 4,500 tonnes (US EPA 2020). Alkyl and alkenyl betaines were also reported as high volume chemicals, with use volumes ranging up to 9,070 tonnes in 2019 (US EPA 2020).

The production volume for APBs in Asia was estimated to be about 10,000 tonnes in 2003 (OECD 2006). Reported volumes for APBs in Japan were 3,804 tonnes in 2018 and 1,763 tonnes in 2023 (NITE n.d.).

Existing Australian regulatory controls

Environment

The industrial use of the chemicals in this evaluation is not subject to any specific national environmental regulations.

International regulatory status

United Nations

Chemicals in this evaluation are not currently identified as a Persistent Organic Pollutants (POP) (UNEP 2001), ozone depleting substances (UNEP 1987), or hazardous substances for the purpose of international trade (UNEP & FAO 1998).

Environmental exposure

These chemicals are used as surfactants in products that are typically released to sewers as part of their domestic or commercial use. Depending on the degradation and partitioning processes of chemicals in STPs, a fraction of the quantity of chemicals in wastewater entering STPs will be emitted to rivers or oceans in treated effluent, or to soil by application of biosolids to agricultural land. Emissions of the substances to environmental surface waters, sediment, and soil are considered as part of this evaluation.

A subset of uses may result in direct release to the environment, such as use in car washing products. In these uses, the chemicals may be emitted directly to the soil compartment, or to surface waters without STP treatment through stormwater drainage systems. However, these are expected to be a minor contribution compared to the widespread, continuous use of

personal care, laundry and dishwashing and cleaning products that make up most of the use volume.

Chemicals used in offshore oil or gas extraction will either remain in the well they were pumped into, will be pumped out as process wastes or within the produced oil or gas. Chemicals in the well are expected to remain in the well and are not expected to be released to the environment. Chemicals remaining in the produced oil or gas are expected to be destroyed in the refining process. Disposal of the wastes containing the chemicals is not expected to result in release of the chemicals to the environment.

Environmental fate

Dissociation, speciation and partitioning

Chemicals in this evaluation are surfactants and therefore tend to concentrate between phase boundaries instead of equilibrating within environmental compartments.

The chemicals have a polar head group containing a quaternary ammonium moiety and a carboxylic acid. The dominant species in environmental conditions is predicted to be the zwitterion, which has both positive and negative charge. The carboxylic acid has estimated pKa = 2.62 and is expected to be deprotonated (negatively charged) at environmental pH (4-9) (US EPA n.d). The quaternary ammonium moiety contains a permanent cation and will remain positively charged across environmental pH.

The chemicals in this evaluation will adsorb to soil, sediment and organic matter. Available information, for the chemicals and structurally related chemicals, indicates that adsorption increases with increasing alkyl chain length. Shorter chain chemicals will have medium to low mobility in soil while longer chain chemicals will have low to slight mobility or be immobile in soil.

Experimental organic carbon-water partitioning coefficients (K_{OC}) range from 316 L/kg for C12 APB to 3,162 L/kg for C14 APB (REACH n.d.-b). Calculated K_{OC} values also varied from 646 L/kg for C12 APB to 261,700 L/kg for C22 (unsaturated) APB (US EPA 2017).

The chemicals in this evaluation have negligible volatility. Therefore, they are not expected to partition into the air compartment.

Degradation

The chemicals in this evaluation are not persistent. They rapidly and ultimately degrade in the environment.

Standard aerobic biodegradability study results are available for several chemicals in the evaluation or structurally related chemicals, including C12 AB and C14 AB, C12 APB and Coco APB. These chemicals all achieved passing results in 28- to 30-day tests conducted according to OECD test guideline (TG) 301, indicating rapid and ultimate biodegradation in the environment.

Ready biodegradability test results for the chemicals in this group include:

- 86–100% biodegradation in 28 days for Coco APB in multiple OECD TG 301 Ready biodegradability tests (OECD 2006; REACH n.d.-c)

- 82–95% biodegradation in 28 days for C12 APB in an EU Method C.4-F test (OECD 2006; REACH n.d.-b)
- 85% biodegradation in 29 days for C12 AB in an OECD TG 301B test (REACH n.d.-d)
- 79% biodegradation in 29 days for C14 AB in an OECD TG 301B test (REACH n.d.-e).

Passing results for ready biodegradability have also been reported for structurally similar surfactants with longer alkyl chain lengths. In one study, a lactic acid salt of C22 APB demonstrated 100% degradation by CO_2 evolution in a 28 day test conducted according to OECD TG 301B (Yamane et al. 2008).

Based on available experimental studies using sea water, chemicals in this evaluation also degrade readily in marine environments. One study, conducted using a method similar to OECD TG 306, reported 76% degradation of Coco APB within 28 days according to dissolved O_2 consumption (REACH n.d.-b). A second non-standard laboratory study conducted using fresh natural seawater reported approximately 90% reduction in surface activity for Coco APB within 5 days (Sun et al. 2004).

The chemicals in this evaluation also degrade under anaerobic conditions. For Coco APB, a test conducted in accordance with OECD TG 311 reported 80–90% degradation after 60 days. A second study conducted on C8-C18 APB, also using a method similar to OECD TG 311, reported a degradation rate of approximately 80% in 62 days (REACH n.d.-b).

Chemicals in this evaluation undergo biodegradation in STPs. A sewage treatment simulation test conducted according to OECD TG 303A (Continuous Activated Sludge tests) was identified for Coco APB (CAS RN 61789-40-0). Degradation by removal of dissolved organic carbon (DOC) was 97% after 35 days, demonstrating effective elimination of the surfactant in STPs (OECD 2006).

No degradation data are available for the alkyl ethoxy betaines included in this evaluation. These chemicals are not expected to be persistent. The ethoxy groups are unlikely to hinder the quaternary amine while slightly increasing the solubility and bioavailability of the chemicals compared to the other chemicals in this evaluation.

Bioaccumulation

The chemicals in this evaluation do not significantly bioaccumulate in aquatic organisms.

No experimental bioaccumulation data were identified for the chemicals in this evaluation. However, calculated bioconcentration factors (BCFs) for fish indicate low bioaccumulation potential for all alkyl chain lengths, with predicted BCF values estimated to be below 2,000 L/kg for all chemicals in the evaluation (US EPA 2017).

Environmental transport

Chemicals in this evaluation are not expected to undergo long range transport based on their short half-lives in the environment and their tendency to partition to surfaces such as sediments.

Predicted environmental concentration (PEC)

No reliable environmental monitoring data are available for the chemicals in this evaluation. A worst-case PEC for the chemicals in this evaluation has been estimated through a modelled STP value.

Use of chemicals in cosmetics, personal care products, and laundry and cleaning products will result in the release of the chemicals to STPs. Once in STP, a significant proportion of the chemicals will be removed via degradation or through physico-chemical processes. A minor proportion of the chemicals will remain and be released to the environmental surface waters in STP effluent.

The concentrations of chemicals reaching STP are expected to be proportional to the volumes of use for the chemicals. The concentration of chemicals released to surface waters will be dependent on the removal efficiency of the chemicals in STP.

A predicted environmental concentration (PEC) for Australian waters was calculated assuming 100% of the total introduction volume (1000 tonnes/year) is released into sewage treatment plants (STP) over 365 days per annum.

Removal from STP

No information on the removal rates under STP treatment is available for the chemicals in this evaluation. Information for other readily biodegradable surfactants indicates that primary treatment typically removes 13–50% of surfactant, while secondary sludge treatment typically removes at least 99% of surfactant (Cowan-Ellsberry et al. 2014; Matthijs et al. 1999).

In Australia, approximately 80% of wastewater is subject to at least secondary treatment, with the remaining 20% subject to only primary treatment (BOM n.d.). An internal survey of Australian STPs indicated that most Australian secondary treatment plants currently utilise activated sludge processes with a minor proportion of wastewater treated using trickling-filter processes.

A removal rate of 30% for primary treatment has been considered in the calculation, based on the average primary removal rate observed for various surfactants by Matthijs et al. (1999). A removal rate of 99% for secondary treatment has been considered in the calculation, based on the typical sludge STP removal rates observed for other biodegradable surfactants (Cowan-Ellsberry et al. 2014; Matthijs et al. 1999).

Dilution factors

An internal survey of Australian STPs indicated that effluent treated to secondary levels is released to rivers or to the ocean, while effluent treated to only primary levels is released to the ocean.

Effluent released to the ocean will be substantially diffused, while river flows can consist entirely of STP effluent in some drier parts of Australia. As such, the PEC for secondary treated effluent considers releases to rivers, with no dilution, as the reasonable worst-case scenario.

For primary treated effluents, the mixing of STP effluent with ocean waters will dilute the chemicals in the effluent and reduce their concentrations. Available information for 3 major STP outfalls in Sydney indicates that effluent is usually diluted by a factor of

100–1,000 when it leaves the immediate mixing zone (Tate et al. 2019). As such, a dilution factor of 100 has been applied to the calculated PEC for primary treated effluent.

PEC calculation

The calculation of the river and ocean PECs is detailed in the table below:

Total Annual Import Volume	1,000	tonnes/year
Proportion expected to be released to sewer	100 %	-
Days per year where release occurs	365	days/year
Emission rate	2,740	kg/day
Water use	200	L/person/day
Population of Australia	25.423	Million
Daily effluent production	5085	ML/day
Removal from primary treatment	30 %	Mitigation
Removal from secondary treatment	99 %	Mitigation
Dilution factor - River	1	-
Dilution factor - Ocean	100	-
PEC - River	5.39	µg/L
PEC - Ocean	3.77	µg/L

Environmental effects

Effects on aquatic Life

Chemicals in this evaluation have the potential to cause adverse effects in aquatic organisms across multiple trophic levels.

Standard acute and chronic freshwater and marine ecotoxicity test results are available for many chemicals in this evaluation. These endpoints were identified in the following sources:

- OECD SIDS (OECD 2006)
- Information held by AICIS for structurally related chemicals
- Scientific literature (Garcia et al. 2008)
- REACH Dossiers (REACH n.d.-b; REACH n.d.-e; REACH n.d.-f; REACH n.d.-g; REACH n.d.-i; REACH n.d.-j; REACH n.d.-k).

In general, the shorter chemicals (C8–C10) have lower toxicity than the chemicals with longer chain lengths (C12–C20). Chemicals with C22 may have the highest acute toxicity based on the lowest endpoint values occurring for C22 (unsaturated) APB.

The chemicals in this evaluation are structurally similar and are expected to cause toxic effects through a similar mode of action. As such, available endpoints from data rich

chemicals are considered suitable for read across to less data rich chemicals in the evaluation.

Toxicity endpoints were compiled based on common surfactant class (APB or AB), alkyl chain length and saturation. As toxicity data were compiled in terms of these structural properties, additional data from structurally similar chemicals not listed in this evaluation were included to support the effects assessment. When multiple reliable endpoints were available for the same chemical type, test species and duration, the geometric mean value was used to account for variations in the reported values (ANZG 2025). These endpoints have been tabulated according to trophic level below.

Acute toxicity

Freshwater fish

Chemical	Endpoint	Method
C8-10 (even numbered) APB	96 h LC50 > 100 mg/L	*D. rerio* (Zebrafish) Semi-static Nominal concentration OECD TG 203
C12 APB	96 h LC50 = 49.4 mg/L	*Danio rerio* (Zebrafish) Semi-static Nominal concentration OECD TG 203
C12-14 (even numbered) AB	96 h LC50 = 4.44 mg/L	*D. rerio* (Zebrafish) Static Nominal concentration OECD TG 203
C18 (unsaturated) APB	96 h LC50 = 1.92 mg/L	*D. rerio* (Zebrafish) Semi-static Measured concentration OECD TG 203
Coco APB	96 h LC50 = 1.9 mg/L	*Cyprinus carpio* (European carp) Semi-static Nominal concentration 92/69/EWG C.1
C8-18 (even numbered) APB	96 h LC50 = 15 mg/L	*D. rerio* (Zebrafish) Static Nominal concentration OECD TG 203
C8-18 (even numbered) + C18 (unsaturated) APB	96 h LC50 = 1.11 mg/L	*Pimephales promelas* (Fathead minnow) Semi-static Nominal concentration OECD TG 203
C22 (unsaturated) APB	96 h LC50 = 0.4 mg/L	*O. mykiss* (Rainbow trout) Semi-static Measured concentration OECD TG 203

Marine fish

Chemical	Endpoint	Method
C18 APB (unsaturated)	96 h LC50 ≥ 1 mg/L	*Cyprinodon variegatus* (Marine fish) Semi-static Nominal concentration OECD TG 203

Freshwater invertebrates

Chemical	Endpoint	Method
C10 AB	48 h EC50 = 48 mg/L	*Daphnia magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 202
C12 AB	48 h EC50 = 5.3 mg/L	*D. magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 202
C12 APB	48 hr EC50 = 45.6 mg/L	*D. magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 202
C12-14 (even numbered) AB	48 h EC50 = 7.76 mg/L	*D. magna* (Water flea) Immobilisation Static Nominal concentration OECD 202
C14 AB	48 h EC50 = 9.8 mg/L	*D. magna* (Water flea) Immobilisation Static Measured concentration OECD TG 202
C14 APB	48 h EC50 = 15.3 mg/L	*D. magna* (Water flea) Immobilisation Static Measured concentration OECD TG 202
C18 (unsaturated) APB	48 h EC50 = 4.85 mg/L	*D. magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 202
Coco APB	48 h EC50 = 4.6 mg/L	*D. magna* (Water flea) Immobilisation Geometric mean concentration (4 studies)

Chemical	Endpoint	Method
C8-18 (even numbered) APB	48 h EC50 = 6.5 mg/L	*D. magna* (Water flea) Immobilisation Static Nominal concentration OECD TG 202
C8-18 (even numbered) + C18 (unsaturated) APB	48 h EC50 = 4.1 mg/L	*D. magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 202
C22 (unsaturated) APB	48 h EC50 = 33.6 mg/L	*D. magna* (Water flea) Immobilisation Static Nominal concentration OECD TG 202

Marine invertebrates

Chemical	Endpoint	Method
C18 (unsaturated) APB	48 h EC50 = 5.8 mg/L	*Acartia tonsa* (Marine copepod) Immobilisation Static Nominal concentration ISO 14669 (1999)
C8-18 (even numbered) + C18 (unsaturated) APB	48 h EC50 = 7 mg/L	*Acartia tonsa* (Marine copepod) Immobilisation Static Nominal concentration ISO 14669 (1999

Freshwater algae

Chemical	Endpoint	Method
C12 AB	72 h EC50 = 3.8 mg/L	*Raphidocelis subcapitata* (Green algae) Growth rate OECD TG 201
C12 APB	72 h EC50 = 3.15 mg/L	*Desmodesmus subspicatus* (Green algae) Growth rate Static Nominal concentration OECD TG 201
C12-14 AB	72 h EC50 = 2.5 mg/L	*Scenedesmus sp.*(Green algae) Growth rate

Chemical	Endpoint	Method
		Measured concentration Unspecified method
C12-14 (even numbered) AB	72 h EC50 = 1.7 mg/L	*R. subcapitata* (Green algae) Growth rate Static Measured concentration OECD TG 201
C14 APB	72 h EC50 = 17.6 mg/L	*D. subspicatus* (Green algae) Growth rate Static Measured concentration OECD TG 201
C18 (unsaturated) APB	72 h EC50 = 8.4 mg/L	*R. subcapitata* (Green algae) Growth rate Static Measured concentration OECD TG 201
Coco APB	72 h EC50 = 10.6 mg/L	*D. subspicatus* (Green algae) Growth rate Static Geometric mean concentration (7 studies)
C8-18 (even numbered) + C18 (unsaturated) APB	72 h EC50 = 2.9 mg/L	*D. subspicatus* (Green algae) Static Geometric mean concentration (2 studies)
C22 (unsaturated) APB	72 h EC50 = 85.4 mg/L	*Selenastrum capricornutum* (Green algae) Growth rate Nominal concentration OECD TG 201

Marine algae

Chemical	Endpoint	Method
C8-18 (even numbered) + C18 (unsaturated) APB	72 h EC50 = 1.23 mg/L	*Skeletonema constatum* (Marine algae) Growth rate Static Nominal concentration ISO 10253

Chronic toxicity

Fish

Chemical	Endpoint	Method
Coco APB	28 d NOEC = 0.16 mg/L	*O. mykiss* (Rainbow trout) Mortality Flow through Nominal concentration OECD TG 204
C8-18 (even numbered) APB	37 d NOEC = 0.135 mg/L	*O. mykiss* (Rainbow trout) Hatching success Flow through Nominal concentration OECD TG 210

Invertebrates

Chemical	Endpoint	Method
C12-14 (even numbered) AB	21 d NOEC = 2.99 mg/L	*D. magna* (Water flea) Immobilisation Semi-static Nominal concentration OECD TG 211
Coco APB	21 d NOEC = 0.3 mg/L	*D. magna* (Water flea) Semi-static Reproduction Geometric mean measured concentration (4 studies)
C8-18 (even numbered) + C18 (unsaturated) APB	21 d NOEC = 0.56 mg/L	*D. magna* (Water flea) Reproduction Semi-static Nominal concentration OECD TG 211

Freshwater algae

Chemical	Endpoint	Method
C12 AB	72 h NOEC = 0.93 mg/L	*R. subcapitata* (Green algae) Growth rate Geometric mean concentration (2 studies) OECD TG 201
C12 APB	72 h NOEC = 0.3 mg/L	*Desmodesmus subspicatus* (Green algae) Growth rate Static Nominal concentration OECD TG 201
C12-14 (even numbered) AB	72 h NOEC = 0.38 mg/L	*R. subcapitata* (Green algae) Growth rate Static Measured concentration OECD TG 201
C14 APB	72 h NOEC = 3.1 mg/L	*D. subspicatus* (Green algae) Growth rate Static Measured concentration OECD TG 201
C18 (unsaturated) APB	72 h NOEC = 2.93 mg/L	*R. subcapitata* (Green algae) Growth rate Static Geometric mean concentration OECD TG 201
Coco APB	72 h NOEC = 2.44 mg/L	*D. subspicatus* (Green algae) Growth rate Geometric mean concentration (5 studies)
C8-18 (even numbered) + C18 (unsaturated) APB	72 h NOEC = 1.8 mg/L	*D. subspicatus* (Green algae) Growth rate Static Nominal concentration OECD TG 201
C22 (unsaturated) APB	72 h NOEC = 42.9 mg/L	*S. capricornutum* (Green algae) Growth rate Nominal concentration OECD TG 201

Marine algae

Chemical	Endpoint	Method
C8-18 (even numbered) + C18 (unsaturated) APB	72 h NOEC = 0.6 mg/L	*S. costatum* (marine algae) Growth rate Static Nominal concentration ISO 10253

Effects on terrestrial Life

Available ecotoxicity data for the chemicals in this evaluation are insufficient to assess effects to terrestrial life. One experimental endpoint for earthworms was identified for C12-14 (even numbered) AB:

Chemical	Endpoint	Method
C12-14 (even numbered) AB	56 d NOEC = 1,000 mg/kg soil dw	*Eisenia fetida* (earthworm) Reproduction OECD TG 222

Effects on sediment dwelling life

Chemical	Endpoint	Method
C18 (unsaturated) AB	10 d LC50 = 2817 mg/kg sediment dw	*Corophium volutator (Pallas)* (mud shrimp) Mortality Static Nominal concentration OSPAR PARCOM 1995 Part A

Endocrine effects/activity

No evidence of endocrine effects or activity have been identified for chemicals in this evaluation.

Predicted no-effect concentration (PNEC)

A PNEC value of 13.5 µg/L in surface water was selected for alkyl and alkenyl betaines and amido betaines by applying an assessment factor of 10 to the chronic fish endpoint for Coco APB (37 d NOEC = 0.135 mg/L).

This endpoint was selected as it is the lowest effect value in the dataset and is considered the pivotal endpoint for the chemicals in this evaluation. An assessment factor of 10 was selected as adequate chronic data for Coco APB are available for fish, aquatic invertebrates, and algae. This assessment factor is conservative, as ecotoxicity information was available for a broad range of chemicals across the group.

No specific PNEC has been calculated for marine organisms. The available information did not indicate any difference in sensitivity between freshwater and marine organisms. As such, the PNEC for freshwater is protective of freshwater and marine organisms.

Categorisation of environmental hazard

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

Persistence

Not Persistent (Not P). Based on measured degradation studies, the chemicals in this group are categorised as Not Persistent.

Bioaccumulation

Not Bioaccumulative (Not B). Based on low calculated bioconcentration factors (BCF) in fish, the chemicals in this group are categorised as Not Bioaccumulative.

Toxicity

Chemicals in this evaluation have been categorised using available aquatic ecotoxicity data and read-across principles.

Toxic (T). Based on read across from C22 (unsaturated) APB, the following chemical is categorised as Toxic:

- C22 AB (CAS RN 26920-62-7).

Not Toxic (Not T). Based on measured acute ecotoxicity endpoints above 1 mg/L and/or chronic endpoints above 0.1 mg/L, the following chemicals are categorised as Not Toxic:

- C12 AB (CAS RN 683-10-3; 11140-78-6)
- C12 APB (CAS RN 4292-10-8; 86438-78-0)
- C14 APB (CAS RN 59272-84-3)
- C18 APB (unsaturated) (CAS RN 25054-76-7)
- Coco APB (CAS RN 61789-39-7, 61789-40-0)
- C12-14 AB (CAS RN 66455-29-6).

Not Toxic (Not T). Based on read across from chemicals with data, it is unlikely that substances with alkyl chain lengths of 18 or less would be toxic. Therefore, the following chemicals are categorised as Not Toxic:

- C16 AB (CAS RN 693-33-4)
- C16 APB (32954-43-1)
- C18 AB (CAS RN 820-66-6)
- C18 (unsaturated) AB (CAS RN 871-37-4)
- C18 AEB (CAS RN 24170-14-7)
- C18 APB (CAS RN 6179-44-8)
- Castor oil APB (CAS RN 86089-12-5)
- Coco AB (CAS RN 68424-94-2)

- Tallow AEB (CAS RN 70750-46-8)
- Tallow APB (CAS RN 91783-17-4).

The chemical C8-22 APB (CAS RN 84082-44-0) lacks specific ecotoxicity data and is a UVCB substance that may contain toxic and not toxic components. The overall ecotoxicity of this chemical is difficult to predict and there is insufficient information to categorise this chemical as toxic according to Australian PBT criteria. The categorisation of this chemical may change if further information becomes available.

Environmental hazard classification

Chemicals in the evaluation have been classified according to the GHS for aquatic hazards (UNECE 2017).

Classifications were primarily based on available experimental ecotoxicity information. Some of the proposed hazard classifications are based on read across principles (UNECE 2017). Many chemicals in this evaluation are UVCBs (unknown or variable composition, complex reaction products or of biological origin) comprising homologues with different alkyl chain lengths. The hazards of these chemicals will depend on the composition, which may differ between different introducers

Classifications were assigned to chemicals by their CAS Registry Number (RN). The proposed default classification for a CAS RN is based on the most conservative ecotoxicological data available for the chemical. If empirical data are available for a specific chemical, for example to justify a lower classification, then this data may be used to amend the default classification for that chemical.

As classifications for these chemicals can change with composition, the classification and labelling entries for these chemicals should be appended with the following note:

‘The chemical is a substance of unknown or variable composition, complex reaction product, or biological material (UVCB). The hazards of the chemical may depend on the composition. For more information refer to the assessment report published on the website of the Australian Industrial Chemicals Introduction Scheme.’

Due to a lack of experimental ecotoxicity data and alkyl chain length distribution data, it is not possible to classify the following chemical for aquatic hazards:

- C8-22 APB (CAS RN 84082-44-0).

The remaining chemicals satisfy the criteria as follows:

Hazardous to the aquatic environment (acute / short term)

Based on read across to C22 (unsaturated) APB, which has an LC50 value in the range 0.1–1 mg/L, C22 AB (CAS RN 26920-62-7) satisfies the criteria for hazard category ‘Aquatic Acute 1’ with the hazard statement ‘H400: Very Toxic to aquatic life’.

Based on measured EC50 and LC50 values in the range 1–10 mg/L, the following chemicals satisfy the criteria for hazard category ‘Aquatic Acute 2’ with the hazard statement ‘H401: Toxic to aquatic life’:

- C12 AB (CAS RN 683-10-3; 11140-78-6)

- C12 APB (CAS RN 4292-10-8; 86438-78-0)
- C18 (unsaturated) APB (CAS RN 25054-76-6)
- Coco APB (CAS RN 61789-39-7; 61789-40-0)
- C12-14 AB (CAS RN 66455-29-6).

The following chemicals contain homologues with alkyl chain length ranging from C12–C18. Based on read across to classified chemicals that have alkyl chain lengths in the same range, these chemicals are expected to satisfy the criteria for hazard category 'Aquatic Acute 2' with the hazard statement 'H401: Toxic to aquatic life:

- C14 APB (CAS RN 59272-84-3)
- C16 AB (CAS RN 693-33-4)
- C16 APB (CAS RN 32954-43-1)
- C18 AB (CAS RN 820-66-6)
- C18 (unsaturated) AB (CAS RN 871-37-4)
- C18 AEB (CAS RN 24170-14-7)
- C18 APB (CAS RN 6179-44-8)
- Castor oil APB (CAS RN 86089-12-5)
- Coco AB (CAS RN 68424-94-2)
- Tallow AEB (CAS RN 70750-46-8)
- Tallow APB (CAS RN 91783-17-4).

Hazardous to the aquatic environment (chronic / long-term)

All chemicals in this evaluation are expected to be rapidly degradable.

Based on measured NOEC values in the range 0.1-1 mg/L, the following chemicals satisfy the criteria for hazard category 'Aquatic Chronic 3' with the hazard statement 'H412: Harmful to aquatic life with long lasting effects':

- C12 AB (CAS RN 683-10-3; 11140-78-6)
- C12 APB (CAS RN 4292-10-8; 86438-78-0)
- C12-14 AB (CAS RN 66455-29-6)
- Coco APB (CAS RN 61789-39-7; 61789-40-0).

The following chemicals contain homologues with alkyl chain length ranging from C12–C18. Based on read across to classified chemicals that have alkyl chain lengths in the same range, these chemicals are expected to satisfy the criteria for hazard category 'Aquatic Chronic 3' with the hazard statement 'H412: Harmful to aquatic life with long lasting effects':

- C14 APB (CAS RN 59272-84-3)
- C16 AB (CAS RN 693-33-4)
- C16 APB (CAS RN 32954-43-1)
- C18 AB (CAS RN 820-66-6)
- C18 (unsaturated) AB (CAS RN 871-37-4)
- C18 (unsaturated) APB (CAS RN 25054-76-6)
- C18 AEB (CAS RN 24170-14-7)
- C18 APB (CAS RN 6179-44-8)
- Castor oil APB (CAS RN 86089-12-5)
- Coco AB (CAS RN 68424-94-2)
- Tallow AEB (CAS RN 70750-46-8)
- Tallow APB (CAS RN 91783-17-4).

Due to a lack of experimental ecotoxicity data or read across data, it is not possible to classify the following chemicals for long term (chronic) toxicity:

- C22 AB (CAS RN 26920-62-7).

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 evaluation into surface water:

Compartment	PEC (µg/L)	PNEC (µg/L)	RQ
Surface water - river	5.39	13.5	0.4
Surface water - ocean	3.77	13.5	0.28

For surface water, RQ values less than 1 indicate that the chemicals in this evaluation 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.

No RQ has been calculated for the sediment or soil environmental compartments. Available ecotoxicity information indicates that the chemicals in this evaluation are unlikely to cause harmful effects to soil or sediment organisms.

Uncertainty

This evaluation was conducted based on a set of 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:

- No Australian monitoring information is available for the chemicals in this evaluation. This includes environmental concentration data for STP effluent and surface waters, as well as a lack of Australia specific homologue distribution information for products. The outcomes of this evaluation may change if new monitoring information becomes available to indicate that environmental concentrations of these chemicals in Australia are higher than currently considered.

  Insufficient data are available for chemicals in this evaluation to characterise the risk to the soil or sediment compartments.

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