



Australian Government

Department of Health, Disability and Ageing

Australian Industrial Chemicals Introduction Scheme

Benzene, 1,1'-sulfonylbis[4-chloro- Evaluation statement (EVA00209)

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Draft



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AICIS evaluation statement

Subject of the evaluation

Benzene, 1,1'-sulfonylbis[4-chloro-

Chemical in this evaluation

CAS name	CAS number
Benzene, 1,1'-sulfonylbis[4-chloro-	80-07-9

Reason for the evaluation

Evaluation Selection Analysis indicated a potential environmental risk.

Parameters of evaluation

The chemical in this evaluation is listed on the Australian Inventory of Industrial Chemicals (the Inventory).

This evaluation considers the environmental risks associated with the industrial uses of benzene, 1,1'-sulfonylbis[4-chloro-, otherwise known as bis(4-chlorophenyl) sulfone (BCPS). Any uses of BCPS in therapeutic, agricultural, veterinary, and/or food products, which are non-industrial uses, are outside of the parameters of this evaluation.

The risks posed to the environment associated with the industrial uses of BCPS have been assessed according to the following parameters:

- Industrial uses listed in the 'Summary of introduction, use and end use' section.
- Expected emission to sewage treatment plants (STPs) or other diffuse release from products containing the chemical following consumer and commercial use.

Summary of evaluation

Summary of introduction, use and end use

No specific Australian use, import, or manufacturing information was identified.

Based on international use data, BCPS is used in high volumes worldwide. The use volume exceeds 1,000 tonnes per year (t/year) in the United States of America (USA), the European Economic Area (EEA), and Japan.

The chemical has functional use as an intermediate in the production of:

- heat-resistant polymers such as polysulfones, polyethersulfones and polyphenylsulfones

- other chemicals, including reactive textile dyes.

The resulting polymers contain residual BCPS and are used to make products including in the following end use categories:

- paint and coating products
- plastic and polymer products
- construction products not covered by other end uses
- electronic products
- automotive care products
- extractive products not covered by other end uses
- water treatment products.

Environment

Summary of environmental hazard characteristics

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

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

Environmental hazard classification

This chemical satisfies the criteria for classification according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) for environmental hazards as follows (UNECE 2017). This evaluation does not consider classification of physical and health hazards:

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (long-term)	Aquatic Chronic 2	H411: Toxic to aquatic life with long lasting effects

Summary of environmental risk

The chemical is predominantly used as a monomer in the production of polymers in high volumes internationally. Residual BCPS from the polymer manufacturing process can be present in the polymers and products made of the polymers. BCPS will be released to the environment either through point sources of manufacture or through diffuse releases from finished plastic articles.

The chemical is persistent in water, water-sediment systems and in air. Available information indicates that BCPS does not meet bioaccumulation thresholds in fish. BCPS is also categorised as Not Toxic to aquatic organisms. For surface waters and sediments, risk quotient (RQ) values less than 1 indicate that BCPS is not expected to pose a significant risk to the aquatic environment, as environmental concentrations are below levels likely to cause harmful effects in fish and sediment-dwelling organisms.

Available information indicates that BCPS can bioaccumulate in air-breathing organisms such as fish-eating birds. Information on analogue chemicals suggests that BCPS is unlikely to cause significant acute effects on birds. Chronic effects on birds cannot be evaluated due to a lack of information.

The chemical is persistent and bioaccumulative in fish-eating birds (PB) according to domestic PBT criteria. Due to their persistence, PB chemicals have the potential to become widely dispersed environmental contaminants. Once in the environment, persistent chemicals that are also bioaccumulative pose an increased risk of accumulating in exposed organisms. As persistent and bioaccumulative chemicals accumulate and remain in environmental biota over long periods, it is difficult to predict their long-term adverse effects.

Given these characteristics, there is a risk to the environment that requires management (see **Proposed means for managing risks**).

Proposed means for managing risk

It is recommended that the chemical be scheduled under the *Industrial Chemicals Environmental Management (Register) Act 2021* (ICEMR Act), with application of appropriate risk management measures to minimise further release to the environment from its introduction and use.

In making the scheduling decision, consideration should be given to the following:

- The chemical is persistent and bioaccumulative (PB) according to domestic PBT criteria.
- As persistent and bioaccumulative chemicals accumulate and remain in environmental biota over long periods, it is difficult to predict their long-term adverse effects.
- The chemical has known or potential use in articles and end uses as listed in the '**Summary of introduction, use and end use**' section.

Conclusions

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

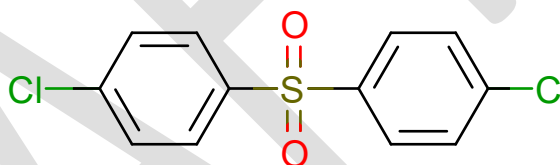
Note:

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

Chemical identity

CAS number	80-07-9
CAS name	Benzene, 1,1'-sulfonylbis[4-chloro-
Molecular formula	C ₁₂ H ₈ Cl ₂ O ₂ S
Associated names	Sulfone, bis(p-chlorophenyl)- bis(4-chlorophenyl) sulfone 4,4'-Dichlorodiphenyl sulfone
Molecular weight (g/mol)	287.16
SMILES (canonical)	<chem>O=S(=O)(C1=CC=C(Cl)C=C1)C2=CC=C(Cl)C=C2</chem>
Structural formula	



Relevant physical and chemical properties

Measured physical and chemical property data for BCPS were retrieved from the dossier submitted under the Registration, Evaluation, Authorisation and Restriction of Chemicals, REACH, legislation in the EU (ECHA CHEM n.d.). The Henry's Law Constant was calculated from the measured water solubility and measured vapour pressure, and the log K_{OA} was calculated in EPISuite using measured log K_{OW} and calculated Henry's Law Constant (US EPA 2017):

Physical form	Solid
Melting point	147–150°C (exp.)
Boiling point	397°C (exp., decomposition)
Vapour pressure	5.1×10^{-6} Pa at 20°C (exp.)
Water solubility	0.86 mg/L at 20°C (exp.)
Henry's law constant	1.7×10^{-3} Pa·m ³ /mol (calc.)
Ionisable in the environment?	No
p<i>K</i>_a	3.9 at 20°C (exp.)
log <i>K</i>_{ow}	3,162 L/kg (exp.)
log <i>K</i>_{OA}	10.1 (calc.)

Introduction and use

Australia

No specific Australian use, import, or manufacturing information was identified. The end uses of polymers and articles containing BCPS are assumed to be consistent with international uses.

International

Available information indicates that BCPS is used in high volumes worldwide. Although the total known production volume in 2006 was estimated to be less than 18,000 tonnes (OECD 2008; OECD n.d.), current use volumes across major international jurisdictions are:

- 10,000–100,000 t/year in the EEA (ECHA CHEM n.d.),
- 4,540–22,700 t/year in the USA between 2020–2023 (US EPA 2024),
- 1,000–5,000 t/year in Japan between 2012–2024 (NITE n.d.).

The chemical is primarily used as a starting material in the production of heat-resistant polymers such as polysulfones, polyethersulfones and polyphenylsulfones, commonly referred to as polyarylethersulfone polymers (PAES). These polymers are used as coatings on metals, in food containers, and in processing machinery and equipment

(ECHA CHEM n.d.; OECD 2008). BCPS is present in these polymers in residual amounts of up to 100 ppm (ECHA 2020).

The polymers are used to produce articles for high-temperature applications including (ECHA 2020):

- automotive parts (e.g. headlight reflector lamps)
- aeronautic parts
- electric/electronics components
- microwave cookware
- piping
- plumbing applications
- water pumps
- oil pumps
- membranes for food processing and water treatment
- visors for fire helmets.

However, BCPS-containing polymers are reported to be generally limited to specific, low-volume applications (ECHA 2020).

The chemical is also used as an intermediate in the manufacture of other chemicals, including reactive textile dyes (US NTP 2001) and the chemical dapsone (CAS RN 80-08-0), which has reported industrial use as an epoxy hardener and non-industrial use as an antileprotic drug (NCBI n.d.).

Available information indicates historic non-industrial uses of BCPS in agricultural products. In these products BCPS was used either as insecticide (ECHA 2020) or has been identified as an impurity in insecticide products. Available information indicates that technical samples of the insecticide dichlorodiphenyltrichloroethane (DDT) contained up to 0.03–0.6% BCPS (IARC 1991).

BCPS or polymers made using BCPS may have applications in the dentistry, food service, hospital goods and medical devices sectors (ECHA 2020). Uses in these sectors are not industrial and are outside the parameters of this evaluation.

Existing Australian regulatory controls

Environment

The industrial use of BCPS is not subject to any specific environmental regulations.

International regulatory status

United Nations

The chemical is 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 and FAO 1998).

OECD

The chemical is listed as an OECD High Production Volume (HPV) chemical and was sponsored by Sweden for an assessment programme. The Screening Information Data Set (SIDS) and Initial Assessment Report have been published. The report concluded that the chemical is a candidate for further work because it has the potential for persistence, potential for bioaccumulation, and chronic toxicity to algae and aquatic invertebrates (OECD 2008).

European Union

The chemical has been identified as a Substance of Very High Concern (SVHC) under the REACH legislation, meeting the very persistent and very bioaccumulative (vPvB) criteria (ECHA 2023a). The date of inclusion in the Candidate List was 14 June 2023 (ECHA n.d.)

Environmental exposure

The chemical is primarily used as an intermediate in the manufacture of polymers and other chemicals. The chemical enters the environment via direct release from STPs through point sources of manufacture or diffuse release of residual chemical from finished polymer products. The main affected compartments are water, sediment and soil.

Environmental fate

Partitioning

The chemical may be present in water, sediments and soil due to release or partitioning processes in the environment.

The chemical is a neutral organic chemical that is slightly soluble in water and very slightly volatile. The Henry's law constant is $1.7 \times 10^{-3} \text{ Pa m}^3/\text{mol}$, indicating that it will be very slightly volatile from water and moist soil. The calculated $\log K_{OA}$ of 10.1 suggests that some partitioning to aerosol particles is expected.

The chemical is lipophilic with a measured octanol-water partition coefficient ($\log K_{OW}$) of 3.9. The soil adsorption coefficient (K_{OC}) of 3,162 L/kg (ECHA CHEM n.d.) indicates that the chemical can adsorb to environmental compartments with high organic carbon content including sediment, soil, and aerosol particles. It can partition from surface water to sediment and has slight mobility in soil.

Based on standard exposure modelling, BCPS released to sewers will partially partition to biosolids in STPs, with the majority released to surface water in treated effluent (Struijs 2014). Based on the results of a standard level III multimedia (fugacity) model, chemicals released to surface water will predominately stay in water with partial partitioning to sediment and negligible partitioning to air and soil (US EPA 2017). The chemical may be directly released to the soil compartment through application of STP biosolids to agricultural land. When applied to soils, it will largely remain in soil due to its low mobility and low volatility under wet and dry conditions.

Degradation

The chemical is persistent in the environment. Available experimental information indicates that BCPS is not readily biodegradable in water. The chemical does not undergo significant biotic or abiotic degradation in water or sediment.

Abiotic degradation in water

The chemical is highly resistant to abiotic degradation in aqueous environments.

Hydrolysis is not a significant degradation pathway for BCPS in the environment. Based on a laboratory study conducted according to OECD TG 111, no significant hydrolysis ($\leq 10\%$) at pH 4, 7, and 9 at 50°C was observed after 21 days (ECHA 2023b). These results indicate that BCPS is hydrolytically stable at environmental pH.

Biodegradation in water and sediment

Available experimental test results indicate that BCPS is not readily or inherently biodegradable in water and sediment.

In an experimental study conducted according to OECD TG 301C (modified MITI test), limited degradation of BCPS was observed after 28 days, -based on O₂ consumption (average 1% biochemical oxygen demand) and test material analysis (0% removal confirmed via HPLC) (ECHA 2023b; NITE n.d.).

In a 100-day study conducted according to OECD TG 308, the partitioning and degradation of BCPS was investigated using two water-sediment systems. The first system consisted of sandy loam and water collected from a natural pond in Tift County, Georgia, USA. The second system used clay loam and water collected from the Goose River in Grand Forks Country, North Dakota, USA. Radiolabelled BCPS was used in the test. Degradation of the test material was measured by applied radioactivity at 20°C. Test conditions were aerobic in the water phase and at the surface of the sediment. BCPS concentrations in the water layer decreased in both systems from 88.8 and 85.1% at day 0, to 12.4 and 2.4% at the end of the study, in Tift and Goose River systems, respectively. Mean sediment concentrations of BCPS slowly increased over time, reaching a maximum concentration of 81.8% in Tift sediment and 79.8% in Goose River sediment at 100 days, indicating partitioning to sediment. Very low amounts of ¹⁴CO₂ were measured throughout the test (0.4–0.5% at 100 days), indicating negligible levels of ultimate degradation. Further analysis showed that no major transformation products were detected in either system during the duration of the test. Disappearance of BCPS in the water-sediment systems was driven by an increase in non-extractable residues throughout the study (up to 4.4% and 15.2% in the two systems). While incorporation into non-extractable residue is not evidence of degradation, disappearance half-lives for BCPS in the water-sediment systems were still estimated to exceed 1 year (ECHA 2023b). Therefore, BCPS is persistent in water-sediment systems.

Other compartments

The chemical is expected to be persistent in air based on its calculated half-life of 18 days through reaction with photogenerated hydroxyl radicals. Calculations were performed assuming a typical hydroxyl radical concentration of 1.5×10^6 molecules/cm³ and 12-hour days (US EPA 2017).

No data for the degradation of BCPS in soil were identified.

Bioaccumulation

The chemical is bioaccumulative in air-breathing organisms but does not meet bioaccumulation thresholds in aquatic organisms.

The log K_{OW} and log K_{OA} of BCPS are above the Australian categorisation thresholds for bioaccumulation in terrestrial life (DCCEEW 2022). Additionally, available monitoring data indicate that birds are exposed to BCPS, and that BCPS concentrations in fish-eating birds are higher than BCPS concentrations in fish in the same region.

Measured and calculated bioconcentration factor (BCF) values are below Australian categorisation thresholds for bioaccumulation in aquatic organisms (DCCEEW 2022).

Bioaccumulation in air-breathing organisms

The measured log K_{OW} of BCPS is 3.9 and the calculated log K_{OA} is 9.15. These values are above the domestic thresholds for a terrestrial bioaccumulation hazard (log $K_{OW} \geq 2$ and log $K_{OA} > 6$) (DCCEEW 2022), indicating potential for bioaccumulation in air-breathing organisms.

Field biomagnification factors (BMFs) of 2.96 to 4.2 were found for cormorant-fish pairs in a recent monitoring study in Austria. The BMFs were based on muscle concentrations for the cormorants and whole fish concentrations for the fish, relative to lipid weight. The BMF of 4.2 was determined for a fish (*Chondrostoma nasus*) found in the stomach of the cormorant (*Phalacrocorax carbo sinensis*), providing direct evidence that the fish was part of the cormorant's diet (Hornek-Gausterer et al. 2021). However, as the cormorants are a migratory species, they may have been exposed to higher levels of BCPS prior to migrating to the sampled area.

Toxicokinetic studies in rats (*Rattus norvegicus*) show that BCPS predominantly accumulates in adipose tissue (body fat). In one test, slow excretion of BCPS was reported after a single intravenous administration, with an elimination half-life of 12 days likely mediated by liver enzyme induction (ECHA 2023b). Fish-eating birds and raptors have been observed to have lower monooxygenase activities in liver, resulting in a potential reduction in detoxification of lipophilic chemicals when compared to mammals (Walker and Ronis 1989). As such, the elimination half-life of BCPS in fish-eating birds may exceed 12 days.

Biomonitoring in fish and fish-eating predators

Various field monitoring studies from the Baltic region over similar time periods have consistently reported lipid-normalised concentrations of BCPS in fish species generally in the 10–100 nanogram per gram lipid weight (ng/g lw) range and in fish-eating birds in the 100–1,000s ng/g lw range. While direct predator-prey studies are not available, the higher concentrations in fish-eating predators are indicative of biomagnification in air-breathing organisms.

Over the period 1998–2008, BCPS concentrations in herring (*Clupea haengus*) from the Baltic and surrounding regions were in the 17–58 ng/g lw range (Norström et al. 2010). Average concentrations in perch (*Perca fluviatilis*) were reportedly in the 15–160 ng/g lw range during 1994–2008 across various Baltic locations (Norström et al. 2004; Norström et al. 2010; Olsson and Bergman 1995; Valters et al. 1999). Average concentrations of 8.7 ng/g lw and 32 ng/g lw were measured in salmon (*Salmo salar*) from the Central Baltic Sea in 1971 and 1996, respectively (Norström et al. 2004).

Over the period 1971–2003, measured BCPS concentrations in the eggs and muscle of fish-eating guillemot (*Uria aalge*) in the Baltic sea were in the 760–2,600 ng/g lw range (Jörundsdóttir et al. 2006; Norström et al. 2004). BCPS concentrations in eggs of white-tail sea eagles (*Haliaeetus albicilla*) from Baltic regions were also reported up to 610 ng/g lw (1987–1991) (Helander et al. 2002). Another study measured BCPS at a concentration of 500 ng/g lw in one white-tail sea eagle egg sampled from the Swedish Baltic coast in 1987 (Olsson and Bergman 1995).

Concentrations of BCPS in the blubber, liver and lung tissues of grey seals (*Halichoerus grypus*) from the Baltic Sea ranged 21–700 ng/g lw from 1993–2001 (Larsson et al. 2004; Norström et al. 2004; Olsson and Bergman 1995).

Bioaccumulation in aquatic life

The chemical does not meet bioaccumulation thresholds in aquatic life based on measured BCF values in fish of 187.5 L/kg wet weight (ww) to 205 L/kg ww.

An experimental bioaccumulation study for BCPS was conducted according to an OECD TG 305 procedure with deviations from current study guidelines (no depuration phase) (ECHA 2023b; ECHA CHEM n.d.). Steady state BCF values of 75 and 82 L/kg ww were reported in *Cyprinus carpio* (common carp) for exposure concentrations of 5 and 50 µg/L, respectively. These values were determined for a 35 day uptake period and were not normalised for lipid content. BCF values normalised to 5% lipid contents in fish are 187.5 L/kg ww and 205 L/kg ww (ECHA 2023b).

Calculated BCFs and bioaccumulation factors (BAFs) are also less than the domestic threshold for an aquatic bioaccumulation hazard (2,000 L/kg), with calculated values of 174–828 L/kg ww for BCFs and 463–1,672 L/kg ww for BAFs (US EPA 2017).

Environmental transport

The chemical may undergo long-range transport (LRT) in the environment due to its long half-life in the atmosphere and water, and its distribution properties. Additionally, there are reports of its occurrence in biota in remote areas of the Arctic region.

Despite its very slight volatility, BCPS has been detected at low concentrations in some air samples in Sweden (ECHA 2023b), indicating that partitioning to air can occur. The calculated atmospheric half-life of BCPS is 18 days (US EPA 2017) indicating its persistence in air (half-life > 2 days). Furthermore, BCPS is expected to occur in both the gas and particulate phases of ambient air through adsorption to airborne particles (Norström et al. 2010). The actual persistence in air, considering the gas and particle phases, is expected to be longer than the half-life calculated in the gas phase, as BCPS adsorbed to airborne particles may be resistant to oxidation by hydroxyl radicals.

The chemical has the potential to undergo LRT in rivers and oceans because of its persistence and partitioning properties. The chemical is persistent in water (see **Degradation**), and a significant proportion of the chemical present in water is expected to remain in water (see **Partitioning**). These properties may lead to the transport of the chemical through oceanic currents over long distances.

Monitoring studies demonstrate the presence of BCPS in remote areas far from industrial activities. BCPS was detected at low concentrations (<13 ng/g lw) in common guillemot (*Uria aalga*) eggs from Iceland, the Faroe Islands, and multiple remote Norwegian islands (Jörundsdóttir et al. 2008). BCPS was frequently detected in the blood of Arctic glaucous

gull (*Larus hyperboreus*) in 2002 and 2004 from Bear Island in the Norwegian Arctic (Verreault et al. 2005).

As residual amounts of BCPS are present in plastics, local sources of contamination in remote areas from human activities (for example, from research stations) cannot be completely excluded.

Predicted environmental concentration (PEC)

Australian monitoring data identified in the literature are qualitative. Environmental monitoring studies covering sewage treatment plant (STP) influent and effluent, river and seawater, and sediments are available for other parts of the world including Europe, Africa and Asia.

Based on measured concentrations in STP effluents, rivers and estuaries from international monitoring studies, the Predicted Environmental Concentration (PEC) for surface waters is 400 ng/L (0.4 µg/L).

Based on measured concentrations in sediment from international monitoring studies, the PEC for sediment is 14 µg/kg (microgram per kilogram) dry weight (dw).

STP effluents and surface water

The chemical has been detected in various surface water sources. Its average concentrations in surface waters of European countries are in the range 0.003–400 ng/L, with the highest recorded in surface water in the United Kingdom (ECHA 2023b). BCPS was measured in a STP effluent sample from Estonia at 17 ng/L and was below the limit of detection of 8 ng/L in STP effluents sampled in other countries surrounding the Baltic Sea (Norström et al. 2010). BCPS was detected in Austrian effluents at a maximum concentration of 0.87 ng/L (ECHA 2023b). In a study from 2017 in Europe, BCPS was detected in effluents from STPs in Zilina, Budapest, Ljubljana, Šabac, and Zagreb at concentrations between 0.4 and 11.8 ng/L (ECHA 2023b). The highest value of 400 ng/L from surface waters in the UK is conservatively chosen as the PEC for risk characterisation.

Higher concentrations of BCPS have been measured in water samples from an industrially-impacted area (Dzikowitzky et al. 2014). These concentrations are not expected to be representative of typical environmental levels in Australia, as they were measured in a drainage channel and river affected by discharge of industrial wastewaters with little treatment.

Sediment

The chemical has been detected in Australian river sediment samples from Queensland. Concentrations ranging from 0.01 to 0.29 ng/g dw were reported in the study (Muz et al. 2020). However, the analytical method used in the study did not directly measure chemicals in the sediment and likely underestimated total concentrations in sediment. The study provides qualitative evidence for the presence of BCPS in Australian sediments.

The chemical was reported at up to 14 ng/g dw (14 µg/kg dw) in sediment samples from the Danube delta as part of Black Sea Survey, 2017 (ECHA 2023b; Hornek-Gausterer et al. 2021). This value from the Danube delta is chosen to estimate the PEC in sediments in Australia.

Higher concentrations of BCPS have been measured in some sediment samples (Berger and Schwarzbauer 2016; Dsikowitzky et al. 2014). These concentrations are from highly contaminated industrial areas, including areas impacted by the plastics industry, and are not considered to be representative of likely environmental levels in Australia.

Environmental effects

Effects on aquatic Life

Acute toxicity

The chemical is not acutely toxic to model aquatic organisms, including fish and invertebrates, up to its water solubility limit. Effects on algae are below the threshold for categorisation as toxic.

In a study conducted according to OECD TG 203, no mortality and no behavioural abnormalities were observed upon exposure of zebrafish (*Danio rerio*) to a saturated solution of BCPS with a measured concentration of 0.98 mg/L. In an OECD TG 211 test on daphnids (*Daphnia magna*), no immobility was observed in the parents at 48 hours up to the maximum test concentration of 0.93 mg/L (ECHA CHEM n.d.).

In an OECD TG 201 test on green algae (*Raphidocelis subcapitata*), no inhibition of growth rate was observed over 72 hours at exposure concentrations up to 0.28 mg/L. A slow onset of growth rate inhibition started at 0.49 mg/L (3.9% inhibition) and 0.80 mg/L (12% inhibition) (ECHA CHEM n.d.). Extrapolation of the data indicates that the median effect toxicity (EC50) would be above the solubility limit of the chemical and above the threshold of 1 mg/L for categorisation as toxic based on acute effects.

Chronic toxicity

The following measured no observed effect concentration (NOEC) values for model organisms across two trophic levels were retrieved from the REACH dossier (ECHA CHEM n.d.):

Taxon	Endpoint	Method
Invertebrate	21 d NOEC = 0.32 mg/L	<i>D. magna</i> (water flea)
		Reproduction Semi-static conditions Measured concentrations OECD TG 211
Algae	72 h NOEC = 0.28 mg/L	<i>R. subcapitata</i> (green algae) Growth rate Static conditions Measured concentrations OECD TG 201

The exposure test on algae showed a 72-hour NOEC of 0.28 mg/L, with slow onset of growth rate inhibition starting at 0.49 mg/L. In the chronic test for daphnids, significant effects on reproduction were reported at 0.55 mg/L (22% inhibition) and 0.93 mg/L (98% inhibition).

No standardised tests on chronic toxicity to fish are available. In the OECD TG 305 test for bioaccumulation in carp (*Cyprinus carpio*) no adverse effects were observed over the course of the test (ECHA CHEM n.d.). The REACH registrant inferred from these observations that the 35-day mortality NOEC for carp is equal to or greater than 0.050 mg/L.

Microorganisms

The chemical does not show acute toxicity to aquatic micro-organisms.

The inhibitory effect of BCPS on the respiration rate of aerobic wastewater microorganisms of activated sludge was tested in a 3-hour respiration inhibition test according to OECD TG 209. The NOEC was reported as greater than or equal to 1,000 mg/L (nominal concentration above the water solubility limit of BCPS, no inhibitory effect observed) (ECHA CHEM n.d.).

Effects on sediment-dwelling life

The following measured NOEC value was retrieved from the REACH dossier for BCPS (ECHA CHEM n.d.):

Taxon	Endpoint	Method
Invertebrates	28 d NOEC = 11.8 mg/kg dw	<i>Chironomus riparius</i> (harlequin fly) Survival and emergence Nominal concentration Static conditions OECD TG 218

The chronic toxicity study (spiked sediment toxicity) tested five endpoints (survival, emergence rate, and development rate in males, in females, and in the total population). The NOEC was 11.8 mg/kg dw for both the emergence rate and survival endpoints.

An EC50 of 40.5 mg/kg dw and an EC10 of 14.9 mg/kg dw were reported for emergence rate. The EC50 and EC10 values for mortality were 47.6 mg/kg dw and 15.1 mg/kg dw, respectively (ECHA CHEM n.d.).

Effects on birds

Information on the effects of BCPS on birds is limited. Analogues of BCPS indicate that BCPS is unlikely to exhibit significant acute avian toxicity. The available data on chronic effects on birds are not sufficient to characterise long-term hazards to these organisms.

BCPS

Limited information on the adverse effects of BCPS to birds is available.

A field observation study on white-tailed sea eagles showed no correlation between various reproductive parameters and the concentration of BCPS in eggs (Helander et al. 2002).

Analogues of BCPS

Information from analogue chemicals demonstrate that these chemicals do not cause significant acute effects on birds. These results indicate that BCPS is also unlikely to be acutely toxic to birds.

Avian toxicity endpoints are available for structurally similar substances:

- sulphenone (CAS RN 80-00-2), an analogue with only one chlorine substitution,
- dapsone (CAS RN 80-08-0), an analogue with two amine groups in place of the two chlorine substitutions
- tetradifon (CAS RN 116-29-0), an analogue with two additional chlorines on one of the aryl rings.

In an acute avian dietary test, LC50s above 5,000 mg/kg diet were reported for four species of birds upon exposure to tetradifon. No mortality was observed at day 8 at exposure concentrations up to 5,000 mg/kg diet for 5 days in ring-necked pheasants, mallards and Japanese quails. In bobwhite quails, a mortality rate of 10% was observed at 5,000 mg/kg diet (WHO 1986). Based on these results, tetradifon is practically nontoxic to birds upon acute dietary exposure, according to the US EPA ecotoxicity categories for terrestrial organisms (US EPA n.d.).

Unbounded oral acute LD50 endpoints for red-winged blackbirds above 100 mg/kg body weight (bw) for sulphenone (Schafer et al. 1983) and above 96 mg/kg bw for dapsone (Schafer and Bowles 2004) have been reported. These results indicate that sulphenone and dapsone are not highly toxic to birds upon acute oral exposure (US EPA n.d.).

Endocrine effects

No specific information is available on the endocrine activity and effects of BCPS in fish or birds. Available information from modelling and rat studies demonstrates some endocrine activity and reproductive effects in mammals. While these findings indicate that BCPS may interact with endocrine systems, the available data do not provide sufficient evidence of an adverse effect of BCPS from an endocrine mode of action.

Endocrine activity

Anti-androgenic and anti-estrogenic activity was observed in several ToxCast assays. Data regarding androgen axis indicates BCPS's antiandrogenic activity. The ToxCast Pathway Model (AUC), the COMPARA (Consensus) and the CERAPP Potency Level (Consensus) were reported to be negative for (anti-) androgenic activity as well as (anti-)oestrogenic activity. In the CERAPP Potency Level a very weak binding to the estrogen receptor is reported (ECHA 2020).

In an extended one generation reproductive test (EOGRT) on rats according to OECD TG 443 (see below) some changes in thyroid hormones were observed including reduced T4 levels (males) and increased TSH levels (females).

Adverse effects

In an EOGRT (OECD TG 443), Sprague Dawley rats (n = 25/sex/dose) were treated with BCPS via the diet at concentrations of 100, 300 or 1,000 ppm. Treatment doses were halved for females during lactation. Exposure started 10 weeks prior to mating for F0 male and females. A subset of F1 animals was maintained under the same dosing regimen as their parents to produce a F2 litter. Effects observed included:

- decreased percentage of progressively motile sperm and decrease in percentage of rapid sperm (F0 and F1 males)
- increased morphologically abnormal sperm (F0 and F1 males)
- dose-related reduction in implantation sites and litter sizes (F1 and F2)
- low adjusted ano-genital distance (F2 males)
- increased relative thyroid weights with minimal to slight hypertrophy of the follicular cells (F0 and F1 males).

The NOAEL for reproductive performance could not be determined and was below 100 ppm (7.13 to 8.85 mg/kg/day) due to the dose-related reduction in F2 litter size (ECHA CHEM n.d.).

Predicted no-effect concentration (PNEC)

A freshwater PNEC of 5.6 µg/L is derived for BCPS from the measured algae chronic ecotoxicity endpoint (chronic value = 0.28 mg/L), using an assessment factor of 50. This assessment factor was chosen due to the availability of chronic ecotoxicity endpoints for two trophic levels; invertebrates and algae (EPHC n.d.).

For sediment-dwelling life, a PNEC of 118 µg/kg dw is derived from the NOEC of 11.8 mg/kg dw obtained from the sediment-water toxicity test and an assessment factor of 100. This assessment factor is chosen because there is only one long-term toxicity endpoint for sediment-dwelling organisms (EPHC n.d.).

For terrestrial organisms, BCPS has been identified as a bioaccumulative and environmentally persistent chemical. Long term adverse effects to birds have not been fully characterised due to a lack of suitable toxicity data on these organisms. Therefore, a PNEC for avian life has not been derived for BCPS.

Categorisation of environmental hazard

The categorisation of the environmental hazards of the assessed chemical according to Australian Environmental Criteria for Persistent, Bioaccumulative and/or Toxic Chemicals (EPHC n.d.) is presented below:

Persistence

Persistent (P). Based on measured degradation studies indicating limited degradation in water and sediment, and a calculated half-life in air, BCPS is categorised as persistent in the environment.

Bioaccumulation

Bioaccumulative (B). Based on the measured value of $\log K_{OW} \geq 2$ and the estimated value of $\log K_{OA} > 6$, BCPS meets the screening criteria for bioaccumulation in terrestrial organisms. Additionally, available information indicates that trophic transfer from fish to birds in the same marine environment has occurred, with BCPS concentrations in fish-eating birds typically an order of magnitude higher than the BCPS concentrations in fish in the same region.

BCPS does not meet the threshold for bioaccumulation in the aquatic environment, based on the measured $\log K_{OW}$ and BCF values in fish.

Toxicity

Not Toxic (Not T). Measured chronic aquatic endpoints for BCPS are above the domestic categorisation threshold of 0.1 mg/L. Some effects occurred below the water solubility limit in an acute aquatic study. However no acute LC50 or EC50 endpoints below 1 mg/L were observed.

Based on available evidence, BCPS is unlikely to cause significant acute effects in birds. Insufficient information is available to characterise long-term effects in these organisms.

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 BCPS to surface waters and sediment.

Compartment	PEC	PNEC	RQ
Surface water	0.4 µg/L	5.6 µg/L	0.07
Sediment	14 µg/kg dw	118 µg/kg dw	0.12

For surface waters and sediment, RQs less than 1 indicate that BCPS is not expected to cause adverse environmental effects based on estimated emissions, as predicted environmental concentrations are below levels of concern.

The chemical is persistent and bioaccumulative (PB) in fish-eating birds according to Australian PBT criteria. Due to their persistence, PB chemicals have the potential to become widely dispersed environmental contaminants. Once in the environment, persistent chemicals that are also bioaccumulative pose an increased risk of accumulating in exposed organisms. As persistent and bioaccumulative chemicals accumulate and remain in environmental biota over long periods, it is difficult to predict their long-term adverse effects.

Uncertainties

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:

- There is a lack of Australian environmental monitoring data and domestic use information. Most of the monitoring data used for the risk characterisation of BCPS are from Europe. Further evaluation and risk characterisation may be required if Australian environmental monitoring and use data become available to indicate that BCPS may be present in Australian surface waters and sediments at concentrations above concentrations of concern in aquatic and sediment-dwelling food webs.
- Long term adverse effects to air-breathing organisms, especially fish-eating birds, have not been fully characterised due to a lack of suitable toxicity data on such

organisms. Suggestions of endocrine activity are also present. However, their influence on long-term toxicity is also currently unclear. Further evaluation may be required if new ecotoxicity data become available indicating that BCPS is more hazardous than considered in this evaluation.

- The chemical BCPS was historically assessed as an insecticide and is structurally related to the historical acaricides, sulphenone (CAS RN 80-00-2), and tetradifon (CAS RN 116-29-0). Exposure to BCPS may cause adverse effects to some species of insects including moths and flies, based on the results of non-standardised tests (ECHA 2020). While these tests indicate the potential for BCPS to cause effects in some insects, the relevance of these results to conditions found in the environment is unclear and the information has not been considered further.

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