Qualitative and Quantitative Tier 3 Assessment

Cocoalkyl Dimethylbenzyl Ammonium Chloride

In accordance with the Dawson River Release (DRR) Chemical Risk Assessment Framework (CRAF), the assessment for this Tier 3 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No-Effects Concentrations (PNECs) for water and soil; and completing a qualitative and quantitative assessment of risk. Each of these components is detailed within this attachment.

Background

Santos has been releasing treated water to the Dawson River since 2015. The Dawson River Release Scheme[1] is located in the southeast region of the Fairview Arcadia Project Area (FAPA) (within the hub compressor station four (HCS4) gathering network). Coal seam water produced in the HCS4 gathering network is collected and is treated at Reverse Osmosis Plant 2 (ROP2) with the treated permeate stored within a permeate pond prior to release to the Dawson River. The outfall location is located within a tributary gully of the Dawson River, which joins the Dawson River midway between "Dawson's Bend" and Yebna Crossing.

The permeate pond is connected to the outfall location by a 5.3-kilometre (km) pipeline constructed across farmland with the released water flowing down a 2.9 km tributary gully before discharging to the Waterbody (nominal capacity 500 megalitre [ML]) and then flowing 1.8 km before joining the Dawson River at its downstream confluence.

ROP 2 at FAPA is a reverse osmosis plant with a specification designed to produce high quality water for the intended release of treated coal seam water to the Dawson River. The process removes the suspended and dissolved solids through a set of six processes to produce high quality treated water. These include coagulation/clarification, oxidation, filtration, softening, reverse osmosis, and finally adjustment of sodium adsorption ratio (SAR).

Cocoalkyl dimethylbenzyl ammonium chloride (also known as alkyl dimethyl benzyl ammonium chloride [ADBAC]) is a component in a water treatment product used to provide corrosion resistance from microbial influenced corrosion in the steel flowlines and spinelines in the produced water management collection system. Process and usage information for this chemical is summarised in **Table 1**.

[1] Santos obtained an amendment to the Fairview Arcadia Project Area (FAPA) Environmental Authority (EA) (EPPG00928713) on 31st May 2013 to authorise the release of desalinated produced water from the Fairview reverse osmosis plant (ROP) 2 to the Dawson River – the Dawson River Release Scheme (DRRS).

Table 1 Water Management Facility Chemicals

Chemical Name	CAS No.	Use	Percent Weight (%) in Product[1]
ADBAC	61789-71-7	Biocide	5

[1] Mid-point of range provided in SDS.
CAS No = Chemical Abstracts Service Number

The water treatment product could potentially be used for biocide treatment in FAPA but is currently not being used. Based on its use in other Santos project areas, dosage rates in water for this chemical in the biocide are in the range of 1×10^{-4} mg/L.

The assessment of toxicity of this chemical was used to develop initial screening criteria for human health exposure scenarios and is presented in the risk assessment dossier provided in **Attachment 1**. There are no carcinogenicity studies on ADBAC, and, as a result, only a non-carcinogenic oral reference dose (RfD) was calculated. A detailed discussion of the derivation of the oral RfD and drinking water guideline values is presented in the attachment. **Table 2** provides a summary of the derivation.

Table 2 Oral Reference Doses and Derived Drinking Water Guidelines

Constituent (CAS No.)	Study	Critical Effect/ Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (mg/L)
ADBAC (61789-71-7)	2-yr rat oral	Decreased body weight, body weight gain	44	100	0.4	1.5

CAS = Chemical Abstracts Service
mg/kg-day = milligram per kilogram-day
mg/L = milligram per litre
NOAEL = No observed adverse effect level
Refer to **Attachment 1** for information on the key studies selected for oral reference dose and drinking water level development.

For ecological receptors, the assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna for the chemical. The qualitative assessment focuses on the aquatic invertebrate and fish species within the surface water resources, and the soil flora and fauna associated with releases to the soil. The quantitative assessment includes evaluating the potential risks to these same aquatic and soil ecological receptors, in addition to higher trophic level organisms such as livestock and terrestrial wildlife.

The determination of toxicological reference values (TRVs) was conducted according to the PNEC guidance in the *Environmental Risk Assessment Guidance Manual for Industrial Chemicals* prepared by the Australian Environmental Agency (AEA, 200u9). PNECs for freshwater and sediment are developed to assess aquatic receptors, and PNECs for soil are developed for terrestrial receptors.

Table 3 presents the chemical, endpoint, no observed effects concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). PNECs for sediment and soil are detailed in **Tables 4** and **5,** respectively. Refer to **Attachment 1** for the development of PNECs, or the rational for PNECs that do not have a calculated PNEC.

Table 3 PNECs Water – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
ADBAC (61789-71-7)	Chronic *Daphnia*	0.0042	10	0.00042

EC_{50} = effects concentration – 50%
mg/L = milligram per litre
NOEC = no observed effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

Table 4 PNECs Sediment – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg wet wt)	Assessment Factor	$PNEC_{sed}$ (mg/kg wet dw)
ADBAC (61789-71-7)	*Chironomus tentans*	520	100	5.2

EC_{50} = effects concentration – 50%
mg/kg wet wt = milligram per kilogram dry weight
NOEC = no observed effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

Table 5 PNECs Soil – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg dry wt)	Assessment Factor	$PNEC_{soil}$ (mg/kg dry wt)
ADBAC (61789-71-7)	Terrestrial plant toxicity	277	100	2.77

EC_{50} = effects concentration – 50%
mg/kg dry wt = milligram per kilogram dry weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 1** for information on the development of PNECs listed above.

A detailed assessment of the potential risks posed by this Tier 3 chemical is provided in the following sections.

General Overview

ADBAC is a mixture of discrete benzalkyl quaternary ammonium salts, in the category of unknown or variable composition, complex reaction products or biological materials (UVCBs). Each salt contains an organic cation based on a quaternary nitrogen that is covalently bonded to a benzyl substituent, two methyl groups, and a single alkyl chain that has seven or more carbon atoms. The molecular structure of ADBAC is presented in **Figure 1**.

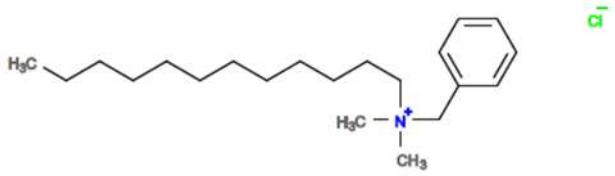

Figure 1 Molecular Structure of ADBAC[2]

This substance is biodegradable and not expected to bioaccumulate. It does have the potential to sorb to soils and settlement. However, sorption is expected to be mitigated by significant biodegradation.

The Persistent, Bioaccumulative and Toxic (PBT) assessment for ADBAC is included in the dossier provided in **Attachment 1**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that ADBAC is not a PBT substance.

Human Health Hazards

The acute toxicity of ADBAC to humans is relatively moderate by the oral route. The substance is corrosive to skin and is expected to be corrosive to eyes. It is not a sensitiser. In repeat dose toxicity tests, including reproductive studies, NOAELs exceeded 10 mg/kg-day. The substance is not genotoxic nor is it carcinogenic.

Based on a review of a chronic oral toxicity study in rats, toxicological reference values were derived for ADBAC. The drinking water guideline value derived for ADBAC using the non-carcinogenic oral RfD is 1.5 mg/L.

Based on its potential use as a biocide in produced water flow lines, ADBAC may be present in treated water (permeate). Managed release of treated water to the Dawson River would have the potential to affect surface water within the river. As the Dawson River meanders through large areas that are uncontrolled, exposures could potentially occur to downstream agricultural workers and residents.

There is low potential for human receptors to be exposed to ADBAC in Dawson River discharge. The combination of mixing/dilution, storage (and associated biodecay), and treatment and retention (and associated biodecay) are all key components that will reduce the potential risk to potential receptors from discharges to surface water. For example, the concentration of the biocide in produced water would be diluted by a factor of at least 90% in the water feed pond due to the aggregation of produced water from other wells within one pond. During water treatment, concentrations would be further reduced by efficiencies of the reverse osmosis system.

Finally, there are no public access points to Dawson River within 1.4 km downstream of the most downstream release location, and while there may be some fishing by local landowners in this reach, other forms of secondary recreation are unlikely. Currently, there is no irrigation in the immediate vicinity of the Waterbody, with the closest irrigation being approximately 5km to the west. There is a

[2] Source NICNAS, 2016

water supply scheme in the Dawson River that supplies irrigators but this is located 250 km downstream, with a search of the Department of Natural Resources, Mines and Energy (DNRME) now Department of Resources (DoR), data base indicating that the nearest licensed surface water take for irrigation is 71 km downstream noting this licence provides authority to extract from an 'Unnamed tributary of the Dawson River', not the Dawson River. The nearest surface water domestic water supply entitlement is 244 km downstream (AECOM, 2019).

Environmental Hazards

In standard aquatic toxicity tests, ADBAC exhibits significant acute and chronic aquatic toxicity. Sediment dwelling organisms are far less sensitive to the substance perhaps based on combined effects of biodegradation and binding to the settlement matrix. This substance is not expected to bioaccumulate.

Toxicity data on water, sediment and soil-dwelling organisms was available to calculate PNECs. Experimental results were available for three trophic levels for water and soil organisms. Experimental results were available for one sediment-dwelling organism.

As described in the previous section (Human Health Hazards), managed release of treated water to the Dawson River would have the potential to affect surface water within the river. As released treated water would become part of the regional surface water resource (i.e., Dawson River water quality and flow), ecological resources (livestock and native flora and fauna) are potential receptors. Specifically, potential receptors include:

- Aquatic ecological receptors within Dawson River downstream of the release point
- Livestock and wildlife that may access Dawson River surface water

Stock access to large portions of the Waterbody is permitted and has been observed. The banks of the Waterbody are severely degraded and lack riparian vegetation due to cattle access/activity. Similarly, cattle access the Dawson River for water at numerous places within and downstream of the receiving environment (frc environmental, 2021).

There is limited extraction of water for general farm supply downstream of the release location to the Dawson River. There is one licensed surface water take for agriculture within the extent of the release location area. Santos is in regular direct communication with the landholder and is not aware of any abstraction being undertaken under this licence to date. In addition, the nearest downstream agricultural area is located approximately 7 km downstream of the release location to the Dawson River.

Biological monitoring has identified the presence of Matters of National Environmental Significance (MNES) receptor white-throated snapping turtle (*Elseya albagula*) in two upstream locations (at site DRR2 on Hutton Creek and at site DRR1 on Dawson River). The presence of MNES receptor Fitzroy River Turtle (*Rheodytes leukops*) has not been identified.

The potential for exposure of sensitive receptors, including MNES, is low. Released produced water mixes with surface water in a manner that is protective of aquatic receptors within the Dawson River (AECOM, 2019). Treated water releases from the permeate ponds are less than 18 megalitre (ML)/day with Santos undertaking periodic releases. Releases are currently dictated by treated effluent production rates. Perennial base flow in the Dawson River downstream of Dawson's Bend at

the Dawson River discharge point has been assessed as 21 ML/day. Baseflow in the Dawson River is associated with spring discharges.

Risk Characterisation

The purpose of the risk characterisation portion of the assessment is to provide a conservative estimate of the potential risk resulting from exposure to ADBAC that may occur during water treatment activities. The risk characterisation evaluates the toxicity of ADBAC and characterises the risk of the chemical assessed for specific exposure pathways identified in the previous sections.

A two-stage process is employed during risk characterization. First, risk ratios are developed for the chemical for potentially complete exposure pathways associated with applicable release scenarios. The risk ratio is calculated by dividing the exposure point concentration (EPC) by the applicable risk-based screening level (drinking water level or PNECs for aquatic and terrestrial receptors). If the ratio of exceedance of screening levels is less than 1.0, then there are no anticipated adverse effects associated with the exposure scenario evaluated. No risk / hazard reduction measures are required. There should be no need for further management controls on the chemical additional to those already in place (DoEE, 2017).

If the ratio is greater than 1.0, then further quantitative analysis is conducted. Consistent with the assessment framework, quantitative assessment of risk will consider only Tier 3 chemicals in end use determination.

Exposure Point Concentration Calculations

A quantitative mass balance calculation was undertaken to estimate the potential concentrations of contingency water treatment chemicals containing ADBAC within diluted produced water. For the mass balance calculation, Water Management Facility (WMF) process information was used to determine the amount of ADBAC in the water feed pond influent (see **Attachment 2**). **Table 6** presents the estimated pond influent concentration.

Table 6 Mass Balance Estimates for ADBAC

Chemical Name	CAS No.	Water Feed Pond Influent (mg/L)
ADBAC	61789-71-7	7.2E-10

CAS No = Chemical Abstracts Service Number
mg/L = milligram per litre

The mass balance of ADBAC was then used to estimate potential EPCs for the evaluation of releases of treated water to the Dawson River.

The concentration of ADBAC within the produced water will decrease, where applicable, to account for the biodegradation and photolytic degradation of constituents over time. As a result, the EPC was adjusted based on biodegradation rates to calculate the theoretical EPCs for two exposure time periods (0 and 30 days) which represent no storage/no degradation (Day 0) and a bounding estimate which considers degradation during storage at the WMF. The biodegradation information was obtained from the OECD ready tests (OECD, 1992) that were developed as a first-tier testing scheme to provide preliminary screening of organic chemicals. The ready tests are stringent screening tests that are conducted under aerobic conditions in which a high concentration of the test substance is

used, and biodegradation is measured by non-specific parameters including dissolved organic carbon, biochemical oxygen demand and carbon dioxide production. **Attachment 3, Table 1** includes the environmental fate information that was used to assess biodegradation of the chemical.

The concentrations in the water feed pond were then further reduced by a factor of 99% to account for efficiencies in the WMF system.

Finally, a nominal dilution factor of 2 was assumed to account for dilution into the receiving water body as well as the retention, attenuation or degradation mechanisms that would occur between the permeate pond and Waterbody and the Waterbody and Dawson River. The use of a dilution factor or mixing ratio is consistent with the approved mixing zone described in the Santos 2013 report *Dawson River Release Scheme – Environmental Authority Amendment Application – Supporting Information*.

These estimated surface water EPCs were used to derive EPCs for sediment using the equilibrium partitioning method. **Attachment 3, Table 1** includes the equation and environmental fate information used to derive the sediment EPC.

Release Scenario Assessment

There is no potentially complete exposure pathway to sources of drinking water; however, as a conservative measure, the theoretical concentrations for the release scenario was compared to human health toxicity-based screening levels to screen for potential effects as a result of surface water used as a drinking water source. The results of this comparison, including the ratio of exceedance of screening levels, is presented in **Attachment 3, Table 2**. As detailed in the table, the risk ratio did not exceed the target level of 1.

To further evaluate potential exposure pathways for aquatic receptors, theoretical concentrations were also compared to the PNECs for aquatic receptors. **Attachment 3, Table 3** presents the results of this comparison, including the ratio of exceedance of screening levels. Similar to above, risk ratios did not exceed the target level of 1.

The primary land use within the development area is agricultural (grazing on improved or unimproved pastures), and it is sparsely populated. To further evaluate potential risks to non-MNES receptors (mammals and avian), additional quantitative analysis of the managed releases to Dawson River was conducted.

Terrestrial receptors evaluated for exposure to Dawson River discharge include domesticated livestock, large mammalian wildlife and small mammalian wildlife. Beef cattle were used to evaluate domesticated livestock, kangaroos were evaluated for large mammalian wildlife, and dingos were evaluated for small mammalian wildlife. The cattle egret was selected to evaluate avian exposures. Exposure assumptions, TRVs and total intake calculations are detailed in **Attachment 3, Tables 4, 5, 6 and 7**. **Attachment 3, Table 4** presents the calculated risk estimates for the kangaroo. **Attachment 3, Table 5** presents the calculated risk estimates for the dingo. **Attachment 3, Table 6** presents the calculated risk estimates for the cattle. **Attachment 3, Table 7** presents the calculated risk estimates for the cattle egret. As indicated in the tables, the calculated HQ for ADBAC did not exceed the risk threshold level of 1 for any of the scenarios evaluated.

Cumulative Impacts

The potential for cumulative impacts associated with water treatment chemicals is limited. Residual chemicals may be entrained within produced water and subsequently transported for water treatment at a WMF. However, these chemicals are removed by the treatment systems; and, therefore, no additional risk is provided during managed releases to Dawson River. Likewise, the presence of water treatment chemicals at the point of produced water storage or during managed releases to the Dawson River also poses no significant increase in risk.

Tier 3 chemicals which trigger persistence and bioacummulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted earlier and discussed in detail in the dossier (**Attachment 1**), ADBAC does not meet the criteria for persistence or bioaccumulation. It does have the potential to sorb to soils and sediment. However, sorption is expected to be mitigated by significant biodegradation. Further, estimated concentrations in surface water and sediment were less than PNECs. Thus, there is negligible incremental risk posed by the use of this Tier 3 chemical and the existing management and monitoring controls are appropriate to ensure that the risk to MNES (and non MNES) receptors remains low.

Uncertainty Analysis

The procedures and assumptions used to assess potential human health risks in this Tier 3 assessment are subject to a wide variety of uncertainties. However, the presence of uncertainty is inherent in the risk assessment process, from the sampling and analysis of the chemical in environmental media to the assessment of exposure and toxicity, and risk characterisation. Accordingly, it is important to note that the risks presented within this Tier 3 assessment are based on numerous conservative assumptions in order to be protective of human health and the environment, and to ensure that the risks presented herein are more likely to be overestimated rather than underestimated.

The discussion detailed in **Table 7** provides an evaluation of uncertainty for this Tier 3 assessment, including elements previously discussed within this assessment.

Table 7 Evaluation of Uncertainty – ADBAC

Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment –COPC concentrations	The concentrations of COPCs in water treatment were estimated based on previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with Santos occurred to identify a conservative estimate of the COPC; however, there is the potential that the empirical concentrations would differ than those presented in the risk assessment.	Low	This assumption may overestimate or underestimate the calculated risks to receptors, dependent on-site-specific conditions.

Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment –COPC concentrations	Concentrations of COPCs evaluated in the quantitative risk assessment were assumed to be 100 percent of mass used in the water treatment process. This is a conservative assumption for chemicals that may degrade rapidly or volatilise.	Medium	This assumption may overestimate the calculated risks to receptors.
Exposure Assessment	The use of the food consumption relationship with body weight for mammalian and avian receptors.	Low to Medium	Low to medium potential to underestimate or overestimate risk
Exposure Assessment – EPC	The assessment for all receptors considers the maximum concentration in days 0 and 30 in any one year and does not evaluate further degradation of residual concentrations.	Medium	Medium to high potential to overestimate risks.
Toxicity Assessment	The use of toxicity values in a risk assessment is based on extrapolations from animal data, adjust factors for inherent uncertainty in the toxicological estimate and use of surrogate toxicity criteria	Low	Low potential to underestimate risk
Toxicity Assessment	The use of LOAEL/NOAEL for calculation of the TRVs	Low to Medium	Low to medium potential to underestimate or overestimate risk
Toxicity Assessment	The use of the allometric scaling method to estimate the population-level effects on wildlife based on individual level of exposures.	Low to Medium	Low to medium potential to underestimate or overestimate risk

References

AECOM. 2019. Revised Boron Site-Specific Water Quality Criterion – Dawson River Release Scheme. Letter from B. Goldsworthy and N. Lee to A. Lavery. 12 July 2019..

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NICNAS (2016). Benzalkyl quaternary ammonium surfactants: Environment tier II assessment. July.

OECD. (1992). Test No. 301: Ready Biodegradability. (Biodégradabilité Facile.) Paris: OECD Publishing.

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Attachment 1 Risk Assessment Dossier

Cocoalkyl dimethylbenzyl ammonium chloride (61789-71-7)

This dossier on cocoalkyl dimethyl benzyl ammonium chloride (ADBAC) presents the most critical studies pertinent to the risk assessment of this substance in its use in drilling muds, hydraulic fracturing fluids and water treatment systems. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from The National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 1994) and the ECHA database that provides information on chemicals that have been registered under the European Union (EU) REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion - ADBAC was not identified in databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. However, ADBAC was assessed as a tier 3 chemical for acute toxicity and as a tier 3 chemical for chronic toxicity. Therefore, ADBAC is classified overall as a **tier 3** chemical and requires a quantitative risk assessment for end uses.

1 BACKGROUND

ADBAC is a mixture of discrete benzalkyl quaternary ammonium salts, in the category of unknown or variable composition, complex reaction products or biological materials (UVCBs). Each salt contains an organic cation based on a quaternary nitrogen that is covalently bonded to a benzyl substituent, two methyl groups, and a single alkyl chain that has seven or more carbon atoms. This substance is biodegradable and not expected to bioaccumulate. It does have the potential to sorb to soils and settlement. However, sorption is expected to be mitigated by significant biodegradation. The acute toxicity of ADBAC to humans is relatively moderate by the oral route. The substance is corrosive to skin and is expected to be corrosive to eyes. It is not a sensitiser. In repeat dose toxicity tests, including reproductive studies, no observed adverse effect levels (NOAEL) exceeded 10 milligrams per kilogram a day (mg/kg-day). The substance is not genotoxic nor is it carcinogenic. ADBAC exhibits significant acute and chronic aquatic toxicity. Sediment dwelling organisms are far less sensitive to the substance perhaps based on combined effects of biodegradation and binding to the settlement matrix.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Coco alkyl dimethyl benzyl ammonium chloride

CAS RN: 61789-71-7

Molecular formula: $C_{21}H_{38}ClN$

Molecular weight: 340 g/mol

Synonyms: Alkyl dimethyl benzyl ammonium chloride; Quaternary ammonium compounds, benzylcoco alkyldimethyl, chlorides; Benzyl (coconut oil alkyl)dimethyl ammonium chloride; Benzyl chloride quaternary salt of N,N'-dimethylcocoamine; Dimethyl cocobenzyl ammonium chloride

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1. This substance as a salt of benzalkyl quaternary ammonium surfactants is expected to have low volatility (de Oude, 1992).

The reported water solubility value is the measured critical micelle concentrations (CMCs) for discrete chemicals in this group (Mukerjee and Mysels, 1971). The CMCs decrease with increasing alkyl chain length as expected (Tezel, 2009).

The octanol-water partition coefficient (K_{ow}) for the chemicals in this group is not considered to provide a reliable indicator of the partitioning behaviour of surface-active substances in the environment (McWilliams and Payne, 2001; Shorts, et al., 2010).

Table 1 Overview of Physico-Chemical Properties of ADBAC[1]

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa*	White solid	1	ECHA
Melting Point	33°C for transition between solid and paste, and 200°C for transition between paste and liquid	1	ECHA
Boiling Point	218°C	1	ECHA
Density	940 kg/m³	1	ECHA
Vapour Pressure	0 Pa	2	ECHA
Partition Coefficient (log K_{ow})	0.004	2	ECHA
Water Solubility	17 mg/L @ 23°C	1	ECHA
Flash Point	The study does not need to be conducted because the flash point is only relevant to liquids and low melting point solids.	1	ECHA
Auto flammability	No autoignition temperature was observed up to the maximum test temperature of 403°C.	2	ECHA
Viscosity	The study does not need to be conducted because the substance is a solid.	-	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for ADBAC.

[1] 1 Data abstracted from ECHA dossier on quaternary ammonium compounds, benzyl-C16-C18 (even numbered)-alkyldimethyl, chlorides (EC No. 939-290-7) based on structural similarity.

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

ADBAC is biodegradable and not expected to bioaccumulate. It does have the potential to sorb to soils and sediment. However, sorption is expected to be mitigated by significant biodegradation.

B. Biodegradation

ADBAC is considered to be readily biodegradable, although no data were provided (EU, 2012). Didecyldimethylammonium chloride (DDAC), a structural analogy of ADBAC, showed 83.3% CO_2 evolution after 28 days in a simulated sewage treatment system. A biodegradation study in two water/sediment systems has been conducted on DDAC. DDAC easily migrated from the aqueous phase to the sediment phase and was easily adsorbed to sediments (high K_{oc}). The degradation in the sediment did not increase very much after the first month and the half-life (DT_{50}) of the total system was not reached within the 120 days test duration (EU, 2012).

C. Environmental Distribution

An OECD Guideline 106 (Adsorption - Desorption Using a Batch Equilibrium Method) was performed based on read-across via grouping to quaternary ammonium salts (ECHA) [Kl. score = 2]. The K_{oc} at 20 degrees Celsius (°C) was determined to be 1.6 $x10^6$ litres per kilogram (L/kg).

D. Bioaccumulation

The measured bioconcentration factor (BCF) in bluegill fish (whole body) after 36 days (35-day exposure plus 21-day depuration) was determined to be 79, with BCF values for edible tissues and non-edible tissues being 33 and 160, respectively (EU, 2012). Thus, ADBAC has a low potential for bioaccumulation (EU, 2012).

6 HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

ADBAC disposition in the rat is facilitated by faecal absorption. The acute toxicity is relatively moderate. The substance is corrosive to skin and is expected to be corrosive to eyes. ADBAC is not a sensitiser. In repeat dose toxicity tests, including reproductive studies, NOAEL exceed 10 mg/kg-day. The substance is not genotoxic nor is it carcinogenic.

B. Toxicokinetics

Following a single or repeated oral doses of ADBAC, >90% was excreted in the faeces and 5-8% was eliminated via urine, <1% was present in the tissues seven days after dosing. Thus, it can be assumed that ADBAC is not readily absorbed from the gastrointestinal tract. An oral absorption of 10% can be assumed (EU, 2012).

In an *in vitro* study using human skin, dermal absorption of ADBAC was determined to be 8.3% (EU, 2012).

C. Acute Toxicity

The acute oral LD_{50} values in rats of ADBAC (purity 82.26%) are 510.9 milligrams per kilogram (mg/kg) for males, 280.8 mg/kg for females, and 204.5 mg/kg for both sexes combined (USEPA, 2006a,b) [Kl. score = 2]. The oral LD_{50} in rats is 344 mg/kg (EU, 2012) [Kl. score = 2].

The LC_{50} value of ADBAC (purity 82.26%) is between 0.054 and 0.51 milligrams per litre (mg/L) (USEPA, 2006a,b).

The dermal LD_{50} values of ADBAC (purity 82.26%) in rats are 1,100 mg/kg for males, 704 mg/kg for females, and 930 mg/kg for both sexes combined (USEPA, 2006a,b) [Kl. score = 2]. The dermal LD_{50} in rabbits is 2,848 mg/kg (EU, 2012) [Kl. score = 2].

D. Irritation

ADBAC is corrosive to the skin of rabbits; it is expected to be corrosive to the eyes of rabbits (USEPA, 2006a,b; EU, 2012) [Kl. score = 2].

E. Sensitisation

ADBAC was not a skin sensitiser when evaluated in a guinea pig Buehler test (USEPA, 2006a,b; EU, 2012). Didecyldimethylammonium chloride, a structurally similar compound, was not a skin sensitiser in a guinea pig maximisation test (EU, 2012) [Kl. score = 4].

F. Repeated Dose Toxicity

In sub chronic oral toxicity studies, the NOAELs were 31, 85 and 13.1 mg/kg-day for rats, mice and dogs, respectively. The adverse effects seen in these studies were mainly decreased body weights, reduced feed consumption, and appearance of clinical signs related to the irritation and tissue damage to the gastrointestinal tract. There were changes in the haematological and clinical

chemistry parameters in the high-dose animals that were interpreted as secondary to reduced feed intake and dehydration that led to reduced kidney blood flow (EU, 2012) [Kl. score = 4].

In a chronic oral toxicity study, decreased body weights and body weight gain were observed in rats given 88 mg/kg ADBAC. The NOAEL for the study is 44 mg/kg-day (USEPA, 2006b; EU, 2012) [Kl. score = 2].

In a chronic oral toxicity study, the NOAEL for non-neoplastic effects in mice is 73 mg/kg-day (EU, 2012) [Kl. score = 4].

In a 90-day dermal toxicity study, there were no systemic effects seen at 20 mg/kg-day ADBAC (purity 81.09%), the highest dose that did not elicit excessive skin irritation. The NOAEL is 20 mg/kg-day (USEPA, 2006a; EU, 2012) [Kl. score = 4].

G. Genotoxicity

The *in vitro* genotoxicity studies on ADBAC are presented in Table 3.

Table 3 *In vitro* Genotoxicity Studies on ADBAC

Test System	Results		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	4	USEPA, 2006a; EU, 2012
Mammalian cell gene mutation (CHO cells)	-	-	4	USEPA, 2006a; EU, 2012
Chromosomal aberration (human lymphocytes)	-	-	4	USEPA, 2006a; EU, 2012
Unscheduled DNA synthesis assay	-	Not tested	2	USEPA, 2006a

*+, positive; -, negative

ADBAC was negative in an *in vivo* mouse micronucleus assay (EU, 2012) [Kl. score = 4].

H. Carcinogenicity

ADBAC was not carcinogenic to rats and mice; no details were provided, although the route of exposure is presumed to be oral based on the chronic toxicity study information (USEPA, 2006a; EU, 2012) [Kl. score = 2].

I. Reproductive Toxicity

In a reproductive toxicity study (details not specified), reduced weight gain and feed consumption were noted in the parental and F_1 offspring. The lowest observed adverse effect level (LOAEL) and NOAEL for the parental and F_1 offspring are 100 and 50 mg/kg-day, respectively. The NOAEL for the F_2 offspring is 50 mg/kg-day. There were no reproductive effects at doses that were not maternally toxic (EU, 2012) [Kl. score = 4].

J. Developmental Toxicity

Pregnant female rats were administered ADBAC (route not specified) at doses of 0, 10, 30 or 100 mg/kg (duration not specified). Maternal toxicity was noted at $\geq$ 30 mg/kg; there was no indication of developmental toxicity at any dose level. The NOAEL for maternal toxicity is 10 mg/kg-day; the NOAEL for developmental toxicity is 100 mg/kg-day, the highest dose tested (EU, 2012) [Kl. score = 4].

In a rabbit developmental toxicity study, the NOAEL for maternal toxicity was 3 mg/kg-day. The NOAEL for developmental toxicity was 9 mg/kg-day, the highest dose tested (EU, 2012) [Kl. score = 4].

K. Derivation of Toxicological Reference and Drinking Water Guidance Values

The toxicological reference values developed for ADBAC follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011).

For oral exposure, the lowest NOAEL is 44 mg/kg-day from a rat chronic toxicity study based on a LOAEL of 88 mg/kg-day for decreased body weights and body weight gain.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 44/(10 x 10 x 1 x 1 x 1) = 44/100 = 0.4 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.44 x 70 x 0.1)/2 = 1.5 mg/L

L. Human Health Hazard Assessment of Physico-Chemical Properties

ADBAC does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

ADBAC exhibits significant acute and chronic aquatic toxicity. Sediment dwelling organisms are far less sensitive to the substance perhaps based on combined effects of biodegradation and binding to the settlement matrix.

B. Aquatic Toxicity

Table 4 lists the results of acute aquatic toxicity studies on ADBAC.

Table 4 Acute Aquatic Toxicity Studies on ADBAC

Test Species	Endpoint	Results (mg a.i./L)	Klimisch score	Reference
Pimephales promelas	96-hr LC_{50}	0.28	2	USEPA, 2006a; EU, 2012
Daphnia magna	48-hr EC_{50}	0.0058	2	USEPA, 2006a; EU, 2012
Selenastrum capricornutum	72-hr EC_{50}	0.049	2	EU, 2012

a.i. = active ingredient

The chronic aquatic toxicity studies on ADBAC are listed in **Table 2**.

Table 2 Chronic Aquatic Toxicity Studies on ADBAC

Test Species	Endpoint	Results (mg a.i./L)	Kl. score	Reference
Pimephales promelas	24-d NOEC	0.0322	2	USEPA, 2006a,b; EU, 2012
Daphnia magna	21-d NOEC	$\geq$0.00415	2	USEPA, 2006a,b; EU, 2012
Selenastrum capricornutum	EC_{10}	0.009	2	EU, 2012
Lemna gibba	7-d EC_{50}	0.25	2	EU, 2012

C. Sediment Toxicity

The 28-day no observed effect concentration (NOEC) for the midge *Chironomus tentans* is 520 mg/kg dry weight (EU, 2012) [Kl. score = 2].

D. Terrestrial Toxicity

Table 3 lists the results of toxicity studies conducted on ADBAC with earthworms, soil microorganisms and birds.

Table 3 Terrestrial Toxicity Studies on ADBAC

Test Species (method)	Endpoint	Results	Kl. score	Reference
Earthworm *Eisenia fetida*	14-d LC_{50}	7,070 mg/kg soil dw	2	EU, 2012
Mustard plant	18-20-d EC_{50}	277 mg/kg soil dw	2	EU, 2012
Soil microorganisms	28-d EC_{50} 28-d EC_{50}	>1,000 mg/kg soil dw* >1,000 mg/kg soil dw**	2	EU, 2012
Northern bobwhite quail	Acute LC_{50}	164 mg/kg	2	EU, 2012
Northern bobwhite quail	Dietary LC_{50}	>3,813 mg/kg	2	EU, 2012
Mallard duck	Dietary LC_{50}	>2,463 mg/kg	2	EU, 2012

*Nitrogen transformation.
**Carbon transformation.

E. Calculation of Predicted No Effect Concentrations (PNECs)

$PNEC_{water}$: Experimental results are available for three trophic levels. Acute EC_{50} values are available for fish (0.28 mg/L), *Daphnia* (0.0058 mg/L) and algae (0.049 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC or EC_{10} value being 0.00415 mg/L for invertebrates. On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 0.00415 mg/L for invertebrates. The $PNEC_{water}$ is 0.000415 mg/L or 0.415 micrograms per litre (µg/L).

$PNEC_{sediment}$: Experimental results are available for one sediment dwelling organism. In a chronic sediment-spiked test with *Chironomus tentans*, the 28-day NOEC was 520 mg/kg dw. Using an assessment factor of 100, the $PNEC_{sediment}$ was determined to 5.2 mg/kg dw.

$PNEC_{soil}$: Experimental results are available for three trophic levels. Acute EC_{50} values are available for earthworms (7,070 mg/kg dw) and plants (277 mg/kg dw). A long-term study has also been conducted on soil organisms. On the basis that the data consists of acute tests from two trophic levels and a long-term test on one trophic level, an assessment factor of 100 has been applied to the lowest reported EC_{50} value of 277 mg/kg dw for plants. The $PNEC_{soil}$ is 2.8 mg/kg dw.

8 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009).

ADBAC is readily biodegradable; thus, it does not meet the screening criteria for persistence.

The measured BCF for ADBAC is 79; thus, ADBAC does not meet the screening criteria for bioaccumulation.

Chronic NOECs for fish, *Daphnia* and algae are available for ADBAC; the lowest EC_{10} or NOEC value is <0.1 mg/L. Therefore, ADBAC meets the screening criteria for toxicity.

The overall conclusion is that ADBAC is not a PBT substance.

B. Other Characteristics of Concern

Only tier 3 chemicals which trigger persistence and bioacummulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted in the prior section, ADBAC does meet the criteria for persistence or bioaccumulation. Further evaluation of cumulative impacts is provided in the quantitative risk assessment.

No other characteristics of concern were identified for ADBAC.

9 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment [1]	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required[3]
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity [2]	Chronic Toxicity[2]	
Cocoalkyl dimethylbenzyl ammonium chloride (ADBAC)	61789-71-7	Not a PBT	No	No	No	No	No	Yes	3	3	3

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).
3 - Tier 3 - Quantitative Risk Assessment: Complete PBT, qualitative and quantitative assessment of risk.

Notes:

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
µg/L	micrograms per litre
ADWG	Australian Drinking Water Guidelines
AICS	Australian Inventory of Chemical Substances
BCF	bioconcentration factor
CHO	Chinese hamster ovary
COC	constituent of concern
DDAC	didecyldimethylammonium chloride
dw	dry weight
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
IUPAC	International Union of Pure and Applied Chemistry
kg	kilograms
kg/m³	kilograms per cubic metre
KI	Klimisch scoring system
kPa	kilopascal
L	litre
L/kg	litres per kilogram
LC	lethal concentration
LD	lethal dose
LOAEL	lowest observed adverse effect level
mg a.i./L	milligrams active ingredient per litre
mg/kg	milligrams per kilogram
mg/kg-day	milligrams per kilogram a day

mg/L	milligrams per litre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
OECD	Organisation for Economic Co-operation and Development
Pa	Pascal
PBT	Persistent, Bioaccumulative and Toxic
PNEC	predicted no effect concentration
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	reference dose
SGG	Synthetic Greenhouse Gases
USEPA	United States Environmental Protection Agency

Attachment 2 Contingency Biocide Dosing Assumptions

Attachment 2
Summary of Exposure Point Concentration Development
(Contingency Water Treatment Chemicals)

Mass Balance

In other Santos project areas, approximately 413 milligrams per litre (mg/L) of Bactron SK-4465 is being dosed (9.2 litres [L] of Bactron SK-4465 added to approximately 1,380 billion barrels [bbl] or 2.2×10^5 litres of legacy/CF1 PFW). The constituent of potential concern (COPC) legacy/CF1 produced formation water (PFW) concentrations are calculated based on the product dose that is apportioned between the COPCs based on the COPC percent weight in the product (composition information in the safety data sheet). The concentration of the COPCs in the water storage pond influent (representative of treatment of combined produced water from legacy/CF1 PFW and bore water) was based on the combined dilution from 2,300 bbl/day.

On this basis, the concentration of COPCs in the water storage pond influent are calculated as follows:

COPC	CAS Number	Percent Weight Product	COPC Legacy/CF1 PFW (mg/L)	Storage Pond Influent (mg/L)
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	5	1.0E-04	7.2E-10

CAS = Chemical Abstracts Service
COPC = constituent of potential concern
mg/L = milligrams per litre
PFW = produced formation water

Attachment 3 Risk Characterisation Tables

Attachment 3, Table 1
Summary of Theoretical Biodegradation of Vendor Chemicals in Contingency Water Treatment

Chemical	CAS No.	Estimated Concentration in Water Feed Pond Influent (mg/L)[1]	Half-Life (days)	Estimated Concentration in Combined Balance Water Feed Pond to WMF (mg/L)		Estimated Concentration in Permeate after 99% treatment efficiency by RO plant (mg/L)[2]		Estimated Concentration in Dawson River Surface Water (mg/L)[3]		Estimated Concentration in Dawson River Sediment (mg/kg)[4]	
				Temporal Scenario (days)		Temporal Scenario (days)		Temporal Scenario (days)		Temporal Scenario (days)	
				0	30	0	30	0	30	0	30
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	7.20E-10	1.50E+01	7.20E-10	1.80E-10	7.20E-12	1.80E-12	3.60E-12	9.00E-13	8.64E-08	2.16E-08

Notes:
mg/L = milligrams per liter
mg/kg = milligrams per kilogram
CAS = Chemical Abstracts Service
NA = not applicable
RO = reverse osmosis
WMF = Water Management Facility

1) Water feed pond influent concentrations detailed in Attachment 2.
2) Concentrations in the water feed pond were further reduced by a factor of 99% to account for efficiencies in the WMF system.
3) A dilution factor of 2 was assumed within the approved mixing zone.
4) $EPC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times EPC_{water}$
Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 kg/m^3[default]
$PNEC_{water}$ = treated water EPC
$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
And:
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 kg/m^3[default]
$Kp_{sed} = K_{oc} \times f_{oc}$
Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg), chemical-specific value found in dossier provided in Attachment 1.
f_{oc} = fraction of organic carbon in sediment = 0.04 [default].

Attachment 3, Table 2
Comparison of Theoretical Concentrations of COPCs to Drinking Water Guidelines
Water Treatment Chemicals

Permeate Pond								
Chemical	CAS No.	Estimated Concentration in Permeate after 99% treatment efficiency by RO plant (mg/L)[1]		Estimated Concentration in Dawson River (mg/L)[1]		Drinking Water Screening Level (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
		Temporal Scenario (days)		Temporal Scenario (days)			Temporal Scenario (days)	
		0	30	0	30		0	30
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	7.20E-12	1.80E-12	3.60E-12	9.00E-13	1.50E+00	2.4E-12	6.0E-13

Notes:
mg/L = milligrams per liter
CAS = Chemical Abstracts Service
NA = not applicable
RO = reverse osmosis
WMF = Water Management Facility

1) Estimated concentrations derived in Table 1.

Attachment 3, Table 3
Comparison of Theoretical Concentrations of COPCs to PNECs (Water and Sediment)
Water Treatment Chemicals

Permeate Pond													
Chemical	CAS No.	Estimated Concentration in Permeate after 99% treatment efficiency by RO plant (mg/L)[1]		Estimated Concentration in Dawson River (mg/L)[1]		PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)		Estimated Concentration in Dawson River Sediment (mg/kg)[1]		PNEC sediment (mg/kg)[2]	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
		Temporal Scenario (days)		Temporal Scenario (days)			Temporal Scenario (days)		Temporal Scenario (days)			Temporal Scenario (days)	
		0	30	0	30		0	30	0	30		0	30
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	7.20E-12	1.80E-12	7.20E-12	1.80E-12	4.20E-04	1.7E-08	4.3E-09	8.64E-08	2.16E-08	3.57E+00	2.4E-08	6.0E-09

Notes:
mg/L = milligrams per liter
mg/kg = milligrams per kilogram
CAS = Chemical Abstracts Service
NA = not applicable
PNEC = predicted no effects concentration
RO = reverse osmosis
WMF = Water Management Facility

1) Estimated concentrations derived in Table 1.

Attachment 3, Table 4
Risk Estimates for Cattle Egret from Vendor Chemicals in Dawson River Release
Water Treatment Chemicals

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL Test Animal		Avian NOAELt [1]	Avian NOAEL Test Animal		Avian Receptor Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	4.40E+01	Rat	3.50E-01	NA	Bobwhite Quail	1.78E-01	3.90E-01	4.3E+01

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ Weightreceptor}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.03	(c)
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	0.39	Siegfried, 1969
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
W.R. Siegfried (1969) Energy Metabolism of the Cattle Egret, ZoologicaAfricana, 4:2, 265-273, DOI: 10.1080/00445096.1969.11447375
c/ Drinking water ingestion rate (WIR) based on the allometric relationship developed by Calder and Braun (1983), where WIR (L/day) = 0.059 x BW (Kg)$^{0.67}$

Constituent Name	CAS No.	EPC [1] Day 0	EPC [1] Day 30	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/L)	CW (mg/L)	TRVs	Day 0	Ingestion	Day 30	Ingestion
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	3.6E-12	9.0E-13	4.3E+01	5.3E-15	1.2E-16	1.3E-15	3.1E-17

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/L = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is estimated concentration in Dawson River in Table 1 for Day 0 and Day 30

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Attachment 3, Table 5
Risk Estimates for Kangaroo from Vendor Chemicals in Dawson River Release
Water Treatment Chemicals

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL Test Animal		Mammal Kangaroo	
			Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	4.40E+01	Rat	3.50E-01	2.50E+01	6.67E-02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ Weightreceptor}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	3	Fleming, 2001
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	25	Fleming, 2001
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
Fleming, 2001
Fleming, Peter; Laurie Corbett, Robert Harden, Peter Thomson (2001). Managing the Impacts of Dingoes and Other Wild Dogs. Commonwealth of Australia: Bureau of Rural Sciences.

Constituent Name	CAS No.	EPC[1] Day 0	EPC[1] Day 30	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/L)	CW (mg/L)	TRVs	Day 0	Ingestion	Day 30	Ingestion
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	3.6E-12	9.0E-13	6.7E-02	8.3E-15	1.2E-13	2.1E-15	3.1E-14

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/L = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is estimated concentration in Dawson River in Table 1 for Day 0 and Day 30

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Attachment 3, Table 6
Risk Estimates for Dingo from Vendor Chemicals in Dawson River Release
Water Treatment Chemicals

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Dingo	
			Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	4.40E+01	Rat	3.50E-01	1.30E+01	6.67E-02

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weighttest}{Body\ Weightreceptor}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.75	Dawson, 1995
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	13	Dawson, 1995
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram

b/ References:
BPJ - Best Professional Judgement
Dawson, 1995
Dawson, Terence J. (1995). Kangaroos: Biology of the Largest Marsupials. Cornell University Press, Ithaca, New York. Second printing: 1998. ISBN 0-8014-8262-3.

Constituent Name	CAS No.	EPC[1] Day 0	EPC[1] Day 30	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/L)	CW (mg/L)	TRVs	Day 0	Ingestion	Day 30	Ingestion
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	3.6E-12	9.0E-13	6.7E-02	4.0E-15	6.0E-14	1.0E-15	1.5E-14

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/L = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is estimated concentration in Dawson River in Table 1 for Day 0 and Day 30

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$

Attachment 3, Table 7
Risk Estimates for Cattle from Vendor Chemicals in Livestock Water
Water Treatment Chemicals

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Cattle	
			Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	4.40E+01	Rat	3.50E-01	4.54E+02	7.33E+00

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weight test}{Body\ Weight receptor}\right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	86	API, 2004
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	454	API, 2004
	AT-NC	Averaging time - noncancer	days	365	BPJ

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram

b/ References:
BPJ - Best Professional Judgement
API, 2004
API. (2004). Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons, Regulatory Analysis and Scientific Affairs No. 4733 July 2004.

Constituent Name	CAS No.	EPC [1] Day 0	EPC [1] Day 30	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/L)	CW (mg/L)	TRVs	Day 0	Ingestion	Day 30	Ingestion
Cocoalkyl dimethylbenzyl ammonium chloride	61789-71-7	3.6E-12	9.0E-13	7.3E+00	1.3E-14	1.8E-15	3.3E-15	4.5E-16

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/L = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is estimated concentration in Dawson River in Table 1 for Day 0 and Day 30

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

$$Hazard\ Quotient = \frac{Total\ Intake\ \left(\frac{mg}{kg-day}\right)}{TRV\ \left(\frac{mg}{kg-day}\right)}$$