

## CALCIUM CARBONATE

This dossier on calcium carbonate presents the most critical studies pertinent to the risk assessment of calcium carbonate in its use in coal seam gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – Calcium carbonate is classified as a **tier 1** chemical and requires a hazard assessment only.

### 1 BACKGROUND

Calcium carbonate is an inorganic compound, the most natural forms being chalk, limestone and marble. It is partially soluble in water, dissociating into calcium ( $\text{Ca}^{2+}$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions; both are ubiquitous in the environment. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Calcium carbonate is of low toxicity concern to aquatic and terrestrial organisms.

### 2 CHEMICAL NAME AND IDENTIFICATION

**Chemical Name (IUPAC):** calcium carbonate

**CAS RN:** 471-34-1

**Molecular formula:**  $\text{CaCO}_3$  or  $\text{CCaO}_3$  or  $\text{CH}_2\text{O}_3\cdot\text{Ca}$

**Molecular weight:** 100.09 g/mol

**Synonyms:** Calcium carbonate, precipitated; carbonic acid, calcium salt (1:1); aragonite; calcium monocarbonate; monocalcium carbonate

**Chemical Name (IUPAC):** calcium carbonate

**CAS RN:** 1317-65-3

**Molecular formula:** Not applicable, UVCB

**Molecular weight:** Not applicable, UVCB

**Synonyms:** Limestone; ground calcium carbonate; chalk; natural calcium carbonate

### 3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

**Table 1 Overview of the Physico-chemical Properties of Calcium Carbonate (CAS RN 471-34-1)**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White powder	1	ECHA
Melting Point	825°C (decomposes) @ 101.3 kPa	2	ECHA
Boiling Point	-	-	-
Density	2700 to 2950 kg/m <sup>3</sup> @ 20°C	2	ECHA
Vapour Pressure	-	-	-
Partition Coefficient (log K <sub>ow</sub> )	-	-	-
Water Solubility	0.0166 g/L @ 20°C (slightly soluble)	1	ECHA

Precipitated calcium carbonate (CAS RN 471-34-1) is produced industrially through the decomposition of limestone to calcium oxide followed by subsequent decarbonisation. Ground calcium carbonate (CAS RN 1317-65-3) results directly from the mining of limestone. This extraction process helps to maintain carbonate close to its original state of purity. Both natural and ground calcium carbonate can contain low levels of impurities, but precipitated calcium carbonate is purer than ground calcium carbonate (PubChem).

### 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 calcium carbonate.

NICNAS has assessed calcium carbonate in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to human health and the environment<sup>12</sup>.

Based on an assessment of environmental hazards, NICNAS identified ground calcium carbonate [also referred to as limestone (CAS RN 1317-65-3)] as a chemical of low concern to the environment (NICNAS, 2017). Chemicals of low concern are unlikely to have adverse environmental effects if they are released to the environment from coal seam gas operations.

<sup>1</sup> <https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=471-34-1%2C+>

<sup>2</sup> <https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=1317-65-3>

**Table 2 Existing International Controls**

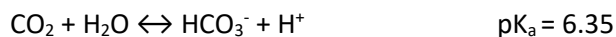
Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine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

## 5 ENVIRONMENTAL FATE SUMMARY

“Calcium carbonate, or CaCO<sub>3</sub>, comprises more than 4% of the earth’s crust and is found throughout the world. Its most natural forms are chalk, limestone, and marble, produced by the sedimentation of the shells of small fossilised snails, shellfish, and coral over millions of years.”<sup>3</sup>

Calcium carbonate is partially soluble in water, dissociating into calcium (Ca<sup>2+</sup>) and carbonate (CO<sub>3</sub><sup>2-</sup>) ions. Both ions are ubiquitous in the environment.

The addition of calcium carbonate to an aquatic ecosystem could result in a shift towards alkalinity and a tendency to increase the pH. The carbonate ions will react with water, forming bicarbonate (HCO<sub>3</sub><sup>-</sup>) and hydroxide (OH<sup>-</sup>) ions, until an equilibrium is reached. A re-equilibration takes place when carbonate (CO<sub>3</sub><sup>2-</sup>) is dissolved in water according to the following equations:



Only a small fraction of the dissolved CO<sub>2</sub> is present as H<sub>2</sub>CO<sub>3</sub> (carbonic acid); the major part is present as CO<sub>2</sub>. The amount of CO<sub>2</sub> in water is in equilibrium with the partial pressure of CO<sub>2</sub> in the atmosphere. The CO<sub>2</sub>/ HCO<sub>3</sub><sup>-</sup>/ CO<sub>3</sub><sup>2-</sup> equilibria are the major buffers of the pH of freshwater.

Based on these equations, CO<sub>2</sub> is the predominant species at a pH smaller than 6.35, while HCO<sub>3</sub><sup>-</sup> is the predominant species at a pH in the range of 6.35-10.33 and CO<sub>3</sub><sup>2-</sup> is the predominant species at a pH higher than 10.33.

Ca<sup>2+</sup> and CO<sub>3</sub><sup>2-</sup> ions are not expected to adsorb on particulate matter or surfaces and will not accumulate in living tissues.

<sup>3</sup> ([http://www.ima-na.org/page/what is calcium carb](http://www.ima-na.org/page/what_is_calcium_carb)).

## 6 ENVIRONMENTAL EFFECTS SUMMARY

### A. Summary

Calcium carbonate is of low toxicity concern to aquatic and terrestrial organisms.

### B. Aquatic Toxicity

#### Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on calcium carbonate.

**Table 3 Acute Aquatic Toxicity Studies on Calcium Carbonate (Nano)\***

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Oncorhynchus mykiss</i>	96-hour LC <sub>50</sub>	>100% (saturated solution)	1	ECHA
<i>Daphnia magna</i>	48-hour EC <sub>50</sub>	>100% (saturated solution)	1	ECHA
<i>Desmodescus subspicatus</i>	72-hour EC <sub>50</sub> 72-hour EC <sub>10</sub>	>14 mg/L** >14 mg/L**	1	ECHA

\*The nano form was tested because this form was anticipated to represent the worst case as it was likely to be more soluble than the bulk form due to the smaller particle size and hence greater surface area.

\*\*Highest attainable test concentration that could be prepared due to the limited solubility of the test material.

#### Chronic Studies

No studies are available.

### C. Terrestrial Toxicity

Table 4 lists the results of terrestrial toxicity studies conducted on calcium carbonate.

**Table 4 Terrestrial Toxicity Studies on Calcium Carbonate (Nano)\***

Test Species	Endpoint	Results (mg/kg soil dw)	Klimisch score	Reference
<i>Eisenia foetida</i>	14-day LC <sub>50</sub> NOEC	>1,000 1000	1	ECHA
Nitrogen transformation	28-day EC <sub>50</sub> NOEC	>1,000 1,000	1	ECHA

\*The nano form was tested because this form was anticipated to represent the worst case as it was likely to be more soluble than the bulk form due to the smaller particle size and hence greater surface area.

## **7 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; ECHA, 2008).

Calcium carbonate is an inorganic salt that dissociates completely to calcium and carbonate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both calcium and carbonate ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Calcium and carbonate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, calcium carbonate is not expected to bioaccumulate.

No chronic aquatic toxicity data exist on calcium carbonate; however, the acute EC<sub>50</sub> values are >1 mg/L in fish, invertebrates and algae. Thus, calcium carbonate does not meet the screening criteria for toxicity.

The overall conclusion is that calcium carbonate is not a PBT substance.

### **B. Other Characteristics of Concern**

No other characteristics of concern were identified for calcium carbonate.

## 8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment <sup>1</sup>	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required <sup>3</sup>
			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 <sup>2</sup>	Chronic Toxicity <sup>2</sup>	
Calcium carbonate, precipitated	471-34-1	Not a PBT	No	No	NA	No	No	No	1	1	1
Calcium carbonate, ground	1317-65-3	Not a PBT	No	No	NA	No	No	No	1	1	1

**Footnotes:**

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 - Tier 1 – Hazard Assessment only.

**Notes:**

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

## 9 REFERENCES, ABBREVIATIONS AND ACRONYMS

### A. References

Department of the Environment, Water, Heritage and the Arts (DEWHA). (2009). Environmental risk assessment guidance manual for industrial chemicals, Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia.

ECHA. ECHA REACH database: <https://echa.europa.eu/information-on-chemicals/registered-substances>

European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.

Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regul. Toxicol, Pharmacol. 25:1-5.

PubChem. National Institutes of Health. National Library of Medicine National Center for Biotechnology Information. <https://pubchem.ncbi.nlm.nih.gov/>

NICNAS. (2017). National assessment of chemicals associated with coal seam gas extraction in Australia, Technical report number 14 - Environmental risks associated with surface handling of chemicals used in coal seam gas extraction in Australia. Project report prepared by the Chemicals and Biotechnology Assessments Section (CBAS), in the Chemicals and Waste Branch of the Department of the Environment and Energy as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.

### B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
dw	dry weight
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
IUPAC	International Union of Pure and Applied Chemistry
kg/m <sup>3</sup>	kilogram per cubic metre
kPa	kilopascal
LC	lethal concentration

mg/kg	milligrams per kilogram
mg/L	milligrams per litre
NOEC	no observed effective concentration
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
UVCB	unknown or variable composition, complex reaction products and biological materials