



# Appendix T3

Chemical risk assessment



## **Narrabri Gas Project**

**Prepared for:  
Santos NSW (Eastern)  
Pty Limited**

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## ACRONYMS

$\mu\text{g}/\text{m}^3$	micrograms per cubic metre
ABS	absorption factor (unitless)
ADI	acceptable daily intakes
ADWG	Australian Drinking Water Guidelines
AEA	Australian Environmental Agency
AF	adherence factor of soil to skin ( $\text{mg}/\text{cm}^2\text{-event}$ )
AF	soil adherence factor ( $\text{mg}/\text{cm}^2$ )
$\text{AF}_i$	overall adherence factor of soil to skin ( $\text{mg}/\text{cm}^2\text{-event}$ )
ANZECC	Australian and New Zealand Environment Conservation Council
API	American Petroleum Industry
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS/NZS	Australian Standards /New Zealand Standards
B	dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)
BTEX	benzene, toluene, ethylbenzene, xylenes
BW	body weight (kg)
CEM	Conceptual Exposure Model
$\text{CF}_{\text{soil}}$	conversion factor for soil ( $1 \times 10^{-6} \text{ kg}/\text{mg}$ )
$\text{CF}_{\text{water}}$	correction factor for water ( $1 \times 10^{-3} \text{ l}/\text{cm}^3$ )
CICAD	Concise International Chemical Assessment Document
$\text{cm}^2$	square centimetres
COPC	constituents of potential concern
CS	Concentration of COPC in soil ( $\text{mg}/\text{kg}$ )
CSG	coal seam gas
CW	Concentration of COPC in water ( $\text{mg}/\text{l}$ )
dS/m	deciSiemen per metre
DTA	direct toxicity assessment
EC	electrical conductivity
EC/LC50	50 percent effective concentration/lethal concentration
EC10	10 percent effective concentration
ECB	European Chemicals Bureau
ECHA	European Chemicals Agency
ECse	electrical conductivity of a saturated extract
ED	exposure duration (years)
EF	exposure frequency (days/year)
EIS	Environmental Impact Statement
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPC	exposure point concentrations
EPHC	Environment Protection and Heritage Council
EPISUITE™	Estimation Programs Interface Suite™
ESLs	ecological screening levels
$\text{ET}_{\text{swim}}$	exposure time (hr/day or hours/hours)
EU	European Union

g/cc	gram/cubic centimetre
GAB	Great Artesian Basin
GDEs	groundwater dependent ecosystems
ha	hectares
HI	hazard index
HILs	health investigation levels
HPV	High Production Volume
HQ	hazard quotient
ILCR	increased lifetime cancer risks
IMAP	Inventory Multi-Tiered Assessment and Prioritisation
IR	ingestion rate (l/hr)
IR-S	ingestion rate of soil (mg/day)
IR-W	ingestion rate (litres/day)
IUCLID	International Uniform Chemical Information Database
km <sup>2</sup>	square kilometre
Kp	dermal permeability factor (Kp – cm/hr)
LCM	loss control muds
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
m	metres
m <sup>2</sup>	square metres
m <sup>3</sup>	cubic metres
mg/kg	milligrams per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligrams per litre
MITC	methylisothiocyanate
mL	millilitre
MNES	Matters of National Environmental Significance
NEPC	National Environmental Protection Council
NEPM	National Environment Protection (Site Assessment) Measure
NGP	Narrabri Gas Project
NHMRC	National Health and Medical Research Council
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NRMMC	Natural Resource Management Ministerial Council
NWQMS	National Water Quality Management Strategy
OECD	Organisation for Economic Cooperation and Development
OH&S	Occupational, Health and Safety
ORNL/RAIS	Oak Ridge National Laboratory/Risk Assessment Information System
PAHs	polycyclic aromatic hydrocarbons
PBT	persistent (P), bioaccumulative (B) and Toxic (T)
PNEC	predicted no-effects concentration
POD	point of departure

PPE	personal protective equipment
QSAR	quantitative structure-activity relationship
RAIS	Risk Assessment Information System
RBA	relative bioavailability factor (unitless)
RBSLs	risk-based screening levels
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical Substances
RED	Re-Registration Eligibility Decision
RfCs	reference concentrations
RfDs	reference doses
RIVM	National Institute for Public Health and Environmental Protection
RO	Reverse Osmosis
RSLs	Regional Screening Levels
SA <sub>body</sub>	total body skin surface area (cm <sup>2</sup> /d)
SA <sub>exp</sub>	exposed skin surface area available for contact (cm <sup>2</sup> /d)
Sai	skin surface area available for contact for body part “i” (cm <sup>2</sup> )
SAR	sodium adsorption ratio
SDS	safety data sheet
SF	slope factor
SIDS	Screening Information Data Set
SR	Sensitivity ratio
SSMP	Significant Species Management Plan
t*	time to reach steady state (hours)
TCs	tolerable concentrations
TDIs	tolerable daily intakes
TI	Total intake of COPC (mg/kg/day)
TRV	toxicity reference values
TSCATS	Toxic Substances Control Act Test Submissions
UCL	upper confidence limit
URF	unit reference factor
USEPA	United States Environment Protection Agency
vpd	vehicles per day
WA	Western Australia
WHO	World Health Organisation
WMP	Waste Management Plan
τ <sub>event</sub>	lag time per event (hours/event)



## 1.0 INTRODUCTION

### 1.1 Overview

The Proponent is proposing to develop natural gas in the Gunnedah Basin in New South Wales (NSW), southwest of Narrabri.

The Narrabri Gas Project (the project) seeks to develop and operate a gas production field, requiring the installation of gas wells, gas and water gathering systems, and supporting infrastructure. The natural gas produced would be treated at a central gas processing facility on a local rural property (Leewood), approximately 25 kilometres' south-west of Narrabri. The gas would then be piped via a high-pressure gas transmission pipeline to market. This pipeline would be part of a separate approval process and is therefore not part of this development that Santos is seeking approval.

This Chemical Risk Assessment has been prepared to address the *Additional Environmental Assessment Requirements under the EPBC Act for the Narrabri Gas Project (EPBC 2014/7376) Update to Matters of National Significance Terms of Reference as at September 2016* (hereafter referred to as EPBC Act Additional Requirements), issued by the Commonwealth Department of Environment for the project.

### 1.2 Description of the project

The project would involve the construction and operation of a range of exploration and production activities and infrastructure including the continued use of some existing infrastructure. The key components of the project are presented in **Table 1-1**.

The Bibblewindi site has existed for over a decade and currently hosts two water storage ponds, a small gas compressor, safety flare, water balance tank and associated infrastructure (**Figure 1-2**). The existing site would be expanded by up to an additional 16 hectares to accommodate an in-field gas compression facility. The ponds would be retained and upgraded as necessary for use as water storage as part of the project.

The Leewood property currently hosts existing water management infrastructure established for the exploration and appraisal program, including two 300 million litre (ML) ponds (each made up of two 150 ML cells) to store produced water and brine, a water and brine treatment plant, a 5 ML treated water storage tank and associated infrastructure (**Figure 1-3**). As part of the project, the existing ponds would be supplemented by the construction of a third 300 ML pond with two cells of 150 ML each (EIS Chapter 6). The water and brine treatment plant for the exploration and appraisal program would largely be removed and a new plant with a capacity of 14 ML per day constructed. The brine concentrator and salt crystalliser would have a capacity of 4 ML/day and 2 ML/day respectively. The 5 ML treated water storage tank would be retained and used in the project.

The existing Bibblewindi to Leewood infrastructure corridor would be widened to 30 metres to accommodate additional underground gathering and transfer pipelines.

The existing Leewood to Wilga Park infrastructure corridor would host an underground power line (optional) to Leewood from the Wilga Park Power Station.



**Table 1-1: Key project components**

Component	Infrastructure or activity
<i>Major facilities</i>	
Leewood	<ul style="list-style-type: none"> <li>• a central gas processing facility for the compression, dehydration and treatment of gas</li> <li>• a central water management facility including storage and treatment of produced water and brine</li> <li>• optional power generation for the project</li> <li>• a safety flare</li> <li>• treated water management infrastructure to facilitate the transfer of treated water for irrigation, dust suppression, construction and drilling activities</li> <li>• other supporting infrastructure including storage and utility buildings, staff amenities, equipment shelters, car parking, and diesel and chemical storage</li> <li>• continued use of existing facilities such as the brine and produced water ponds</li> <li>• operation of the facility</li> </ul>
Biblewindi	<ul style="list-style-type: none"> <li>• in-field compression facility</li> <li>• a safety flare</li> <li>• supporting infrastructure including storage and utility areas, treated water holding tank, and a communications tower</li> <li>• upgrades and expansion to the staff amenities and car parking</li> <li>• produced water, brine and construction water storage, including recommissioning of two existing ponds</li> <li>• continued use of existing facilities such as the 5ML water balance tank</li> <li>• operation of the expanded facility</li> </ul>
Biblewindi to Leewood infrastructure corridor	<ul style="list-style-type: none"> <li>• widening of the existing corridor to allow for construction and operation of an additional buried medium pressure gas pipeline, a water pipeline, underground (up to 132 kV) power, and buried communications transmission lines</li> </ul>
Leewood to Wilga Park underground power line	<ul style="list-style-type: none"> <li>• installation and operation of an underground power line (up to 132 kV) within the existing gas pipeline corridor</li> </ul>
<i>Gas field</i>	
Gas exploration, appraisal and production infrastructure	<ul style="list-style-type: none"> <li>• seismic geophysical survey</li> <li>• installation of up to 850 new wells on a maximum of 425 well pads</li> <li>• new well types would include exploration, appraisal and production wells</li> <li>• includes well pad surface infrastructure</li> <li>• installation of water and gas gathering lines and supporting infrastructure</li> <li>• construction of new access tracks where required</li> <li>• water balance tanks</li> <li>• communications towers</li> <li>• conversion of existing exploration and appraisal wells to production</li> </ul>

Component	Infrastructure or activity
Ancillary	<ul style="list-style-type: none"> <li>• upgrades to intersections on the Newell Highway</li> <li>• expansion of worker accommodation at Westport</li> <li>• a treated water pipeline and diffuser from Leewood to Bohena Creek</li> <li>• treated water irrigation infrastructure including: <ul style="list-style-type: none"> <li>• pipeline(s) from Leewood to the irrigation area(s)</li> <li>• treated water storage dam(s) offsite from Leewood</li> </ul> </li> <li>• operation of the irrigation scheme</li> </ul>

### 1.3 Scope and structure of assessment

This chemical risk assessment assesses the chemicals proposed to be used in the drilling and development of gas wells, and those proposed for produced water and brine treatment processes at the Leewood Water Management Facility (WMF). The scope of this work has been developed to align with guidance provided by the Commonwealth and approved chemical risk assessments completed for other coal seam gas (CSG) projects (e.g., Santos GLNG Project in Queensland). In addition, this risk assessment was conducted to specifically cover chemical usage within the Narrabri Gas Project Area in accordance with the EPBC Act Additional Requirements. Consistent with the framework for these documents, this document has been developed and reviewed by third party reviewers, with their signature page provided as **Appendix A**.

At this time, planned development activities associated with the project (**Figure 1-1**) that are relevant to this assessment include drilling and well construction, the in-field gas compression facility (Bibblawindi site), and the water and brine treatment plant (Leewood WMF). Drilling and well construction would occur within a 95,000-hectare area of the existing Petroleum Exploration Licence (PEL) 238. Hydraulic fracturing is not proposed as part of the project.

The chemicals to be used or proposed to be used in gas extraction are defined in the EPBC Act Additional Requirements as “*all chemicals in drilling fluids, hydraulic fracturing fluids and in the treatment of flowback or produced water*”. The chemicals assessed at this time are limited to those used in drilling fluids and water treatment, and include the following:

- Chemicals used to make drilling fluids (vendor-supplied chemicals)
- Chemicals in operational drilling fluids (mixture of vendor-supplied chemicals)
- Chemicals in recovered drilling fluids (vendor-supplied and geogenic chemicals)
- Chemicals used in water treatment activities (vendor-supplied chemicals)
- Chemicals in residual permeate and brine after treatment (a mixture of vendor supplied and recovered drilling fluids).

Well drilling, well construction, well completion and water treatment activities and methodologies are described in detail in the Project Description (Chapter 6).

The EPBC Act Additional Requirements require the chemical risk assessment to evaluate the potential human health and environmental effects of these chemicals. The goal of the chemical risk assessment is to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially exposed human receptors and to Matters of National Environmental Significance (MNES), including water resources. To achieve this goal, the following guidance references, as applicable, were used in the chemical risk assessment process:

- Environmental Risk Assessment Guidance Manual – for industrial chemicals (Environment Protection and Heritage Council [EPHC], 2009)
- Environmental Risk Assessment Guidance Manual – for agricultural and veterinary chemicals (EPHC, 2009)

- The National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 as amended 2013 (NEPM, 2013)
- Environmental Health Risk Assessment – Guidelines for assessing human health risks from environmental hazards (enHealth, 2012a)
- Risk management – Principles and guidelines. The Australian / New Zealand Standards (AS/NZS ISO 31000:2009) (AS/NZS, 2009)
- Managing environment-related risk. Australian / New Zealand Standard (AS/NZS Handbook HB 203:2012) (AS/NZS, 2012)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment Conservation Council [ANZECC] and Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000) and Australian Drinking Water Guidelines (National Health and Medical Research Council [NHMRC], 2011)
- United States Environmental Protection Agency (USEPA) (2014). EPA-Expo-Box (A Toolbox for Exposure Assessors) (USEPA, 2016a)
- Organisation for Economic Co-operation and Development (OECD) (2014). The OECD Environmental Risk Assessment Toolkit: Tools for Environmental Risk Assessment and Management (OECD, 2014).

All risk assessment methods apply a hierarchy in the use of data for exposure and toxicological assessment to provide the least uncertainty in the risk assessment process. To facilitate this hierarchy, the EPA-Expo-Box and the OECD Environmental Risk Assessment Toolkit provide a compendium of risk assessment tools that link to guidance, databases, models, key references and related resources. These tools are compatible with the various Australian guidance's cited above. However, the Australian guidance has precedence when there are differences between the tools.

The EPA-Expo-Box specifically provides tools for exposure assessment. The problem formulation, conceptual exposure model and the exposure assessment utilise these tools extensively in the approach to assessing exposure in the environmental media potentially affected by the drilling chemicals and water treatment chemicals, the potential exposure pathways and receptors and calculating exposure based on intake equations and exposure assumptions. The OECD Environmental Risk Assessment Toolkit broadly covers the various components of the risk assessment process. Therefore, these tools were used in the hazard assessment including preparation of the risk assessment dossiers (e.g., physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data from databases linked to the OECD eChemPortal) and in the exposure assessment to define default exposure parameters.

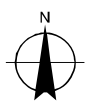
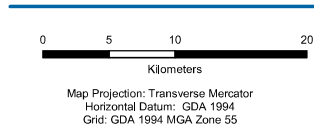
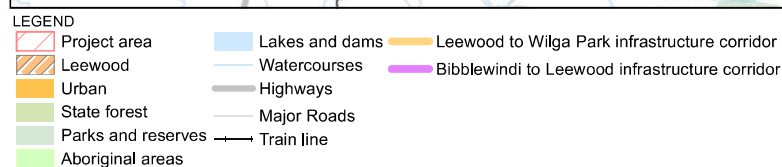
The toolboxes are all based on the principles contained within USEPA's Risk Assessment Guidelines. As a toolbox, not all of the tools are to be utilised, and only those tools that are appropriate to the chemical, its functional toxicity and the exposure pathway used for assessment should be used. For example, the OECD Environmental Risk Assessment Toolkit includes New Chemical Assessment, Pesticide Testing and Assessment, and Emissions Scenarios. The EPA-Expo-Box includes approaches utilising Direct Measurement (Point-of-Contact), Indirect Estimation (Scenario Evaluation), and Exposure Reconstruction (Biomonitoring and Reverse Dosimetry), all of which are important tools as part of risk assessment processes. However, all are not applicable for the assessment of drilling fluids and water treatment chemicals within the NGP area. The risk assessment provided in this report documents where and how the specific tools are used to ensure the objectives established within the EPBC Act Additional Requirements are met, and uncertainty in the risk assessment is minimised. **Table 1-2** presents the key elements of the chemical risk assessment and where the topic is addressed.

**Table 1-2: Key Elements of the Chemical Risk Assessment**

Terms of Reference Topic		Risk Assessment Section
Introduction	Objectives, Scope of Study, Regulatory, and Guidance and Best Practices	Section 1.0 Section 2.0 Section 5.0 Section 6.0 Section 7.0 Section 8.0
Environmental and Geologic Setting	Hydrogeologic framework, groundwater resources, and environmental values	Section 3.0
Gas Extraction Processes	Lifecycle assessment	Section 4.0
Problem Formulation and Issue Identification	Definition of bounds of the human health and environmental risk assessment	Section 5.1
	Key issues with regard to potential concern from the potential exposure What is the concern Why is it a concern Urgency of the concern Perception of the concern	Section 5.2
	Identification of constituents of potential concern	Section 5.3.2
	Conceptual exposure model and potentially complete exposure pathways	Section 5.3
	Potential management options proposed to mitigate hazards	Section 2.3 Section 3.1 Section 9.0
Hazard Assessment	Assessment of human health and environmental hazard of chemicals identified in the problem formulation and issue identification step	Section 6.1
	Persistent, Bioaccumulative and Toxic (PBT) substances assessment	Section 6.22
	Development of soil and water guideline values protective of ecological receptors	Section 6.1.1 Section 6.1.2
Exposure Assessment	Mass balance calculations to identify amount of each chemical used in the process	Section 6.3.2
	Estimated potential exposure point concentrations in effected media	Section 7.1

Terms of Reference Topic		Risk Assessment Section
	Fate and transport modelling to characterise degradation or potential transport (e.g., in groundwater)	Section 5.3.3.2 Section 6.3.2
	Identification of potentially complete exposure pathways for ecological and terrestrial receptors	Section 5.3.5
Risk Characterisation	Cumulative risk calculations for each receptor across potentially complete exposure pathways and routes of exposure	Section 8.0
	Identification of main or significant contributors to risk	Section 8.0
	Sensitivity analysis	Section 8.3
	Uncertainty analysis	Section 8.4
Risk management and mitigation		Section 9.0
Summary and Conclusions		Section 10.0
References		Section 11.0
Appendices	Third Party Review	Appendix A
	Safety Data Sheets	Appendix B
	Risk Assessment Dossiers	Appendix D





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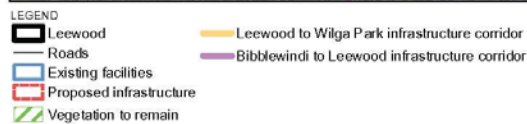
Figure 1-1



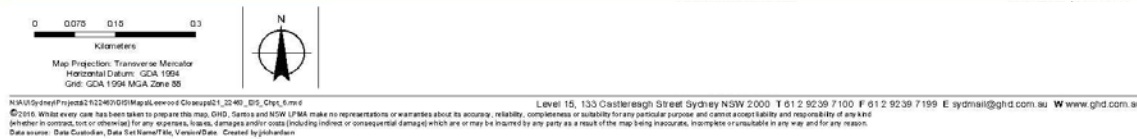


**Figure 1-2: Existing and Proposed Infrastructure at Bibblewindi**





Aerial Imagery: Dec 2013



**Figure 1-3: Existing and Proposed Infrastructure at Leewood**



## 2.0 NGP SETTING

A detailed discussion of the Project Area and project description are provided in Chapter 6 (Project Description) of the EIS (Santos, 2016). Chapter 7 (Produced Water Management) of the EIS presents a description of the Leewood WMF. The general context of the proposed activities is provided in the following sections; for additional detail, Chapter 6 of the EIS remains the point of reference.

### 2.1 NGP Location

The project would be located in north-western NSW, approximately 20 kilometres' south-west of Narrabri, within the Narrabri local government area (LGA).

The project area is contained within the existing petroleum exploration lease (PEL) 238 and incorporates petroleum assessment lease (PAL) 2 and petroleum production lease (PPL) 3. Santos NSW Pty Ltd and its joint venture participants, who hold these tenures, lodged four petroleum production lease applications (PPLAs) in May 2014 covering the project area, being PPLAs 13, 14, 15 and 16. The total project area is around 95,000 hectares; however, the disturbance footprint from project infrastructure would take up no more than 1,000 hectares, or around one per cent of the project area.

The project area contains a portion of the region known as 'the Pilliga'; which is an agglomeration of a forested area covering more than 500,000 hectares in north-western NSW around Coonabarabran, Baradine and Narrabri. Nearly half of the Pilliga is allocated to conservation and is managed under the NSW *National Parks and Wildlife Act 1974*. The Pilliga has spiritual meaning and cultural significance for the Aboriginal people of the region.

Other parts of the Pilliga were dedicated as State forest, and set aside for the purpose of 'forestry, recreation and mineral extraction', with a strategic aim to "provide for exploration, mining, petroleum production and extractive industry" under the *Brigalow and Nandewar Community Conservation Area Act 2005*. The parts of the project area on state land are located within this section of the Pilliga.

The Bibblewindi site is located within the Bibblewindi State Forest in PAL 2. The Leewood WMF is located within PAL 2, adjacent to the Newell Highway approximately 24 kilometres' south-west of Narrabri, NSW.

### 2.2 Project Activities Associated with Chemicals Used in Natural Gas Extraction

The activities associated with the chemicals used in natural gas extraction are defined as follows:

- Drilling and completion – The drilling and construction of wells and associated activities
- Water treatment chemicals – Pre-treatment or post-treatment of produced water in the WMF that includes filtration, nano-filtration, reverse osmosis (RO), brine concentration and brine crystallisation facilities.

In general, the storage and use of the chemicals associated with drilling and development are undertaken on well leases. The storage of water treatment chemicals and the use of these chemicals in treatment will only occur at Leewood only. In addition, the transportation of these chemicals and associated materials will occur on public or private roads, with produced water and treated permeate transferred by pipeline to and from the WMF respectively.

### 2.3 Overarching Management and Mitigation Strategies

Key plans integral to the management of the potential risk of impacts to MNES associated with chemical transportation, storage, use, and management/monitoring of potential effects are provided in **Table 2-1** below. Chapter 30 of the EIS provides information on environmental management and monitoring for the project.

**Section 9.0** further discusses the risk management recommendations that address the mitigation, management, monitoring and reporting procedures to ensure that existing controls are effective at managing the hazards and risks presented in this chemical risk assessment.

In addition, the project activities would be undertaken in accordance with Commonwealth and State regulations and relevant Australian Standards for the transportation, storage and management of chemicals and management of associated environmental hazards. Key regulations include:

- Australian Dangerous Goods Code including requirements for driver and vehicle licencing and documentation
- NSW Work Health and Safety Regulation 2011
- NSW Dangerous Goods (Road and Transport) Act 2008
- NSW Environmentally Hazardous Chemicals Act 1985
- NSW Waste Avoidance and Resource Recovery Act 2001
- NSW Work Health and Safety Act 2011
- NSW Protection of Environmental Operations Act 1997.

**Table 2-1: Summary of Key Management Plans and Risk Assessments**

Plan or Risk Assessment	Description of Components in Document
Santos Environment, Health and Safety Management System (EHSMS)	The EHSMS provides a framework for environmental and safety procedures across Santos' operations and is consistent with AS 4801:2000 <i>Occupational Health and Safety Management Systems</i> and AS/NZS ISO 14001:2004 <i>Environmental Management Systems</i> .
NGP Field Development Protocol (the Protocol)	The Protocol sets a framework for identifying and assessing environmental values and avoiding or minimising potential environmental impacts associated with the development of the project. The Protocol systematically identifies the constraints within the Project Area considering sensitivity, conservation significance, and legislative requirements and develops a framework for avoidance and minimization of impacts.
Waste Management Plan	A waste management plan would be developed to manage the generation, handling, placement, and transport of waste during the construction, operation, decommissioning and rehabilitation phases of the project. The plan will detail the location of waste sources, specific waste and recycling collection systems and infrastructure, and transportation requirements. In addition, training requirements for personnel would be presented to improve efficiency in minimisation of waste streams, reuse and recycling options, and routine inspections.
Managed Release Scheme (MRS) (Eco Logical, 2016)	The MRS evaluates the potential environmental impact on Bohena Creek because of managed releases of treated production water to the surface water body. The MRS identifies a 'wet weather' episode release schedule that would be initiated when natural creek flows were equal to or more than 100 ML/day. This would minimise potential impacts on the natural flow regime of the Bohena Creek and related environmental values.
Biodiversity Offset Management Plan	The Biodiversity Offset Management Plan details how the biodiversity offset strategy and offset package will be implemented. The biodiversity offset strategy is set forth in Appendix J1, Ecological Impact Assessment, of the EIS and provides a comprehensive strategy for residual impacts of the project following the implementation of avoidance, minimization, and mitigation strategies. In addition to offsets for ecological components, the offset strategy ensures that Aboriginal people have opportunities to increase cultural knowledge of their country and to access and manage its natural and cultural values.
Pest, Plant and Animal Management Plan	The plan would target feral fauna identified as high risk to the survival of native flora and fauna in the Pilliga. The plan would include minimisation of weed transportation.

Plan or Risk Assessment	Description of Components in Document
Water Monitoring Plan	Appendix G3 of EIS presents the Water Monitoring Plan developed for the Project Area. The Water Monitoring Plan is designed to assist Santos, to take appropriate mitigation actions if unanticipated adverse impacts to water quality as a result of gas field development activities are observed. As such, the Water Monitoring Plan focuses on water assets and receptors and aims to provide early detection of any change in water resource condition that may have adverse impacts.
Produced Water Management Plan	The Produced Water Management Plan presents the way in which produced water would be managed under the project within the regulatory framework and with minimal environmental impact. Water storage facilities and beneficial reuse options such as irrigation, stock watering, dust suppression, construction and drilling are discussed and evaluated in the plan.

### 3.0 ENVIRONMENTAL SETTING

The following section describes the environmental setting within the Santos NGP area, further details are available in the Project Description and relevant technical chapters and appendices including the MRS and Ecological Impact Assessment that is Appendix J1 of the EIS (Eco Logical, 2016a; Eco Logical 2016b) and Chapter 11 of the EIS (Groundwater and Geology) and supporting Appendix G4 Hydrological Baseline Study.

The Project Area is in north-western New South Wales, southwest of the town of Narrabri. Around two-thirds of the Project Area are within the Pilliga forests (**Figure 3-1**); the remaining portion of the Project Area is utilised for agricultural (dry-land cropping and livestock grazing) purposes.

The ecology of the Pilliga has been fragmented and otherwise impacted by commercial timber harvesting and related activities over the last century through:

- the establishment of more than 5,000 kilometres of roads, tracks and trails
- the introduction of pest species
- the occurrence of drought and wildfire.

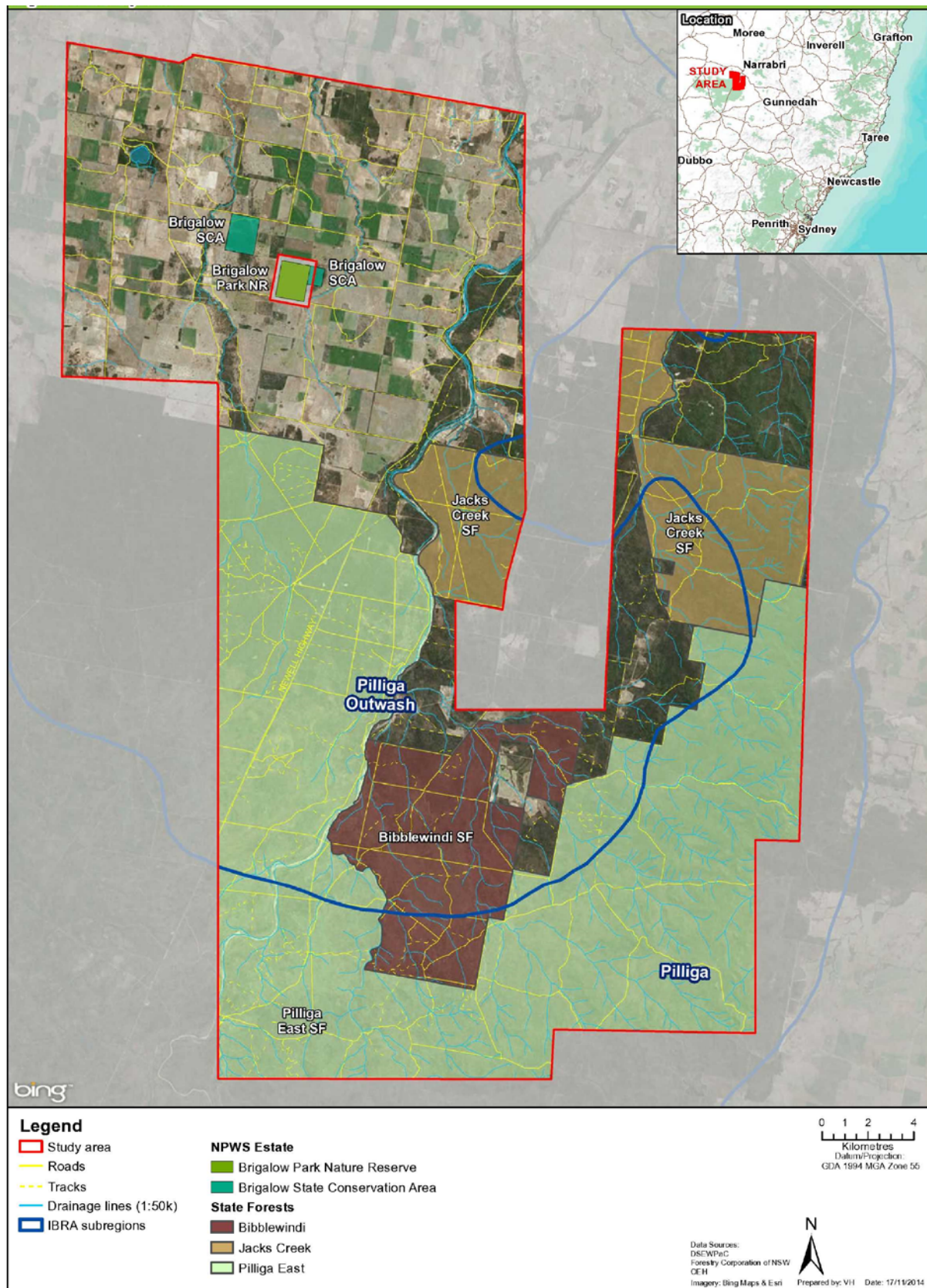
The Project Area does not include the Pilliga National Park, Pilliga State Conservation Area, Pilliga Nature Reserve, and Brigalow Park Nature Reserve. However, the Brigalow State Conservation Area is within the project area. A 50-metre surface exclusion zone protects the Brigalow State Conservation Area from surface developments. **Figure 3-1** presents the Project Area, Pilliga forests, and the exclusion zone.

The Project Area is comprised of the following landscape features (GHD, 2016): alluvial plains, channels and floodplains (Coghill and Baradine Creeks) and stepped stony ridges (Bugaldie and Cubbo Uplands). Native vegetation covers approximately 75-percent of the Project Area; derived native grassland consists approximately 10-percent of the Project Area (**Figure 3-2**).

No agricultural land in the Project Area is mapped by the NSW Government to be biophysical strategic agricultural land (BSAL), and detailed soil analysis has established the absence of BSAL. This has been confirmed by the issue of a BSAL Certificate for the project area by the NSW Government. The Project Area is located predominantly within the Lower Namoi sub-catchment of the Namoi Catchment, which is within the Murray-Darling Basin. The Namoi River is a perennial watercourse and the main surface water system in the catchment. The major tributaries include Macdonald River, Manilla River, Peel River, Mooki River, Cox's Creek, Maules Creek, Bohena Creek, Bundock Creek and Baradine Creek. Most of the tributaries (e.g., Bohena Creek) have intermittent flow.

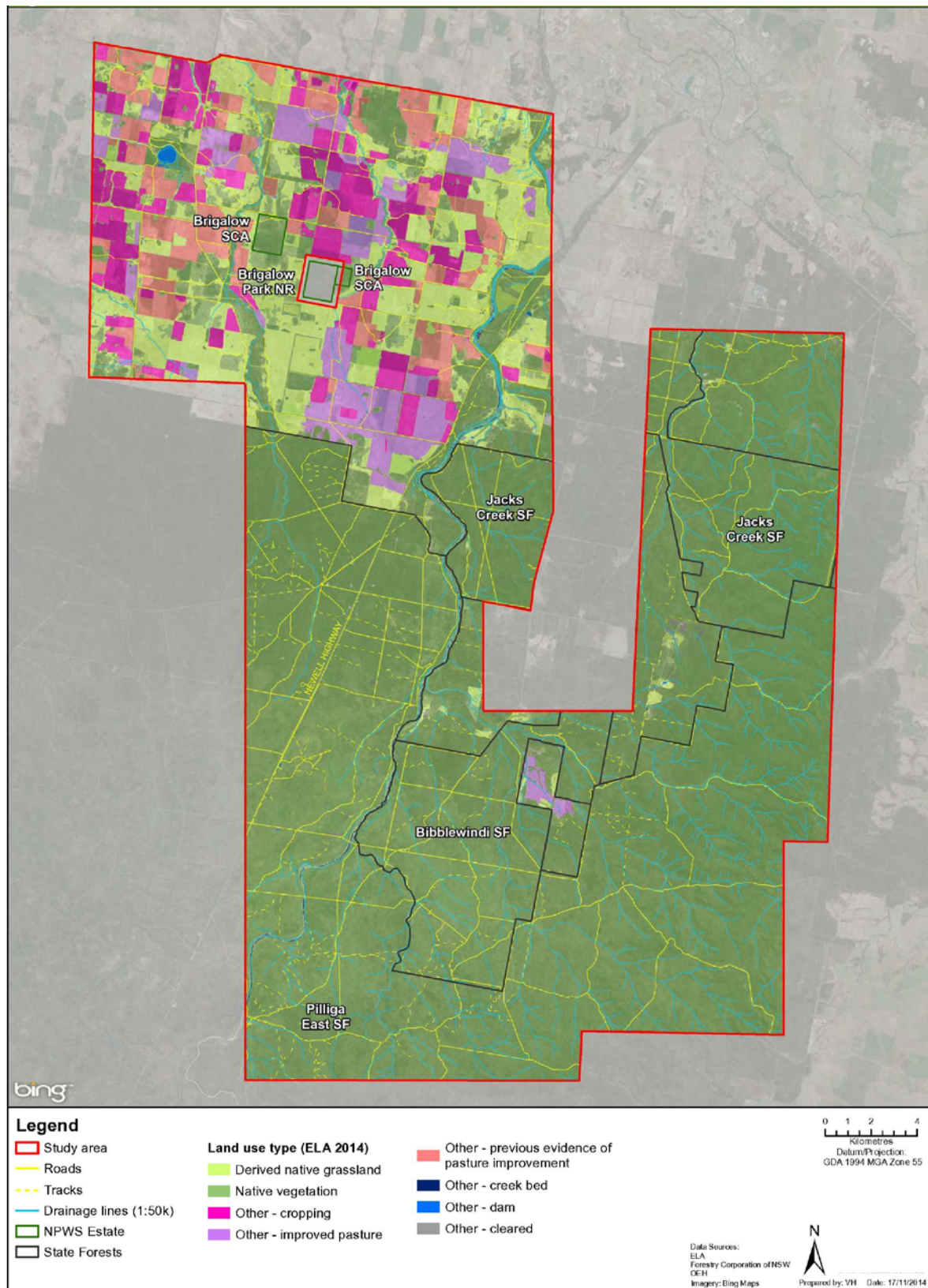
Tributaries to the Bohena Creek sub-catchment drain in a north-westerly direction towards the Namoi River floodplain with the headwaters located in forested conservation areas (e.g., Pilliga Forest). Sheep and cattle grazing and dryland cropping are the primary land uses of the unforested areas of the Bohena Creek sub-catchment (**Figure 3-2**). The creek has a low nutrient status because of a substrate dominated by sand (i.e., lack of organic matter) and is classified as a lowland chain of symmetrical, discontinuous ponds (Eco Logical, 2016). The main habitat features present within Bohena Creek are fringing vegetation provided by *P. australis*, which grows in low to medium densities, and overhanging and trailing vegetation.





**Figure 3-1: Pilliga Forest within the Project Area**





**Figure 3-2: Land Use in Project Area**

### 3.1 Hydrogeology and Groundwater Usage

A detailed discussion of the Groundwater Usage and Geology is provided in Chapter 11 of the EIS and supporting technical Appendix G. The NGP is located within both the Permo-Triassic Gunnedah Basin

(containing the target coal seams for coal seam gas development) and the overlying Jurassic-Cretaceous Surat Basin. The Gunnedah Basin covers an area of over 15,000 km<sup>2</sup> and forms the central part of the Sydney-Gunnedah-Bowen Basin system. The Project area is located near the northern and western boundaries of the Gunnedah Basin.

Overlying the Gunnedah Basin is the Coonamble Embayment of the Surat Basin, which itself forms the western province of the Great Artesian Basin (GAB). Groundwater sources forming the eastern and southern fringes of the Coonamble Embayment comprise the southern-most recharge (intake) beds for the GAB.

The main productive aquifers in the Project Area comprise the sandstone formations of the Great Artesian Basin (GAB). Shallow groundwater sources include Upper and Lower Namoi alluvial groundwater sources; GAB shallow groundwater sources; and the Pilliga Sandstone. Deeper groundwater is present in the Project Area in the Gunnedah-Oxley Basin Groundwater Source.

The NGP falls within several water sharing plans (WSPs), the primary mechanism for the *Water Management Act 2000* (WM Act), which dictates how surface water and groundwater resources are managed in NSW. The relevant WSPs to the Project Area are the Upper and Lower Namoi Groundwater Sources, the NSW GAB Groundwater sources, the NSW Murray-Darling Basin Porous Rock Groundwater Sources, and the NSW Murray-Darling Basin Fractured Rock Groundwater Sources.

As shown in **Figure 3-3** and **Figure 3-4**, the primary use of registered bores in the vicinity of the Project Area is for watering of livestock, irrigation and domestic supply. The majority of the bores in the region are less than 150 metres deep and tap shallow groundwater sources within the Namoi Alluvium and Pilliga Sandstone. In the alluvium, groundwater flow is topographically controlled; however, the regional direction of groundwater flow is northerly and flows the courses of the Mooki and Namoi Rivers and Cox's Creek. No registered bores are present within the Bohena Creek alluvium. Regional groundwater flow in the Pilliga Sandstone is northwest.

The potential for GDEs to be present has been assessed in the GDE Impact Assessment (CDM Smith 2016) and related studies. The assessment found:

- There is no potential Type 1 GDEs (aquifer and stygofauna) identified.
- There are nine potential Type 2 GDEs (reliant on the surface expression of groundwater (springs and baseflow)) considered likely to be dependent on groundwater. All of these potential GDEs have low ecological values, mainly due to the absence of protected or important wetland species, and due to the heavily or moderately modified nature of the sites. None of the potential Type 2 GDEs support Matters of National Environmental Significance (MNES) defined under the EPBC Act. The overall risk assessment score for all nine potential Type 2 GDEs is low due to the source of water or the indiscernible impact to water sources as a result of the project relative to existing variations in groundwater pressure due to climate patterns and other extractive uses.
- No vegetation communities listed under the EPBC Act were identified as potential Type 3 GDEs (source groundwater predominantly from the water table) within the project area. The overall risk assessment score for potential Type 3 GDEs is low, based on the low likelihoods of potential impacts due to the predicted drawdowns in the source aquifers as a result of the project being less than 0.5 m and occurring very slowly over hundreds of years, resulting in negligible predicted impacts on GDEs.



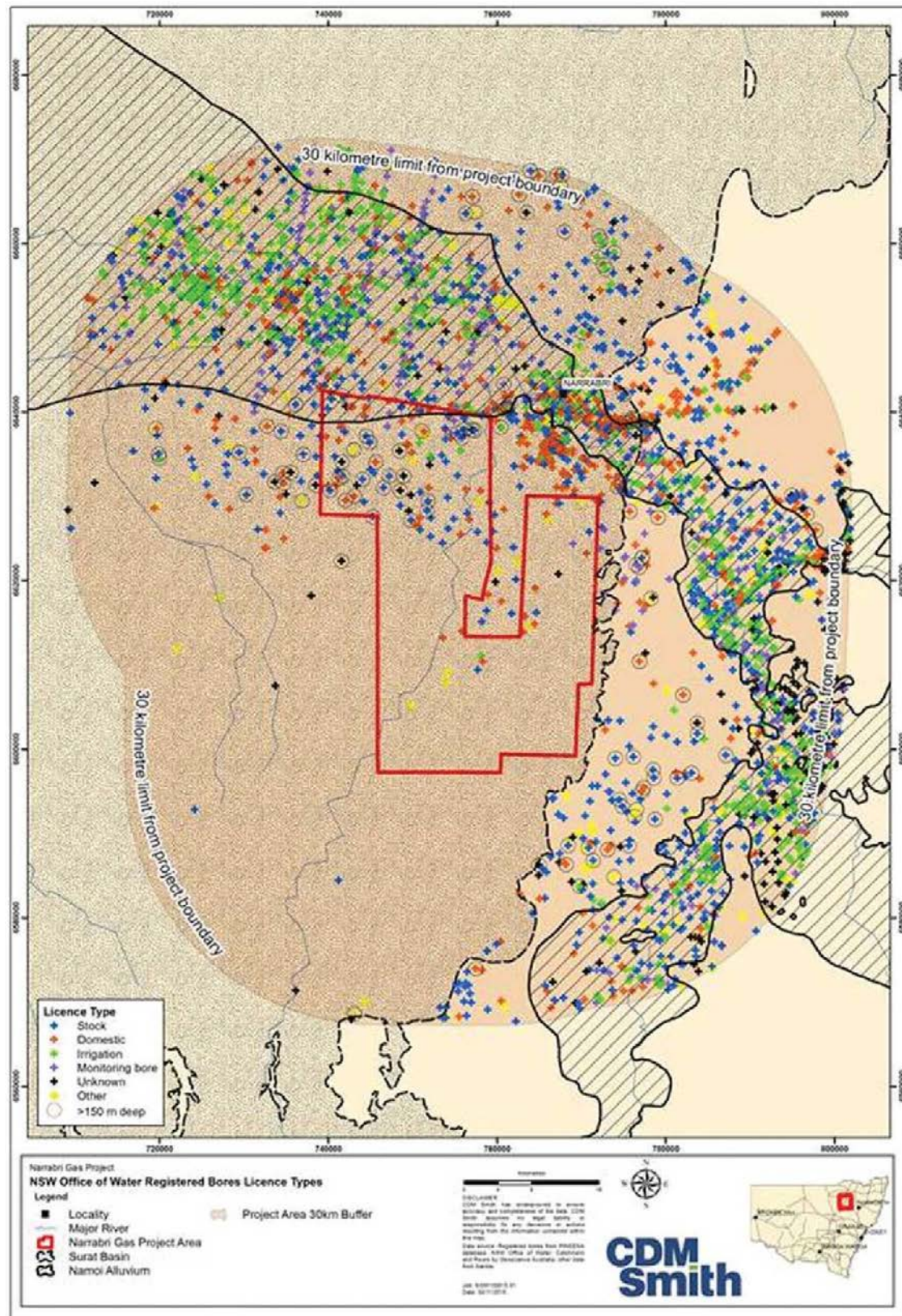
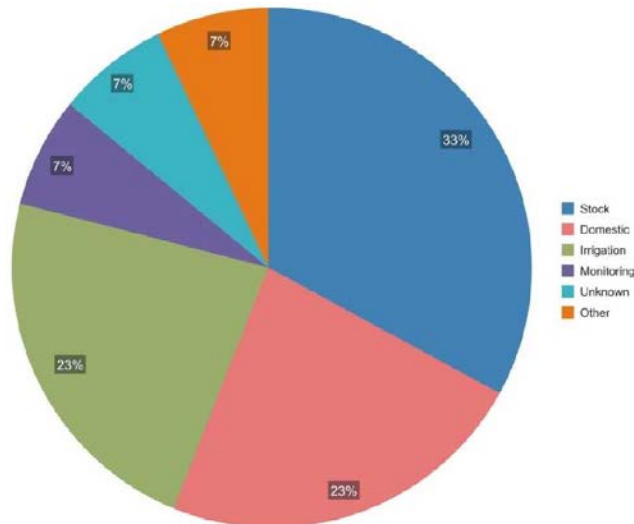


Figure 3-3: Groundwater Bores in the Project Area





Source: NSW DPI Water - PINNEENA (v.4.1) groundwater database

**Figure 3-4: Groundwater bore license types within 30 km of Project Area boundary**

## 3.2 Ecology

The following sections discuss the ecological setting, including MNES and other environmental values relevant to the Project Area. Site-specific discussion relative to ecological receptors evaluated in the risk assessment is included in **Section 5.3.4**.

### 3.2.1 Terrestrial Ecology

**Table 3-1** presents a summary of the findings of this assessment within the Project Area. Terrestrial MNES within the Project Area are presented in **Table 3-2**. Further details are available in the EIS, MRS and Ecological Impact Assessment that is Appendix J1 of the EIS (Eco Logical, 2016a; Eco Logical 2016b).

**Table 3-1: Summary of Terrestrial Ecology Assessments**

Assessment	Category	Findings
Ecological Impact Assessment (Appendix J1 EIS, 2016)	Threatened species listed under NSW <i>Threatened Species Conservation Act 1995</i> (TSC Act)	<ul style="list-style-type: none"> <li>• Flora <ul style="list-style-type: none"> <li>○ Ten TSC Act listed threatened flora species are known to occur in the project area, including: <ul style="list-style-type: none"> <li>▪ 6 vulnerable species</li> <li>▪ 3 endangered species</li> <li>▪ 1 critically endangered species</li> </ul> </li> </ul> </li> <li>• Fauna <ul style="list-style-type: none"> <li>○ Twenty-seven TSC Act listed threatened fauna species are known to occur within the project area, including: <ul style="list-style-type: none"> <li>▪ 16 birds</li> <li>▪ 10 mammals</li> <li>▪ 1 reptile</li> </ul> </li> <li>○ The following TSC Act listed fauna species are considered likely, or to have the potential, to occur in the project area: <ul style="list-style-type: none"> <li>▪ 1 likely mammal</li> <li>▪ 4 potential mammals</li> <li>▪ 16 potential birds</li> </ul> </li> </ul> </li> </ul>
	Threatened species listed under Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	<ul style="list-style-type: none"> <li>• Flora <ul style="list-style-type: none"> <li>○ Five EPBC Act listed threatened flora species were recorded in the study area, including: <ul style="list-style-type: none"> <li>▪ 3 vulnerable species</li> <li>▪ 2 endangered species</li> </ul> </li> </ul> </li> <li>• Fauna <ul style="list-style-type: none"> <li>○ Three EPBC Act listed threatened fauna species were recorded in the study area, including: <ul style="list-style-type: none"> <li>▪ 2 mammals</li> <li>▪ 1 bird</li> </ul> </li> <li>○ In addition, the following EPBC Act listed fauna species are considered likely, or to have the potential, to occur in the project area: <ul style="list-style-type: none"> <li>▪ 1 likely mammal</li> <li>▪ 2 potential mammals</li> <li>▪ 5 potential birds</li> </ul> </li> </ul> </li> </ul>
	Migratory species listed under EPBC Act	<ul style="list-style-type: none"> <li>• Seven (7) migratory bird species listed under the EPBC Act are known to occur within the project area.</li> </ul>

Assessment	Category	Findings
	Threatened ecological communities (TECs) listed under TSC Act	<ul style="list-style-type: none"> <li>Four TECs are known or likely to occur within the project area: <ul style="list-style-type: none"> <li>Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions</li> <li>Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions</li> <li>Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions</li> </ul> </li> <li>Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions</li> </ul>
	TECs listed under EPBC Act	<ul style="list-style-type: none"> <li>Two TECs are known or likely to occur within the project area: <ul style="list-style-type: none"> <li>Weeping Myall Woodlands</li> <li>Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)</li> </ul> </li> </ul>

**Table 3-2: MNES Under the EPBC Act identified as potentially present in Project Area**

MNES	Description
Ecological Communities	<ul style="list-style-type: none"> <li>Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant)</li> <li>Weeping Myall Woodlands</li> </ul>
Flora – Vulnerable	<ul style="list-style-type: none"> <li><i>Bertya opposens</i> (Coolabah Bertya)</li> <li><i>Lepidium aschersonii</i> (Spiny Peppercress)</li> <li><i>Rulingia procumbens</i></li> </ul>
Flora – Endangered	<ul style="list-style-type: none"> <li><i>Lepidium monoplacoides</i> (Winged Peppercress)</li> <li><i>Tylophora linearis</i></li> </ul>
Birds – Vulnerable	<ul style="list-style-type: none"> <li><i>Polytelis swainsonii</i> (Superb Parrot)</li> </ul>
Birds – Endangered	<ul style="list-style-type: none"> <li><i>Anthochaera phrygia</i> (Regent Honeyeater),</li> <li><i>Botaurus poiciloptilus</i> (Australasian Bittern),</li> <li><i>Lathamus discolor</i> (Swift Parrot; also marine)</li> <li><i>Rostratula australis</i> (Australian Painted Snipe; also marine)</li> </ul>
Mammals – Vulnerable	<ul style="list-style-type: none"> <li><i>Chalinolobus dwyeri</i> (Large-eared Pied Bat)</li> <li><i>Nyctophilus corbeni</i> (South-eastern Long eared Bat)</li> <li><i>Phascolarctos cinereus</i> (Koala)</li> <li><i>Pseudomys pilligaensis</i> (Pilliga Mouse)</li> </ul>
Mammals – Endangered	<ul style="list-style-type: none"> <li><i>Dasyurus maculatus</i> (Spotted-tailed Quoll)</li> </ul>

MNES	Description
Migratory Species	<ul style="list-style-type: none"> <li>• <i>Apus pacificus</i> (Fork-tailed Swift)</li> <li>• <i>Ardea ibis</i> (Cattle Egret)</li> <li>• <i>Ardea modesta</i> (Great Egret)</li> <li>• <i>Calidris acuminata</i> (Sharp-tailed Sandpiper)</li> <li>• <i>Gallinago hardwickii</i> (Latham's Snipe)</li> <li>• <i>Haliaeetus leucogaster</i> (White-bellied Sea-Eagle)</li> <li>• <i>Hirundapus caudacutus</i> (White-throated Needletail)</li> <li>• <i>Merops ornatus</i> (Rainbow Bee-eater)</li> <li>• <i>Myiagra cyanoleuca</i> (Satin flycatcher)</li> <li>• <i>Plegadis falcinellus</i> (Glossy Ibis)</li> </ul>

There is not expected to be significant impacts to the MNES presented in **Table 3-2** due to disturbance to ecological habitat as a result of the project (EIS Appendix J1).

### 3.2.2 Aquatic Ecology

Aquatic habitats within the Project Area include watercourses, wetlands, springs, and groundwater dependant ecosystems. Bohena Creek is a key surface water feature within the proposed development area and is the proposed location of surface water discharge of treated water.

Habitat for aquatic biota (e.g., aquatic plants, macroinvertebrates, fish, turtles, and platypus) are present within watercourses associated with the Project Area. **Table 3-3** provides a summary of the aquatic ecology assessment conducted as part of the EIS; refer to the MRS Appendix G1 of the 2016 EIS for further detail. It should be noted that no stygofauna was observed as part of the ecological impact assessment (Eco Logical 2016b)

**Table 3-3: Summary of Aquatic Ecology**

Category	Description
Threatened species listed under the <i>Fisheries Management Act 1994</i> (FM Act)	<ul style="list-style-type: none"> <li>• One threatened species, the Murray-Darling Basin population of Eel-tailed Catfish (<i>Tandanus tandanus</i>), was considered likely to be located in the Namoi River catchment.</li> <li>• An additional 2 threatened species were considered to have the potential to occur in the Namoi River catchment, including <ul style="list-style-type: none"> <li>○ River Snail (<i>Notopala sublineata</i>)</li> <li>○ Silver Perch (<i>Bidyanus bidyanus</i>)</li> </ul> </li> </ul>
EPBC Act	<ul style="list-style-type: none"> <li>• One threatened species, Murray Cod (<i>Maccullochella peelii peelii</i>) is considered to have the potential to occur in the Namoi River catchment.</li> </ul>
<i>Water Management Act 2000</i>	<ul style="list-style-type: none"> <li>• Nine potential groundwater dependent ecosystems (GDEs) were identified within the maximum extent of predicted drawdown exceeding 0.5 m (refer to EIS Appendix F Groundwater Impact Assessment). <ul style="list-style-type: none"> <li>○ These included two sites recognised as high priority GDEs by the NSW Office of Water, Eather Spring and Hardy's Spring. Both Eather Spring and Hardy's Spring have been highly modified through excavation, damming of drainage lines and stock access.</li> </ul> </li> </ul>

### 3.3 Management of Impacts to Ecological and other receptors

As documented in **Section 2.3**, the key strategies regarding potential impacts to MNES and other environmental values involve avoidance, minimization, mitigation, and management. The key to this

strategy is location selection provided by the Field Development Protocol. In accordance with this protocol, **Table 3-4** presents exclusion zones identified for the Narrabri Gas Project which is critical to the avoidance and mitigation of impacts on sensitive ecological receptors. In addition, infrastructure will be located away from sensitive receptors (occupied residences) as well as managed in a manner to mitigate potential ancillary risks (for example the establishment of vegetation-free zones around flares).

In combination with the avoidance and minimisation strategies, numerous other mitigation and management strategies would be employed to manage the risk to MNES. Common strategies employed include:

- Establishment of designated chemical storage areas and the storage of chemicals in accordance with Australian Standards and regulatory requirements (such as development consent and Environment Protection Licence conditions)
- Produced water and brine ponds are engineered, constructed and operated in accordance with regulatory hydraulic performance requirements
- Removal of surplus chemicals at the end of well drilling and completions
- Management of all waste in accordance with waste classification, transport and tracking and disposal requirements.
- Beneficial reuse of cuttings in the rehabilitation of well pads and treated water for construction and drilling, dust suppression, stock watering and irrigation.

**Table 3-4: Exclusion zones for the Narrabri Gas Project**

Constraints/Exclusion Areas	Applicability
Nature Reserve/National Park/Aboriginal Areas	Exclusion from the Project Area
State Conservation Areas (Brigalow)	Exclusion of all surface infrastructure, and sub-surface exclusion to a depth of 110 m
Riparian Corridors	Exclusion of all non-linear surface infrastructure and large ponds and dams
1% Annual Exceedance Probability (AEP) Flood Areas	Exclusion of all large ponds and dams
Currently known Aboriginal cultural heritage sites, Yarrie Lake	Exclusion of all surface infrastructure and a buffer of at least 200 m around Yarrie Lake

## **4.0 LIFECYCLE OF GAS FIELD DEVELOPMENT AND PRODUCED WATER TREATMENT**

The two main lifecycle components of the project that introduce chemicals and chemical products to the risk assessment are drilling activities required in the construction of the well, and the treatment of produced water and brine at the Leewood water management facility (WMF).

For drilling activities, the water based drilling fluid is created through the blending of manufacture-specific products and water on site or transported to the site in a tanker from the drilling fluid treatment facility located at the Narrabri Operations Centre. The drilling fluid is used to lubricate the drill bit, maintain the stability of the borehole, facilitate the removal of drilling cuttings from the well and bring them to the surface and prevent clays from swelling.

The Project also includes the treatment and reuse of produced water generated through the gas extraction process. Produced water collected from each gas well would be transferred to the Leewood central WMF for treatment and beneficial reuse including for drilling and construction, dust suppression, stock watering, irrigation or release to Bohena Creek under suitable flow conditions (flows are greater or equal to 100 ML/day).

Elements of the life cycle of chemicals used by the project includes:

- The transportation of chemicals from the warehouse to the well pad and the WMF
- Activities associated with drilling fluid mixing and use at the well lease
- Management, treatment and beneficial reuse during or after the completion of drilling activities
- Produced water treatment at the WMF
- Beneficial reuse of treated water.

### **4.1 Transport of Chemicals to and from Well Pad and to the WMF**

Drilling fluid would either be prepared on the well pad or would be transported to the well pad in a tanker from the previously approved drilling fluid treatment facility located at the Narrabri Operations Centre (on Yarrie Lake Road, Narrabri). If prepared on the well pad, the vendor chemicals that make up the drilling fluid would be conveyed to the site via vehicular transport from the supplier or storage warehouse. Once drilling is completed, drilling fluids would be transported back to the drilling fluid treatment facility so that it can be beneficially re-used in future drilling operations, or disposed of at a licensed waste facility.

Chemicals used by the WMF will be conveyed to Leewood via vehicular transport from the supplier or storage warehouse. The specific routes to well pads and Leewood would vary depending upon the supplier warehouse and source location. However, the route would include a combination of State-controlled highways, regional connecting roads, and rural access roads. The transportation would be conducted in accordance with relevant regulatory requirements.

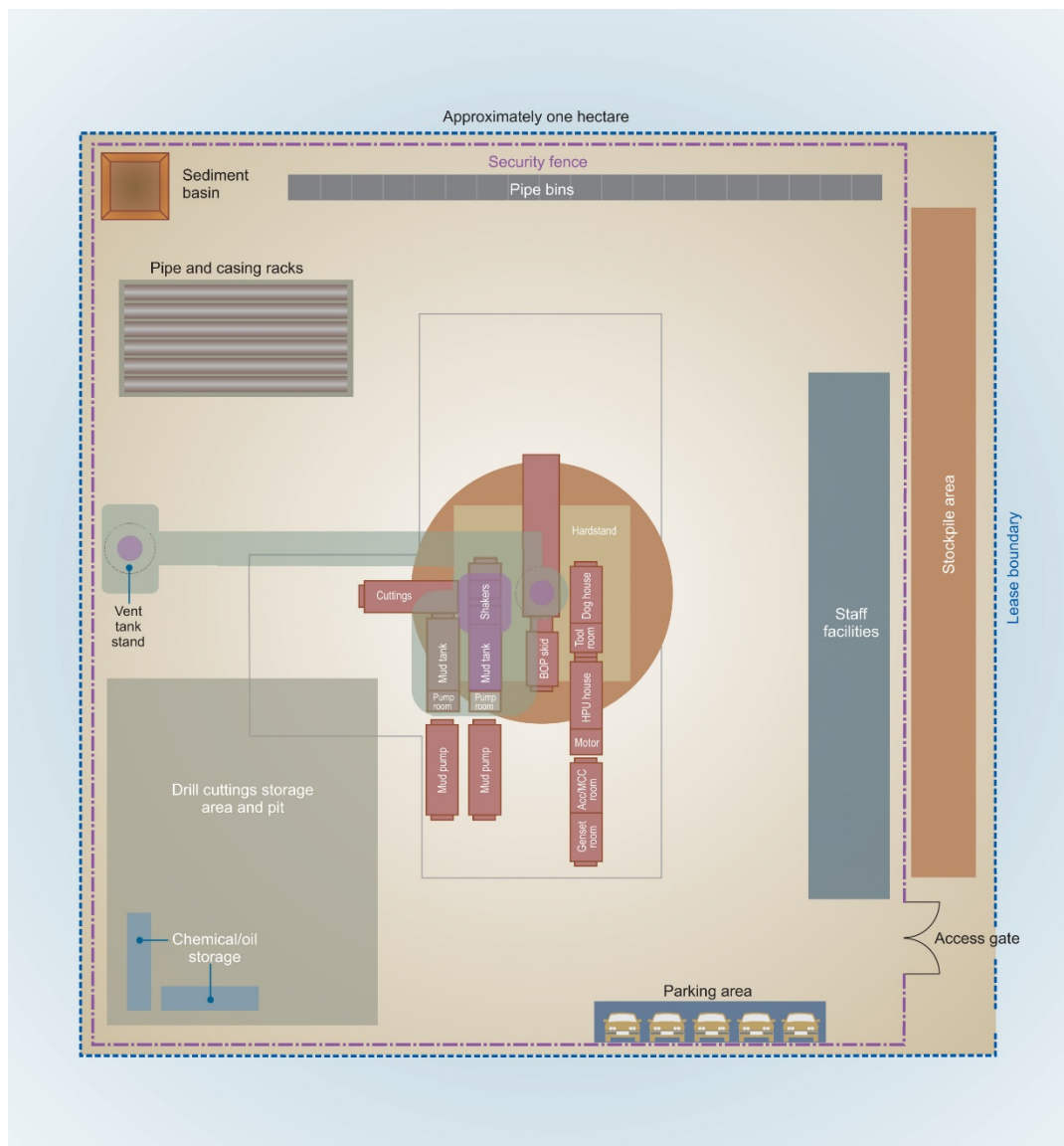
Potential exposure to these products could occur as a result of accidental releases such as spillage during loading and offloading activities or an accident during transport.

## 4.2 Drilling and Completion Operations

Operations on the well pad relevant to potential chemical exposures to human and environmental receptors include the following:

- Storage of products
- Blending of the products on the surface prior to use
- Use of the products during drilling
- Recovery, separation, and recycling of cuttings, drilling fluids and completion fluids
- Storage of recovered drilling fluids, completion fluids in preparation for treatment, disposal and/or beneficial reuse.

During construction and drilling activities the well pad areas would be approximately one hectare (ha) in size and would be fenced. The typical well pad layout during drilling is shown in **Figure 4-1**. Drilling fluids and drill cuttings would typically be stored in a combination of surface tanks and lined pits on site.



**Figure 4-1: Typical well pad layout during drilling**

Chemicals will be stored and handled in accordance with relevant Australian Standards, including AS 1940-2004 *The storage and handling of flammable and combustible liquids*.

Well leases would be designed and managed to contain all activities (including the handling of liquids and drilling muds) to the well pad area. Access to well pads would be restricted to approved and trained personnel. Perimeter fencing would further limit access to unauthorised persons.

Well leases would be partially rehabilitated once production commences unless the well pad hosts other support infrastructure such as telecommunication towers.

#### **4.3 Treatment, Recycling, Disposal and Beneficial Reuse**

Residual materials generated through the construction and operational phases of the well life cycle include recovered drill cuttings, drilling fluids and produced water. Produced water management is discussed in **Section 4.4**.

Drilling fluids and drill cuttings are returned to the surface and stored in lined pits or tanks. Drill cuttings generally comprise rock and solid material and makeup around 30 percent of the material recovered from the well. Drill cuttings would be separated as much as practicable from the used drilling fluid and later re-used on well pads in site rehabilitation using a mix, turn, bury strategy. Drill cuttings not appropriate for beneficial reuse on well pads for rehabilitation purposes would be transported off site and disposed of at an appropriately licensed waste management facility. Used drilling fluid would be transported to the drilling fluid treatment facility (as discussed in **Section 4.1**) for treatment and reuse at other wells or transported to a licensed waste facility for disposal.

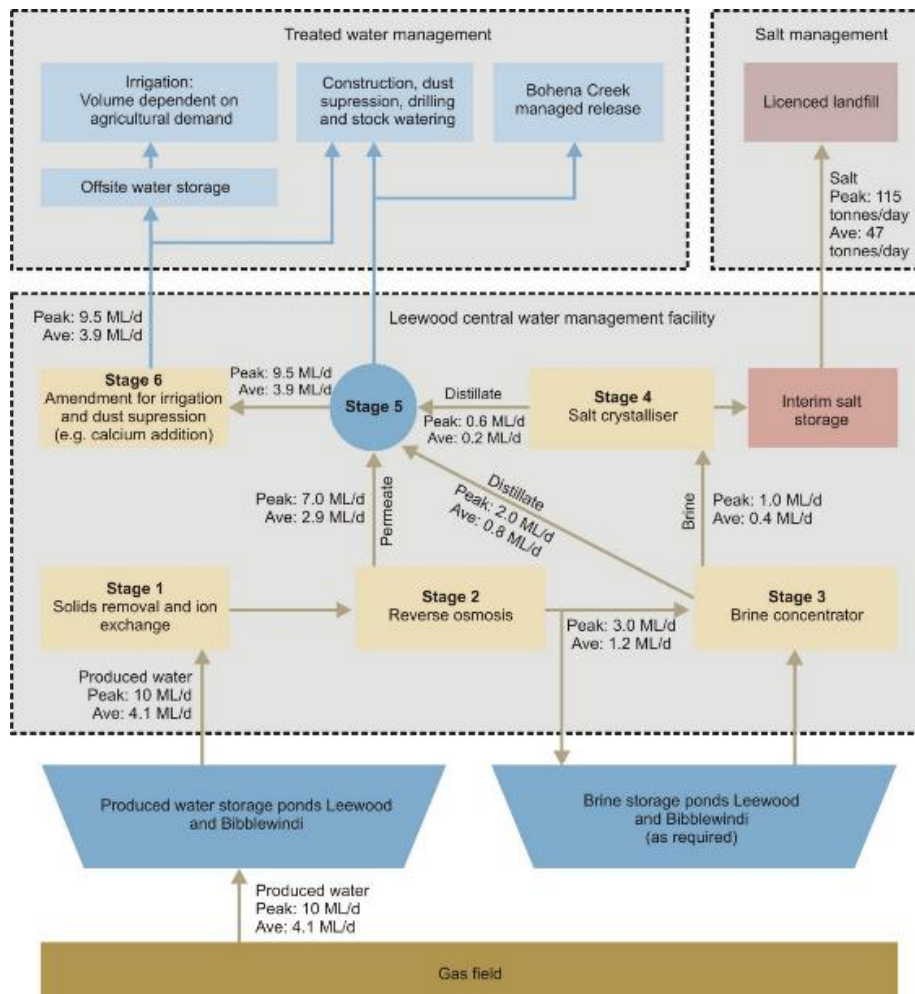
#### **4.4 Produced Water Transfer, Storage and Treatment**

Depressurising coal seams by the removal of produced water is a fundamental step in the extraction of natural gas. The quality of produced water can vary depending on the type of geological formation; the average salinity of produced water generated during exploration and appraisal activities within the Project Area is around 14,000 micro Siemens per centimetre which is approximately 30 per cent of the salinity of seawater. The estimated volume of extracted water will vary with the highest rates predicted for the first two to four years at around 10 ML/day with a gradual decline thereafter with a long-term average of 4 ML/day; the estimated total volume of produced water over the project assessment period of 25 years is 37.5 gigalitres (GL).

Produced water extracted at each production well would be transferred to Bibblewindi and Leewood via a network of water gathering lines and in-field balance tanks. Produced water would be stored in double-lined ponds at Bibblewindi and Leewood, before undergoing treatment at the Leewood WMF. The key stages of the water treatment process are described in Chapter 7 of the EIS and would include the use of microfiltration, ion exchange, reverse osmosis (RO), thermal evaporation and salt crystallisation technologies.

The primary products from this process are a treated water stream and a brine stream. In addition, the operation of the WMF would generate small volumes of algae and other solids that would be transported to a licensed landfill for disposal. Process steps are highlighted in **Figure 4-2**.





**Figure 4-2: Overview of the water treatment process (EIS Chapter 7)**

The saline waste stream produced by the process would be further concentrated, crystallised into a solid salt product and transported and disposed of to an off-site licensed landfill (EIS Chapter 7). Following treatment, treated water would be temporarily stored at the WMF. Treated water may be reused for beneficial purposes such as construction drilling, stock watering, dust suppression and irrigation or for release to Bohena Creek. The managed releases to Bohena Creek will occur if background flows are greater than or equal to 100 ML/day.

Chemicals would be stored on site in accordance with the relevant Australian Standard.

#### 4.4.1 Beneficial Reuse of Treated Produced Water

Treated water will be used for a range of beneficial purposes such as drilling and construction, dust suppression, stock watering and irrigation. Potentially surplus treated water would be released to Bohena Creek under suitable flow conditions (when background flows are greater or equal to 100 ML/day).

On average, up to around 4 ML/day of treated water could be used for dust suppression, construction and drilling (EIS Chapter 7). Usage would depend on a range of variables including the extent of construction activities, drilling activity and seasonality. Water would be applied to roads and operating areas including Leewood, Bibblewindi and other trafficked areas including well sites undergoing maintenance and rehabilitation in the project area, to suppress dust as required.

The irrigation scheme would be designed to have the capacity to beneficially reuse 12 ML/day of treated water (BeneTerra, 2015). Irrigation water quality will satisfy suitability guidelines for 'low to medium strength effluent' as per the DEC Guidelines (DEC NSW, 2004) and trigger values listed in ANZECC guidelines (ANZECC, 2000). Irrigation water will not be applied to areas with protected vegetation, but rather lands utilised for the specific purpose of agricultural use with crops such as lucerne and pasture grasses as well as cotton.

Studies on Bohena Creek have found that at flow conditions of at least 100 ML/ day, the release of up to 12 ML/day of treated water would have a negligible on the creek. Bohena Creek is an intermittent creek (Eco Logical 2016) that is characterised as flowing at least 15 percent of the time. Eco Logical (2016) concluded that flows of at least 100 ML/day occurred, on average, during approximately 44 days per year. The managed release of treated water to Bohena Creek is most likely to be required during the peak water production period (around years two to four); particularly during extended wet weather when the volume of treated water generated exceeds demand of the beneficial reuse activities.

#### **4.5 Life Cycle Components**

The life cycle components for all elements described above and the primary operations and the potential release mechanisms to the environment are tabulated below.

**Table 4-1: Life Cycle Components and Potential Release Mechanisms**

Life Cycle Component	Primary Operation	Potential Release Modes
Drilling Process/Drilling Fluids	Transport of Chemicals from Warehouse or Drilling Fluid Treatment Facility to Well Pad	Vehicle accidents
		Chemical handling accidents (offloading/loading)
		Storage of chemicals – spillage
	Drilling Operations	Spills during mixing
		Partitioning of drilling chemicals into groundwater
	Treatment, Recycling, Disposal and Beneficial Reuse	Management and treatment of solid waste streams including chemical storage bags and containers
		Spills during transport of used drilling fluids back to drilling fluid treatment facility (including vehicle accidents)
		Beneficial reuse of drill cuttings using mix, turn, bury strategy except when containing high percentage of coal fines, these will be transported off-site for disposal with potential release similar to used drilling fluid transport
Leewood Water Management Facility (WMF)	Transport of Chemicals to WMF	Vehicle accidents
		Chemical handling accidents (offloading/loading)
		Storage and spillage
	Produced Water	Pipeline loss (well heads and water transfer line to WMF)
		Storage in ponds and tanks
		Treatment (inc. RO)
		Filtrate and sludge treatment and waste storage
		Transfer and storage of treated water in offsite dams
	Brine Treatment	Storage in ponds
		Recirculation to RO
		Treatment (Thermal Evaporation / Salt Crystallisation)
	Beneficial Reuse of Treated Water	Irrigation and stock watering
		Drilling and construction
		Dust suppression
		Managed release to Bohena Creek (via pipeline)
	Transportation and Disposal of Waste Products (Filter Solids, Algae etc.) and Salt Solids from Crystalliser	Vehicle accidents
		Handling accidents (offloading/loading)
		Storage and spillage

## 5.0 PROBLEM FORMULATION AND ISSUE IDENTIFICATION

Problem formulation and issue identification in the chemical risk assessment process involves defining the bounds of the human health and environmental risk assessment to ensure the risk managers are informed properly and utilising the best practices. It identifies the key issues regarding the potential concern from the potential exposure to the individual, such as 1) what is the concern; 2) why is it a concern; 3) what is the urgency of the concern; and 4) what is the perception of the concern. A description of the current environmental setting includes identifying potential receiving environments and susceptible or vulnerable populations, and the site-specific details of each of the components of exposure (i.e., source, transport, route, receptor) that are potentially complete exposure pathways. This step involves a conceptual exposure model and assessment endpoints; and an analysis plan that outlines the goals, scope, and complexity of the chemical risk assessment. Potential management options may be proposed to mitigate those hazards and exposure pathways that may be the most significant contributors to the overall risks.

### 5.1 Risk Assessment Scope

The scope of the risk assessment encompasses the lifecycle of chemicals used in drilling and completions and the water treatment process as discussed in **Section 1.3**.

Potential environmental media affected by this lifecycle includes soil, air, surface water and groundwater. Susceptible receptors would include workers associated with lifecycle operations, associated community representatives that may be affected by the lifecycle operations and recipients of treated water. In addition, environmental receptors include natural resources and ecological receptors associated with the Project Area. **Table 5-1** summarises the specific bounds of this chemical risk assessment.

**Table 5-1: Bounds Defined Specific to Project**

Lifecycle Stage	Bounds
Transportation of chemicals	The transportation route includes the road network traversed from the source/supplier or storage warehouse to the well lease or to the WMF and from the well lease to the fluid treatment facility (in the case of used drilling fluids). The adjacent environment is included within this boundary. Refer to <b>Figure 5-1</b> for a map of existing roads within the Project Area.
Well lease operations	Well leases and adjacent environments are included within the boundary for well lease operations.
Produced water transfer and storage	Produced water from the well heads would be transferred via flowlines and pipelines to Bibblewindi and Leewood for storage and treatment at Leewood. The flowline/pipeline network for Bibblewindi and Leewood and adjacent environments are included within this boundary.
Operations of the Leewood WMF	The operations of the WMF are constrained by the physical bounds of the facility including the storage ponds for produced water and brine and the treated water storage tank. In addition to the WMF, Bohena Creek is a likely receiving body for treated water and is included within the bounds of the Project.
Treatment and Beneficial Reuse	The treatment and beneficial reuse of drill cuttings (except drill cuttings with high coal fines targeted for off-site disposal) and treated produced water associated with the project.

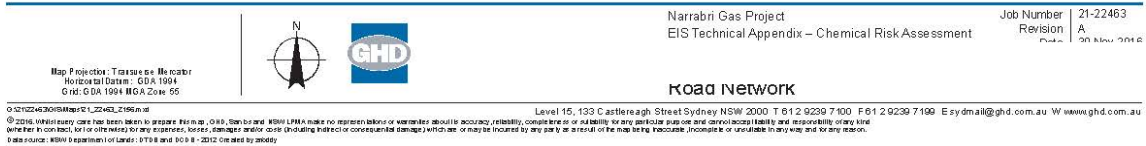
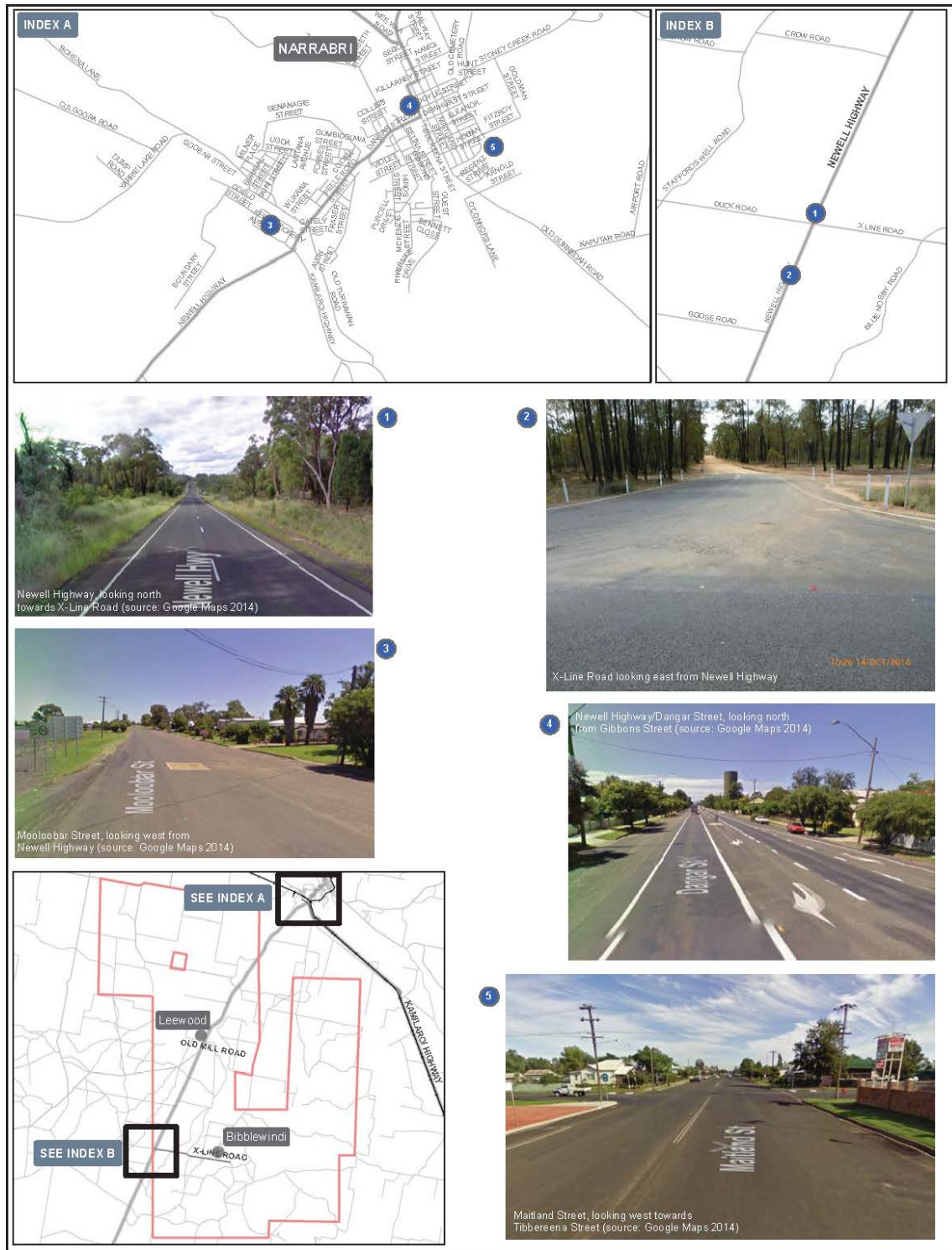


Figure 5-1: Existing Road Network



## 5.2 Key Issues

Identifying key issues that are amenable to risk assessment evaluation is an integral part of the risk assessment process. As presented in **Section 4.0**, the life cycle of the gas field development and produced water treatment process identified the potential issue or concern and discussed why it is a concern based on the potential for exposure to human and ecological receptors. Whilst each lifecycle generates concerns specific to the stage, concern over handling and management of chemicals to minimise potential harmful effects to human health and the environment is present in each stage.

### 5.2.1 Perception of Concerns

Whilst there is limited public discussion regarding the potential adverse effects to health and the environment associated with transport of drilling and completion products from the supplier or storage warehouse to the well lease, there is public concern regarding use of chemicals used in the drilling of wells, and management of wastes generated during drilling and well completion processes (Lloyd-Smith, 2016). The public concern stems from a perception of a lack of full health and environmental hazard assessment of the chemicals and product formulations by the National Industrial Chemical Notification and Assessment Scheme (NICNAS), and the perceived potential hazardous nature of the known individual chemicals.

The subsequent parts of the risk assessment process provide an evaluation of the concerns presented in the previous sections. Both qualitative and quantitative approaches are utilised to evaluate potential exposures to workers and non-occupational human receptors, as well as environmental receptors (terrestrial and aquatic ecological flora and fauna).

## 5.3 Conceptual Exposure Model

An essential component of the risk assessment is the Conceptual Exposure Model (CEM) that describes the chemical source(s), pathways of chemical migration through environmental media and identifies the potential susceptible populations (both human and ecological) that may potentially be exposed. In the development of the CEM, current environmental setting and land uses, environmental fate and transport mechanisms, and lifecycle stages of chemical usage and relevant receptors, are evaluated to determine which pathways are potentially complete and identify potential receptors for those pathways.

### 5.3.1 Lifecycle Environmental Exposure

**Section 3.0** discussed the environmental setting of the Project Area and focused on the hydrogeology and groundwater usage, and characterised the ecosystems and management measures to limit potential risks to the ecosystems. This section summarises the salient portions of that section as it directly relates to the lifecycle of the drilling fluids and the operations of the WMF assessed in this chemical risk assessment. The potential receptors will be discussed in **Section 5.3.4** Potential Receptors.

#### 5.3.1.1 Transport of Chemicals

Key access routes for the project include:

- Newell Highway
- X-Line Road
- Old Mill Road
- Yarrie Lake Road / Goobar Street / Mooloobar Street
- Old Gunnedah Road / Maitland Street / Tibbereena Street.

The Newell Highway is a highway and a major transport corridor linking Queensland, NSW and Victoria. The highway is a two-way sealed road and is approved by NSW Roads and Maritime Services for higher mass limit road trains. It has a speed limit of 110 kilometres per hour, reducing to

50 kilometres per hour approaching Narrabri. The Newell Highway would be the main haulage route from Queensland or NSW to the Narrabri Operations and Logistics Centre and construction sites at the gas field, Bibblewindi, the Bibblewindi to Leewood infrastructure corridor and Leewood. X-Line Road and Old Mill Road are unsealed roads. Yarrie Lake Road and Gunnedah Road are rural ‘collector’ roads.

Existing background traffic levels on the Newell Highway are around 1,860 vehicles per day (and 169 in peak hour). Average daily traffic count data provided by NSW Roads and Maritime Services indicate that approximately 73 per cent of vehicles travelling on the Newell Highway were light vehicles, with the remainder comprising heavy vehicles (including approximately 17 per cent being B-doubles or other vehicles with greater than five axles). Further details on the existing traffic network are provided in Chapter 22 of the EIS.

Chemicals would be transported in accordance with legislative requirements and Australian Standards that include chemical-specific packing volumes and materials (i.e. multiple smaller containers for higher hazards products). In the majority of transportation instances, vendor chemicals would be supplied in multiple volumes per transportation vehicle. The likelihood of the entire shipment of vendor chemicals being released into the environment in a single accidental event is low.

#### **5.3.1.2 Drilling and Completion Operations**

The Field Development Protocol defines the process that would be used by the Proponent to site gas field infrastructure. Well leases would be installed within a variety of environmental settings within the Project Area.

Wells would be progressively commissioned and decommissioned within the project area. Exploration and appraisal wells may be converted to production wells depending on their gas yields. Existing (and approved but not yet constructed) chip holes, core holes and pilot wells under the exploration and appraisal program may be utilised.

Periodic maintenance equipment including workover rigs may be required from time to time. They would utilise the remaining cleared area of the well pad plus approximately 0.2 hectares for equipment lay down and to meet operational safety requirements.

Equipment and infrastructure required to drill and complete a well and the storage of the associated products and chemicals are contained within the operational area of the well pad. Fencing and signage restrict access to authorised occupational workers only. A gate or livestock grill may be used at the site entrance depending on well location. Whilst access to the well lease by livestock is limited by the fencing, there is the potential that fauna may access the well pad; however, this would be considered limited during this phase, due to the level of activity on the well lease and 24-hour operations.

#### **5.3.1.3 Treatment, Recycling, Disposal and Beneficial Reuse**

Management of drill cuttings during rehabilitation would occur on well pads, except when the drill cuttings contain a high percentage of coal fines that will be transported off-site for disposal. Management during rehabilitation would occur using a mix, turn and bury strategy and would be carried out with regard to the volume and characteristics of the drill cuttings and the receiving soil. Fencing and signage restrict access to authorised occupational workers during drilling and operations.

In addition, produced water may be treated water for a range of beneficial purposes such as drilling and construction, dust suppression, stock watering and irrigation. Potentially surplus treated water would be released to Bohena Creek under suitable flow conditions (when background flows are greater or equal to 100 ML/day).

Further detail of potential exposure pathways for treatment, recycling, disposal and beneficial reuse of drill cuttings and treated produced water is provided in **Section 5.3.3.3** and **Section 5.3.3.4** respectively.

### 5.3.2 *Chemicals of Potential Concern*

In accordance with National Environment Protection (Site Assessment) Measure (NEPM) and enHealth guidance, the constituents of potential concern (COPCs) are identified as part of the Problem Formulation and Issue Identification (NEPM, 2012; enHealth, 2012a). The approach for the identification of the COPCs is outlined in the Approach – Indirect Estimation (Scenario Evaluation) step in Expo-Box (USEPA, 2016a) and in the Hazard Assessment – Evaluating Existing Information step in the OECD (2014). The chemicals used in the processes are described in the sections below.

#### 5.3.2.1 Drilling Chemicals

The drilling fluids employed by the Proponent would comprise low toxicity and generally inert substances that are broadly utilised throughout the petroleum and gas industry in Australia with many also utilised for the drilling of water bores. There are 6 products to be potentially used in the drilling process including:

- 5% KCl/Polymer/PHPA Mud
- KCl/Polymer Mud
- Inhibited KCl/Polymer Mud with BORE-HIB
- Inhibited KCl/Polymer Mud with Glycol
- LCM Pill 1 Mud
- LCM Pill 2 Mud.

The first four fluids (muds) are the primary products to be used as drilling fluids. The LCM muds are used to prevent formation water from entering the well by blocking the pores in the permeable/fractured rock. These are considered secondary drilling fluid products for use as required and are generally used at much lower volumes than the primary drilling fluid products.

A quantitative risk assessment will be undertaken for each of the primary fluid products and a qualitative risk assessment will be undertaken for each of the primary and secondary drilling fluid products.

The drilling fluid vendor chemicals present in these products including their purpose and maximum quantity (i.e. in the total fluid) are included in **Table 5-2**. The concentration of these chemicals used in the process will be presented in **Section 6.0**.



**Table 5-2: Drilling Fluid Chemicals**

Chemical Name/Use	CAS Registry Number	Use	Quantity <sup>1</sup>
<b>Primary Drilling Fluids</b>			
Copolymer of acrylamide and sodium acrylate	25085-02-3	Shale inhibitor	0.33 ml
Drilling water/Water in Product	7732-18-5	Base fluid	321.06 ml
Glyoxal	107-22-2	Fluid loss stabiliser	1.25 ml
Methanol	67-56-1	Antimicrobial	1.25 ml
Pentanedial / Glutaraldehyde	111-30-8	Antimicrobial	0.2 ml
Potassium chloride	7447-40-7	Inhibitor	11.08 ml
Sodium carbonate	497-19-8	Buffer	0.42 ml
Sodium carboxymethyl cellulose	9004-32-4	Fluid loss stabiliser	1.25 ml
Sodium hydroxide	1310-73-2	pH stabilizer	0.09 ml
Starch	9005-25-8	Fluid loss stabiliser	1.33 ml
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	Fluid loss stabiliser	1.33 ml
Xanthan gum	11138-66-2	Viscosifier	0.91 ml
Methylisothiocyanate (MITC)	556-61-6	NA <sup>2</sup>	0 ml <sup>2</sup>
Ethylene oxide/propylene oxide copolymer	9003-11-6	Defoamer	0.02 ml
Polyalkylene	9038-95-3	Shale inhibitor	10.49 ml
Polypropylene glycol	25322-69-4	Defoamer	0.02 ml
Silicic acid, potassium salt	1312-76-1	Shale stabiliser	10.66 ml
Sodium chloride	7647-14-5	Additive	12.5 ml
<b>Secondary Drilling Fluids</b>			
Almond Hulls	NA*	Loss circulation material	NA
Copolymer of acrylamide and potassium acrylate	31212-13-2	Shale inhibitor	NA
Bentonite	1302-78-9	Weight additive	NA
Calcined petroleum coke	64743-05-1	Loss circulation	NA
Calcium Carbonate	471-34-1	pH stabiliser	NA
Cellophane	9005-81-6	Loss circulation	NA
Crystalline silica, cristobalite	14464-46-1	Weight additive	NA
Crystalline silica, quartz	14808-60-7	Bridging agent, weight additive, pH stabiliser, Loss circulation material	NA
Crystalline silica, tridymite	15468-32-3	Weight additive	NA
Walnut hulls	Mixture (1756)*	Loss circulation	NA
Wood fibre	Mixture (1757)*	Loss circulation	NA

<sup>1</sup> Based on maximum of combined muds assessed

<sup>2</sup> MITC is result of hydrolysis of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet); therefore, there is no initial quantity of MITC in the vendor chemicals.

ml – millilitre

NA – quantity used varies with severity of loss

\* Naturally occurring product

In addition, geogenic chemicals may be present in recovered drilling fluids and flowback water, due to the subsurface mixing of chemical products with the natural geological materials. These geogenic chemicals are also considered COPCs and have been evaluated separately from the vendor-supplied chemicals.

Safety Data Sheets (SDSs) for each of the six basic drilling fluid formulations / products are included in **Appendix B** of this report. None of the drilling fluid chemicals supplied by the vendors contain benzene, toluene, ethylbenzene, xylenes (BTEX) or polycyclic aromatic hydrocarbons (PAHs) as additives.

### 5.3.2.2 Chemicals Used by the WMF

The vendor chemicals used in the WMF will be considered as COPCs in this risk assessment for both qualitative and quantitative assessment. The WMF vendor chemicals present in these products including their purpose and maximum quantity are included in **Table 5-3**. The SDSs for the WMF formulations / products are included in **Appendix B** of this report. The concentration of these chemicals used in the process will be presented in **Section 6.0**.

**Table 5-3: Water Management Facility Chemicals**

Product Name	Chemical name	CAS No.	Use	Approximate quantity stored on site (Plant available Storage)
Osmoflo Osmotreat Si P01077, P01078, P01079	Proprietary Polymer A Proprietary Ester A	Polymer A-CASRn EsterA-CASRn	Reverse osmosis scale inhibitor Reverse osmosis scale inhibitor	2.3 T
Hybind 2002 (alternative Pac 23)	Aluminium Chlorohydrate	1327-41-9	Coagulation	4T
Sodium Metabisulphite	Sodium Metabisulphite	7681-57-4	Reducing agent, dechlorination	2.4T
Sodium Hypochlorite Solution	Sodium Hypochlorite, NaOCl Chlorine	7681-52-9 7782-50-5	Sanitisation	3.62T
Caustic Soda 50%	Sodium Hydroxide NaOH	1310-73-2	pH control agent	2.64T
Citric Acid Solution (50%)	Citric Acid, C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	77-92-9	pH control agent	2.4T
Hydrochloric Acid	Hydrochloric Acid, HCl <sup>3</sup>	7647-01-0	pH control agent	8T
Calcium Chloride	Calcium Chloride, CaCl <sub>2</sub> <sup>4</sup>	10043-52-4	calcium ion source and pH adjustment	3.6T
EDTA Tetra Sodium Salt	Ethylene diamine tetraacetic acid, EDTA (C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>8</sub> )	64-02-8	Hardness control	1.15T
Polydadmec	Polydadmec	26062-79-3	Flocculating agent	0.03T

Product Name	Chemical name	CAS No.	Use	Approximate quantity stored on site (Plant available Storage)
Enviro Flocc 4017	Acrylamide homopolymer	9003-05-8	Flocculating agent	0.5T
Nalco® 7330	14% 5-chloro-2-methyl-4-isothiazolin-3-one trace 2 methyl-isothiazolin-3 one (MI) trace sodium phosphinate magnesium nitrate	26172-55-4 2682-20-4 10377-60-3	Biocide Biocide	1.02T
Osmocide 20%	Proprietary Mixture D1 Proprietary Mixture D2	MixtureD1-CasRn MixtureD2-CasRn	Biocide Biocide	1.3T
Kuriverter IK-110	Proprietary Mixture A1 Proprietary Mixture A2 Proprietary Mixture A3	MixtureA1-CasRn MixtureA2-CasRn MixtureA3-CasRn	pH control agent	1.2T
Osmoclean CD	Proprietary Mixture B1 Proprietary Mixture B2	MixtureB1-CasRn MixtureB2-CasRn	pH control agent Hardness control agent	<0.12T for intermittent use
Osmoclean DW	Proprietary Mixture C1 Proprietary Mixture C2	MixtureC1-CasRn MixtureC2-CasRn	pH control agent Hardness control agent Surfactants	<0.12T for intermittent use
Sodium dodecyl sulfate	Sodium dodecyl sulfate	151-21-3	Surfactant	<0.025T for intermittent use
Sodium chloride	Sodium chloride	7647-14-5	Hardness control	<1T for intermittent use
Hydrex 9209	Polyacrylate, Homopolymer of maleic acid, Sodium hydroxide	9003-04-7 26009-09-2 1310-73-2	Flocculating agent Scale inhibitor pH control agent	13 (density ~1300 kg/m <sup>3</sup> )
Caustic soda – liquid (46%-50%)	Sodium Hydroxide	1310-73-2	pH control agent	15 (density ~1500 kg/m <sup>3</sup> )

<sup>1</sup> Approximate quantity stored on site (Plant available Storage)  
T tonnes

### 5.3.3 Exposure Pathway Analysis

The assessment of exposure involves the evaluation of the data available for study, the details associated with the surrounding environment, the nature of the exposure identified, and the potential mobility of the COPC, as provided in the NEPM and enHealth guidance. For an exposure pathway to be considered complete, all of the following must be present:

- A source of a chemical(s)
- A mechanism of release, retention, or transport of a chemical in a given medium (i.e., air, water, or soil)
- A point of human or ecological contact with the exposure medium (i.e., exposure point)
- A route of exposure at the point of contact (i.e., ingestion, inhalation, or dermal contact).

Should one of these elements not exist, the exposure pathway is incomplete and further assessment of risks is not required. Potentially complete exposure pathways are evaluated either qualitatively or quantitatively through estimates of intakes based on a careful evaluation of the exposure and assumptions on human health criteria (i.e., types of intake, population characteristics, COPC concentrations at the exposure point, and exposure factors). This assessment of exposure is consistent with enHealth (2012a) and the approach for the Exposure Assessment Tools by Tiers and Types – Aggregate and Cumulative step in EPA-Expo-Box (USEPA, 2016a) and in the Exposure Assessment – General Guidance for Exposure Assessment step in OECD (OECD, 2014).

Based on the assessment of land use provided in the ecological impact assessment (Appendix J1 of the EIS) and the presence of protected areas within the Project Area, likely human exposure cohorts would include:

1. Workers both at well pads and at the WMF including operators, maintenance staff and supervisors.
2. First responders who may come into contact with the products whilst responding to emergency calls.
3. Trespassers who stray (either advertently or inadvertently) onto parts of the Project Area on which operations are occurring including the well pads post rehabilitation. Trespassers would also have limited (i.e., area fenced) access to the produced water and brine storage ponds.
4. Agricultural workers/residents who have access to lands where irrigation of treated water is occurring.
5. Residents and recreational users who have access to areas where treated waters are using for dust suppression and construction water.

Given the well pads would typically be located greater than 750 m apart and drilling activities, including drilling fluid and cuttings management, would be focused on individual well pad site, the potential for cumulative impacts from releases are considered limited. The transportation of chemicals to well pad sites may utilise common major roads however the probability of multiple accidents and associated releases in identical locations (based on the number of truck movements) is considered to be very low.

The key relevant EVs and MNES are assessed using the tools presented in the OECD toolkit for hazard assessment and Exposure Assessment – General Guidance for Exposure Assessment. In addition, the EPA-Expo-Box tools have been used in the quantitative assessment of impacts to livestock, mammals (small and large) and avian species if there is a potential for exposure. The assessment includes the preparation of risk-based screening criteria in the hazard assessment to quantify the magnitude of potential for exposure based on releases from the lease area to adjacent water resources or well lease soils, which may be a source of exposure. This quantification evaluates the potential concentrations in the environmental media where there are potentially complete exposure pathways for MNES and other environmental values (i.e., adjacent surface water resources and terrestrial fauna habitat), as well as the qualification of the potential for releases to occur.

**Figure 5-2** through **Figure 5-4** present the conceptual site exposure models for the three main chemical lifecycle components that were assessed in the chemical risk assessment. The three components and their individual elements are:

1. Drilling Process and the Use of Drilling Fluids including:
  - a. Transport of chemicals to the well lease
  - b. Drilling and completion operations
  - c. Removal of drilling fluids for treatment and beneficial reuse of drill cuttings.
2. Operations of the Leewood Water Management Facility (WMF) including:
  - a. Transport of chemicals to the WMF
  - b. Pipelines transporting produced water to WMF
  - c. Produced water treatment
  - d. Waste management and disposal.
3. Beneficial reuse of treated produced water from the WMF including:
  - a. Irrigation and stock watering
  - b. Drilling and construction
  - c. Dust suppression
  - d. Managed release to Bohena Creek under suitable flow conditions.

**Figure 5-2** through **Figure 5-4** present the specific release mechanisms for each of the lifecycle phases and the potentially affected environment. The figures also present potential exposure cohorts and ecological receptor groups likely to be in contact with the impacted media. Potential exposures are presented by media which include soils, surface water and groundwater; as Bohena Creek is adjacent to the WMF and is a receiving body for treated produced water, it is identified separately so as to distinguish it from other surface bodies that could be potentially impacted by chemicals not associated with the WMF.

Exposures are categorised as complete (identified as “C”) in that a source, a migration pathway, a mechanism for exposure and a potential receptor are present, or the exposure pathway is considered as incomplete (IC) because one of the four elements of the complete exposure pathway are not present. Exposure pathways that have an insignificant or low probability (I/LP) to be complete are exposure routes where the potential risks are limited due to attenuating, fate and transport mechanisms, infrequent exposure occurrence, and minimal projected chemical concentrations at the point of exposure. Exposures classified accordingly to the above scheme are presented in

**Figure 5-2** through **Figure 5-4** for all potentially affected media to demonstrate completeness of assessment of all potential complete exposure pathways and receptors.

	Lifecycle Primary Source	DRILLING PROCESS							
	Modes of Release	Transport of Chemicals to Well Lease		Drilling and Completion Operations		Treatment, Recycling, Disposal and Beneficial Reuse		Transport of Recovered Drilling Fluids	
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Surface Water	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
SOILS									
Human Receptors	Worker	C	6.4.1	C	6.4.1	C	8.1.2	C	6.4.1
	First Responder	C	6.4.1	IC	5.3.4.2	IC	5.3.4.3	C	6.4.1
	Agricultural Worker or Resident	I/LP	6.4.1	IC	5.3.4.2	I/LP	8.1.2	I/LP	5.3.4.4
	Recreational	I/LP	5.3.4.1	IC	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.3
	Trespasser	I/LP	6.4.1	I/LP	8.1.1	I/LP	8.1.1	I/LP	5.3.4.4
Ecological Receptors	Terrestrial flora	I/LP	6.4.1	IC	5.3.4.2	I/LP	6.4.2.3	I/LP	5.3.4.4
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	6.4.1	I/LP	8.1.1	I/LP	8.1.1	I/LP	5.3.4.4
	Aquatic flora	I/LP	5.3.4.1	IC	5.3.4.2	IC	5.3.4.3	I/LP	5.3.4.4
	Aquatic fauna	I/LP	5.3.4.1	IC	5.3.4.2	IC	5.3.4.3	I/LP	5.3.4.4
SURFACE WATER									
Human Receptors	Worker	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
	First Responder	I/LP	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	I/LP	5.3.4.4
	Agricultural Worker or Resident	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
	Recreational	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
	Trespasser	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
Ecological Receptors	Terrestrial flora	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4



	Lifecycle Primary Source	DRILLING PROCESS							
	Modes of Release	Transport of Chemicals to Well Lease		Drilling and Completion Operations		Treatment, Recycling, Disposal and Beneficial Reuse		Transport of Recovered Drilling Fluids	
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Surface Water	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
	Aquatic flora	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
	Aquatic fauna	I/LP	5.4.3.1	I/LP	5.3.4.2	I/LP	5.3.4.3	I/LP	5.3.4.4
GROUNDWATER									
Human Receptors	Worker	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	First Responder	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Agricultural Worker or Resident	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Recreational	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Trespasser	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
Ecological Receptors	Terrestrial flora	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Terrestrial fauna (e.g., livestock, wildlife)	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Aquatic flora	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4
	Aquatic fauna	IC	5.4.3.1	IC	5.3.4.2	IC	5.3.4.3	IC	5.3.4.4

**NOTE**

C	Complete exposure pathway
IC	Incomplete exposure pathway
I/LP	Insignificant / Low Probability Exposure Pathway

**Figure 5-2: Conceptual Site Exposure Model for Drilling Process and the Use of Drilling Fluids**

	Lifecycle Primary Source	LEEWOOD WMF							
	Modes of Release	Transport of Chemicals to WMF	Produced Water Pipeline to WMF			Produced Water & Brine Treatment at WMF	Waste Mgmt. and Disposal		
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	Yes		Yes		Yes		Yes	
	Surface Water (exc. Bohena Creek)	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
SOILS									
Human Receptors	Worker	C	6.4.1	C	6.4.1	C	6.4.1	C	6.4.1
	First Responder	C	6.4.1	C	6.4.1	C	6.4.1	IC	5.3.5.6
	Agricultural Worker or Resident	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Recreational	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Trespasser	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
Ecological Receptors	Terrestrial flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic fauna	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
BOHENA CREEK									
Human Receptors	Worker	I/LP	5.3.4.4	C	6.4.1	C	6.4.1	C	6.4.1
	First Responder	I/LP	5.3.4.4	C	6.4.1	IC	5.3.5.6	IC	5.3.5.6

	Lifecycle Primary Source	LEEWOOD WMF							
	Modes of Release	Transport of Chemicals to WMF	Produced Water Pipeline to WMF			Produced Water & Brine Treatment at WMF	Waste Mgmt. and Disposal		
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	Yes		Yes		Yes		Yes	
	Surface Water (exc. Bohena Creek)	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
Ecological Receptors	Agricultural Worker or Resident	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Recreational	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Trespasser	I/LP	5.3.4.4	I/LP	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Terrestrial flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic fauna	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
		SURFACE WATER OTHER THAN BOHENA CREEK							
Human Receptors	Worker	I/LP	5.3.4.4	C	6.4.1	IC	5.3.5.6	IC	5.3.5.6
	First Responder	I/LP	5.3.4.4	C	6.4.1	IC	5.3.5.6	IC	5.3.5.6
	Agricultural Worker or Resident	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Recreational	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Trespasser	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6

	Lifecycle Primary Source	LEEWOOD WMF							
	Modes of Release	Transport of Chemicals to WMF	Produced Water Pipeline to WMF			Produced Water & Brine Treatment at WMF	Waste Mgmt. and Disposal		
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	Yes		Yes		Yes		Yes	
	Surface Water (exc. Bohena Creek)	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
Ecological Receptors	Terrestrial flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic flora	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
	Aquatic fauna	I/LP	5.3.4.4	I/LP	6.4.2.4	IC	5.3.5.6	IC	5.3.5.6
GROUNDWATER									
Human Receptors	Worker	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	First Responder	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Agricultural Worker or Resident	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Recreational	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Trespasser	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
Ecological Receptors	Terrestrial flora	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Terrestrial fauna (e.g., livestock, wildlife)	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6

	Lifecycle Primary Source	LEEWOOD WMF							
	Modes of Release	Transport of Chemicals to WMF	Produced Water Pipeline to WMF			Produced Water & Brine Treatment at WMF	Waste Mgmt. and Disposal		
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	Yes		Yes		Yes		Yes	
	Surface Water (exc. Bohena Creek)	Yes		Yes		Yes		Yes	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
	Aquatic flora	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6
	Aquatic fauna	IC	5.3.4.4	IC	5.3.4.5	IC	5.3.5.6	IC	5.3.5.6

**NOTE**

C	Complete exposure pathway
IC	Incomplete exposure pathway
I/LP	Insignificant / Low Probability Exposure Pathway
NA	Not Applicable

**Figure 5-3: Conceptual Site Exposure Model for the Leewood Water Management Facility**



	Lifecycle Primary Source	REUSE OF TREATED PRODUCED WATER							
	Modes of Release	Irrigation & Stock Watering		Drilling & Construction		Dust suppression		Direct Discharge to Bohena Creek	
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	No		No		No		Yes	
	Surface Water other than Bohena Creek)	Yes		Yes		Yes		No	
	Stock Water	Yes		No		No		No	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
SOILS									
Human Receptors	Worker	IC	5.3.4.7	C	8.1	C	8.1	IC	5.3.4.8
	Agricultural Worker or Resident	I/LP	8.1	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Recreational	I/LP	5.3.4.7	IC	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Trespasser	I/LP	8.1	I/LP	8.1	I/LP	8.1	IC	5.3.4.8
Ecological Receptors	Terrestrial flora	I/LP	5.3.4.7	IC	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Terrestrial fauna (e.g., livestock, wildlife)	C	8.2	IC	5.3.4.7	I/LP	8.2	IC	5.3.4.8
	Aquatic flora	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Aquatic fauna	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
BOHENA CREEK									
Human Receptors	Worker	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	IC	5.3.4.8
	Agricultural Worker or Resident	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
	Recreational	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
	Trespasser	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
Ecological Receptors	Terrestrial flora	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
	Terrestrial fauna (e.g., livestock, wildlife)	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
	Aquatic flora	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6

	Lifecycle Primary Source	REUSE OF TREATED PRODUCED WATER							
	Modes of Release	Irrigation & Stock Watering		Drilling & Construction		Dust suppression		Direct Discharge to Bohena Creek	
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	No		No		No		Yes	
	Surface Water other than Bohena Creek)	Yes		Yes		Yes		No	
	Stock Water	Yes		No		No		No	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
	Aquatic fauna	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.10	I/LP	6.4.2.6
SURFACE WATER OTHER THAN BOHENA CREEK									
Human Receptors	Worker	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Agricultural Worker or Resident	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Recreational	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Trespasser	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
Ecological Receptors	Terrestrial flora	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Terrestrial fauna (e.g., livestock, wildlife)	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Aquatic flora	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
	Aquatic fauna	I/LP	5.3.4.7	I/LP	5.3.4.7	I/LP	5.3.4.7	IC	5.3.4.8
STOCK WATER									
Ecological Receptors	Terrestrial fauna (e.g., livestock, wildlife)	C	8.2	NA	NA	NA	NA	NA	NA
GROUNDWATER									
Human Receptors	Worker	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Agricultural Worker or Resident	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Recreational	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Trespasser	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
Ecological Receptors	Terrestrial flora	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8

	Lifecycle Primary Source	REUSE OF TREATED PRODUCED WATER							
	Modes of Release	Irrigation & Stock Watering		Drilling & Construction		Dust suppression		Direct Discharge to Bohena Creek	
Affected Environment	Soils	Yes		Yes		Yes		Yes	
	Bohena Creek	No		No		No		Yes	
	Surface Water other than Bohena Creek)	Yes		Yes		Yes		No	
	Stock Water	Yes		No		No		No	
	Groundwater	Yes		Yes		Yes		Yes	
		Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>	Pathway	Report <sup>1</sup>
	Terrestrial fauna (e.g., livestock, wildlife)	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Aquatic flora	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8
	Aquatic fauna	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.7	IC	5.3.4.8

**NOTE**

C	Complete exposure pathway
IC	Incomplete exposure pathway
I/LP	Insignificant / Low Probability Exposure Pathway
NA	Not Applicable

**Figure 5-4: Conceptual Site Exposure Model for the Reuse of Treated Produced Water**

The following sections identifies the media (soils, surface water and groundwater) potentially affected by the life cycle phases with the potential exposure pathways presented in **Figure 5-2** through **Figure 5-4**.

While groundwater is identified as a potentially affected media, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is insignificant. The potential for effects on groundwater quality is considered low probability (see **Section 5.3.3.2.1**). Given the limited fate and transport that would occur for any surface release, the likelihood of a potential groundwater pathway being complete from a surface water release has a very low probability and any exposures would be insignificant.

#### **5.3.3.1 Transport of Chemicals**

During movement of raw products from the supplier or storage warehouse to well leases, there is the potential for accidents to occur during the transport and transfer of products. Workers involved with loading and offloading activities and transportation may be exposed to the products dependent upon the nature of the accident. If the products are transported in enclosed containers, workers would not routinely have potential exposures to the products. However, if the workers fill tanks or containers at either the supplier or storage warehouse or upon delivery at the well lease, there is the potential for occupational exposure to occur. In addition to employees handling the products, exposures have the potential to occur as a result of accidental release during transit (i.e., traffic accident or failure of containment equipment). Under such circumstances, exposures may occur to workers responsible for transport and to emergency first responders on or adjacent to the transportation route.

Should an accident occur that results in the release of products to the environment, chemicals may contact soils at the point of release, or potentially flow towards surface water bodies in the vicinity of a release.

#### **5.3.3.2 Drilling and Completion Operations**

As noted in **Section 2.1**, the Project Area comprises a combination of State Forest and agricultural lands with surface water resources (i.e. creek) and ecological resources (livestock and native flora and fauna). Therefore, potential receptors could include, recreational users of the forest, landholders (including agricultural workers), livestock and native flora and fauna. In addition, a trespasser may gain entry despite perimeter fencing.

Given the occupational nature of the well lease activities, workers involved with well lease operations could be exposed to the chemicals in products through these various activities. Raw products and chemicals would be stored in tanks or containers on the well lease. Blending would occur in an enclosed system at the surface and then drilling fluid is pumped down the well. Chemicals remain on-site for a short period of time (well site establishment would take approximately 14 days and drilling would take approximately 10-30 days to complete), limiting the potential time for workers or the environment to become exposed to raw products.

Whilst the likelihood of a failure of the tanks or storage containers as well as secondary containment systems (bunds) is low, there is the potential for a failure of equipment that would result in the release of products to the well lease, and these products may migrate off the lease to the surrounding environment, including creeks proximal to the well lease (though the well lease is specifically designed to contain all activities to the well pad). In the event of a release to the surrounding environment, ecological receptors may be exposed.

At the completion of the drilling and following workover and establishment of surface infrastructure the well pad will be fenced to preclude access by the public, livestock and large native fauna. Trespassers and small fauna and avian species may still access the well pad sites.

During routine operations, there is the potential for occupational exposure from operational activities such as extraction of water using pumps and sucker trucks or maintenance activities. Normal occupational health and safety measures are expected to limit the exposure of workers to fluids and sediments stored in storages. The follow section presents an evaluation of the fate and transport mechanisms for the potential groundwater exposure pathway to be complete, either by introduction of chemicals in the drilling process, or by the release of chemicals to surface soils or surface waters within the Project Area.

#### **5.3.3.2.1 Supplemental Fate and Transport of Drilling Fluid Chemicals in Groundwater**

The potential for a significant drilling fluid loss during drilling is rare, particularly given the volumes used and the management controls in place during drilling. However, fate and transport modelling was conducted for a scenario where drilling fluids were lost into the formation as a conservative ‘worst’ case scenario to assess the potential for migration of drilling fluid chemicals in groundwater and the longevity of potential changes in water quality.

A conservative 2-D modelling approach was adopted to assess the fate and transport of key chemical constituents in groundwater and the maximum lateral extent at which exceedances of risk-based criteria could potentially occur. Properties governing groundwater flow and solute transport through the various aquifer systems and target natural gas formations were used in combination with the expected maximum concentrations of key constituents to assess the potential for lateral changes in water quality. To provide a highly conservative assessment it was assumed that drilling fluid loss had occurred across an entire thickness of an aquifer being drilled. The modelling assumptions and results are provided in **Appendix C** and a summary of findings is provided in the sections below.

The modelling was conducted using just dilution as the primary mechanism of decreasing concentrations of sodium and sulfate in groundwater, i.e., no retardation in the formation. Literature sourced half-life values were used for estimating the degradation of organic constituents (methanol, glyoxal, glutaraldehyde and methyl isocyanate). Model outputs were evaluated to assess the magnitude and extent of changes in water quality.

The modelling indicates that under this highly conservative scenario the maximum lateral migration of constituent concentrations that may pose a change in water quality above established criteria is < 70 m in the Alluvials and Pilliga Sandstone units. The greatest lateral migration of constituents above the drinking water screening criteria was for Glutaraldehyde and MITC, which have the lowest criterion values. In accordance with the Field Development Protocol, no project infrastructure would be located within 200 metres of an occupied residence (where potable water bores are most likely to be located) unless a written agreement is in place with the relevant landholder. The use of these chemicals during drilling will not lead to exceedances above ANZECC irrigation and stock watering guideline values in groundwater extracted from water bores.

The potential for releases to groundwater associated with the storage and conveyance of produced water, brine and treated water is considered negligible. The chemicals within the produced water are limited to residuals from the chemicals used in the drilling fluids and if present are at very low concentrations. Further natural mass loss mechanisms (biotic and abiotic decay) during storage and flow from wells not containing residual drilling chemical will reduce constituent concentrations in the produced water with gathering lines and water storage structures to below analytical reporting limits. Chemicals are only added to the water at the Leewood WTP within the plant, with the majority dissociating, degrading or removed by the water treatment system and concentrated in the brine waste stream.



Further, ponds used for the storage of produced water and brine, and gathering and water transfer pipelines, are engineered in a manner that limits the potential for releases to the environment and pipeline pressures are continuously monitored and in the event of unexpected changes in pressure (indicative of a release) operations would be shutdown remotely. This automated monitoring in combination with routine monitoring and inspections will limit the potential time period over which a release may occur.

Beneficial uses of treated water have a limited potential to contain chemicals of concern and are unlikely to lead to infiltration to groundwater. Beneficial uses for dust suppression and construction water are short-term activities and insufficient water volumes will be applied to lead to leaching to groundwater. Similarly, irrigation is not considered to lead to a significant flux to groundwater as activities will be conducted to minimise leaching fractions to deeper soils. On this basis, the potential for impacts to groundwater from chemicals associated with drilling and water treatment in the water gathering and transfer pipelines, ponds and beneficial uses are considered limited.

Accordingly, the potential for impact on ground water quality is considered limited even under a worst-case scenario utilising conservative assumptions. Therefore, whilst potential exposure of sensitive receptors to COPCs in groundwater is considered further in this risk assessment, the potential pathway is considered to be incomplete.

#### **5.3.3.3 Treatment, Recycling, Disposal and Beneficial Reuse of Drill Cuttings**

Management of drill cuttings during rehabilitation would occur on well pads, with materials incorporated into the well pad during rehabilitation as a mix, turn and bury process. The exception to this management practice would be when the drill cuttings contain a high percentage of coal fines. These will be transported off-site for disposal with potential release similar to used drilling fluid transport. In addition, drilling fluids that have been removed will be transported back to the drilling fluid treatment facility so that they can be beneficially reused in future drilling operations, or disposed of at a licensed waste facility.

The residual concentrations of chemicals in the drill cuttings may result in incidental exposure to potential receptors from the areas where these materials have been applied. Workers engaged in the treatment and management of drill cuttings may be exposed to the recovered and recycled residuals, and there is the potential for trespassers, and ecological receptors, to be exposed to the residuals COPCs retained on drill cuttings.

#### **5.3.3.4 Treatment, Recycling, Disposal and Beneficial Reuse of Produced Water**

Potential exposures may occur to workers involved with the treatment of produced water and beneficial reuse of treated water and to receptors exposed to treated water as a result of one of the beneficial reuse scenarios. As described, produced water would be piped from the wellheads to the Leewood WMF for treatment and beneficial reuse for drilling and construction, dust suppression and irrigation and stock watering, with managed release to Bohena Creek under suitable flow conditions.

##### ***5.3.3.4.1 Water Treatment***

After conveyance to the WMF, produced water would be temporarily stored in a pond prior to treatment. Treatment would generate a treated water stream and a brine stream. Following treatment, treated water would be temporarily stored either at the WMF or Off-Site. The WMF will be located at Leewood that currently hosts existing infrastructure established for the earlier exploration and appraisal program. The WMF would be constructed on the Leewood property and therefore there would be minimal affect to environmental habitats.

As the WMF will be a controlled working environment, exposures would be limited to On-Site workers. Trespassers and wildlife or livestock are also infrequent expected exposed receptors.

#### **5.3.3.4.2 Irrigation, Dust Suppression, and Stock Watering**

Beneficial reuses of treated produced water include irrigation, stock watering and dust suppression. These uses are likely to consume the largest volumes of treated water. Treated water used for irrigation or stock watering would most likely be transferred by pipeline to the user with interim storage of up to 200ML on the user(s) property. Up to 9,000 ha of suitable irrigation area has been identified within 20 km of the WMF, with water balance modelling indicating around 500 ha of land would be able to be irrigated with the treated water. Treated water for dust suppression is likely to be transferred by pipeline and/or road tanker to the area which it is used.

#### **5.3.3.4.3 Bohena Creek**

As noted above, releases to Bohena Creek would occur during suitable background flow conditions. Bohena Creek and its tributaries are considered highly ephemeral and only flow during periods of sustained heavy rainfall. Eco Logical (2016) noted that there are no registered bores in the Bohena Creek alluvium, although it does not discount the possibility of unregistered bores that are likely limited to stock watering use only. It also notes that there are no licensed surface water extractions from the Bohena Creek although the creek may be used for the unlicensed extraction of surface water, principally for stock use or fire-fighting.

An Ecological Risk Assessment (ERA) was undertaken to assess the potential for chemicals in treated water released to Bohena Creek to adversely affect aquatic and riparian ecosystems including water and soil processes, flora, and fauna (invertebrates and vertebrates) (Eco Logical 2016). The impact assessment assumes a release criterion when Bohena Creek is flowing above a minimum threshold natural flow ( $\geq 100$  ML/day). Overall potential impacts range from a significance level of “insignificant” to “low”. Eco Logical (2016) noted that the release of treated water is not expected to result in persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the aquatic environments. In addition to ecological receptors, Bohena Creek and the downstream receiving waters are likely to be used for recreational purposes. As releases to Bohena Creek would only occur during flows  $\geq 100$  ML/day, these releases would be significantly diluted and exposures are expected to be insignificant or low probability.

As releases, will only occur during periods when Bohena Creek is flowing ( $\geq 100$  ML/day), treated water is expected to match or exceed current water quality in Bohena Creek and significant dilution is expected, impacts to groundwater are expected to be insignificant.

#### **5.3.4 Potential Receptors and Assessment of Potentially Complete Pathways**

Throughout the life cycle, there is the potential for human and environmental receptors to be exposed to the chemicals and process streams. There is the possibility that susceptible (e.g., elderly or children) and or vulnerable populations are located around the Project Area.

The potential for these environmental receptors to be adversely exposed is considered low due to the extensive and comprehensive analysis in the EIS, and the associated management plans that minimise this potential for exposure where possible (i.e., for occupational exposures or by restrictions on infrastructure development locations). On the well lease, the potential for exposure of sensitive receptors (including MNES) is considered low as the well pads would be cleared of vegetation and would therefore provide limited habitat value. In addition, activities and operation of equipment on the well pad do not make it a setting conducive to incursion of fauna during construction and drilling. Impacts to areas of high ecological value would be avoided or minimised as much as practicable through application of the Field Development Protocol including the micro-siting process.

The chemical risk assessment includes ecological receptors associated with the aquatic and terrestrial ecosystems. The hazard assessment, exposure assessment and risk characterisation assess the potential risks to these receptors based on both qualitative and quantitative methodologies. The qualitative assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna to the chemical. This 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. In addition, a quantitative assessment includes evaluating the potential risks to additional higher trophic level organisms such as terrestrial wildlife (including MNES) and livestock.

A detailed assessment of habitat in the Project Area is presented in **Table 5-4**. The table assesses availability of habitat for ecological receptors in either forested or pasture areas. Well leases and water gathering/transmission lines can be present in either forested or pasture areas. The Leewood WMF and irrigation areas are in pasture areas. On this basis, if there is a likelihood of ecological habitat occurring in either the forested or pasture areas, there is the potential for a complete exposure scenario for that ecological receptor. Therefore, these exposure pathways are then systematically evaluated in the risk assessment process described in **Section 6.0**.

The following sections discuss the potential receptors for each phase of the lifecycle. Potentially complete exposure pathways (C), or exposure pathways that have an insignificant or low probability to be complete (I/LP), for each of the lifecycle phases are presented in **Figure 5-2** through **Figure 5-4**.

As discussed above, exposures are categorised as complete in that a source, a migration pathway, a mechanism for exposure and exposure exists.

**Table 5-4: Assessment of Potential Ecological Receptors for Drilling and Completion Operations**

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2014b)	Habitat (OEH, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
<i>Anseranas semipalmata</i>	Magpie Goose	V	Mar	Still relatively common in the northern Australian tropics, from Fitzroy River in Western Australia across to Rockhampton in Queensland, but disappeared from south-east Australia by 1920 due to drainage and overgrazing of reed swamps used for breeding. Since the 1980s, however, there have been an increasing number of records in central and northern NSW, and vagrants can even follow food sources to south-eastern NSW. This species is known north of the study area, mainly around Narrabri Lake and Wee Waa (OEH, 2014a). It has not been recorded in the study area.	Mainly found in shallow (less than 1-metre-deep) sedge or rush-dominated wetlands; mainly those on floodplains of rivers (Marchant & Higgins, 1993; Simpson & Day, 2010). The species forages in terrestrial as well as aquatic habitats, including grasslands, pastures, wetlands, well-vegetated dams and crops. It roosts in tall vegetation and nests are formed in trees over deep water or on a floating platform of flattened reeds.	Moderate	Potential	Magpie Goose forages in well-structured vegetated wetlands and roosts in vegetation within or adjoining these wetlands. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E, M	An extremely patchy distribution across the inland slopes of south-east Australia between north-eastern Victoria and south-eastern Queensland. Birds are also found in drier coastal woodlands and forests in some years. In NSW, most records are from the Great Dividing Range, mainly on the North-West Plains, North-West and South-West Slopes, Northern Tablelands, Central Tablelands and Southern Tablelands regions; as well as the Central Coast and Hunter Valley regions. Regent Honeyeaters have been recorded sporadically	Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, and riparian forests of <i>Casuarina cunninghamiana</i> (River Oak) (S T Garnett, 1993). The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes. Eucalypts that reliably produce large amounts of nectar occurring in the Pilliga are <i>E. sideroxylon</i> , <i>E. melliodora</i> (Yellow Box) and <i>E. albens</i> (White Box).	High	Potential	Regent Honeyeater forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2014b)	Habitat (OEH, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
				in the Pilliga (in 1991, 1992, 1997 and 2003; OEH 2014a).						
<i>Apus pacificus</i>	Fork-tailed Swift	-	M	A non-breeding visitor to all states and territories of Australia. In NSW, the Fork-tailed Swift is recorded in all regions. Many records occur east of the Great Divide; however, a few populations have been found west of the Great Divide. These are widespread but scattered further west of the line joining Bourke and Dareton. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs (DoE, 2014).	Varied habitat with a possible tendency to more arid areas but also over coasts and urban areas (Simpson & Day, 2010).	High	Known	Fork-tailed Swift forages is an almost exclusive aerial species, foraging aerially up to hundreds of metres above ground. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Ardea alba</i>	Great Egret, White Egret	~	M, Mar	Widespread in Australia. They occur in all states/territories of mainland Australia and in Tasmania. They have also been recorded as vagrants on Lord Howe, Norfolk and Macquarie Islands (DoE 2014a).	Reported in a wide range of wetland habitats including swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; and mangrove swamps (Kushlan & Hancock, 2005; Marchant & Higgins, 1990).	Moderate	Known	Great Egret forages across a wide range of habitats including pasture and agricultural land. As such this species has the potential to interact with drilling fluids or soils within well leases, or water storage ponds.	No	Yes
<i>Ardea ibis</i>	Cattle Egret	~	M, Mar	Widespread and common species in Australia. recorded in the northern portion of the study area (DoE 2014a).	Occur in tropical and temperate grasslands, wooded lands and terrestrial wetlands, and very rarely in arid and semi-arid regions. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora.	Moderate	Known	Cattle Egret forages across a wide range of habitats including pasture and agricultural land. As such this species has the potential to interact with drilling fluids or soils within well leases, or water storage ponds.	No	Yes



Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEI, 2014b)	Habitat (OEI, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1	E	Widespread but uncommon over south-eastern Australia. In NSW, they may be found over most of the state except for the far north-west.	Tussock and hummock grasslands, preferring the former to the latter. It also occurs in low shrublands and low open grassy woodlands, and is occasionally seen in pastoral and cropping country, golf courses and near dams.	Low	Potential	Australasian Bittern forages in well-structured vegetated wetlands and roosts in vegetation within or adjoining these wetlands. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper		M, Mar	Spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Marchant & Higgins, 1993).	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgeland and other ephemeral wetlands, but leave when they dry (Higgins & Davies, 1996).	Low	Potential	Sharp-tailed Sandpiper forages in wetlands with inundated or emergent vegetation. As this species has been previously observed within saltworks, it has the potential to interact with drilling fluids or soils within well leases, or water storage ponds.	No	Yes
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes, including the Southern Pilliga forest area.	Recorded in a variety of habitats, including wet and dry sclerophyll forests, Cyprus Pine dominated forest, woodland, sub-alpine woodland, edges of rainforests and sandstone outcrop country (DoE, 2014). This species roosts in caves, rock overhangs and disused mine shafts and as such is usually associated with rock outcrops and cliff faces (Churchill, 2008). It also possibly roosts in the hollows of trees (Duncan, Baker, & Montgomery, 1999).	High	Potential	Large-eared Pied Bat roosts in caves and forages amongst the mid and canopy layers of forest. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Now found on the east coast of NSW, Tasmania, eastern	Inhabits a range of environments including rainforest, open forest,	Moderate	Potential	Spotted-tailed Quoll is a carnivorous mammal	No	No

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEI, 2014b)	Habitat (OEI, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
				Victoria and north-eastern Queensland.	woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are found in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces.			which forages on a wide range of species across its home range and lives in dens in rocky areas, logs or trees. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.		
<i>Gallinago hardwickii</i>	Latham's Snipe, Japanese Snipe	~	M, Mar	Recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. The range extends inland over the eastern tablelands in south-eastern Queensland (and occasionally from Rockhampton in the north), and to west of the Great Dividing Range in New South Wales (DoE, 2014).	Occurs in permanent and ephemeral wetlands up to 2000 m above sea-level, usually inhabiting open, freshwater wetlands with low, dense vegetation such as swamps, flooded grasslands or heathlands, around bogs and other water bodies. This species can also occur in habitats with saline or brackish water and in modified or artificial habitats.	Low	Potential	Latham's Snipe forages in well structured vegetated wetlands. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	~	M, Mar	Distributed along the coastline of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The inland limits of the species are most restricted in south-central and south-western Australia, where it is confined to a narrow band along the coast (DoE, 2014).	Areas of large open water bodies. It has been recorded at or in the vicinity of freshwater swamps, rivers, lakes, reservoirs, billabongs, saltmarsh and sewage ponds, as well as coastal waters. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, forest and even urban areas.	Moderate	Known	White-bellied Sea-Eagle forages across large open water bodies where suitable prey occurs. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Hirundapus caudacutus</i>	White-throated Needletail	-	M, Mar	Found throughout eastern and south-eastern Australia. In eastern NSW, it is found to extend inland to the western slopes of the Great Divide and occasionally to the adjacent inland plains (DoE, 2014).	In Australia, this species is almost exclusively aerial and found over most types of habitat (DoE, 2014). No breeding habitat in southern hemisphere.	High	Known	White-throated Needletail is an almost exclusive aerial species, foraging aerially. As such this species is unlikely to interact with drilling	No	No

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2014b)	Habitat (OEH, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
								fluids or soils within well leases, or water storage ponds.		
<i>Lathamus discolor</i>	Swift Parrot	E1	E, Mar	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes.	On the mainland, they occur in areas where eucalypts are flowering profusely or where there is abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as <i>Eucalyptus robusta</i> , <i>Corymbia maculata</i> , <i>C. gummifera</i> (Red Bloodwood), <i>E. sideroxylon</i> (Mugga Ironbark) and <i>E. albens</i> . Commonly used lerp infested trees include Inland Grey Box <i>E. microcarpa</i> , Grey Box <i>E. moluccana</i> and Blackbutt <i>E. pilularis</i> .	High	Potential	Swift Parrot forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Merops ornatus</i>	Rainbow Bee-eater	~	M, Mar	Distributed across much of mainland Australia, and occurs on several near-shore islands. It is not found in Tasmania, and is thinly distributed in the most arid regions of central and Western Australia (DoE, 2014).	Occurs in open country, chiefly at suitable breeding places in areas of sandy or loamy soil: sand-ridges, riverbanks, road-cuttings, sand-pits, occasionally coastal cliffs.	High	Known	Rainbow Bee-eater forages in woodland and forest within the mid and canopy layers, but will occasionally take earthworms. The Rainbow Bee-eater breed in burrows in the ground. As such this species has the potential to interact with drilling fluids or soils within well leases, or water storage ponds.	Yes	Yes
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	~	M, Mar	In NSW, they are widespread on and east of the Great Divide and sparsely scattered on the western slopes, with very occasional records on the western plains (DoE, 2014).	Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (DoE, 2014).	High	Known	Satin Flycatcher forages in woodland and forest within the mid and canopy layers. As such this species is unlikely to interact with drilling fluids or soils within	No	No

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEI, 2014b)	Habitat (OEI, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
								well leases, or water storage ponds.		
<i>Nyctophilus corbeni</i> (syn. <i>Nyctophilus timoriensis</i> (South-eastern form))	South-eastern Long Eared Bat / Corben's Long-eared Bat	V	V	The distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species.	Inhabits a variety of vegetation types including mallee, bullock and box eucalypt dominated communities. However, it is more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices and under loose bark.	High	Known	South-eastern Long Eared Bat forages in woodland and forest within the mid and canopy layers, but occasionally taking prey from the ground. As such this species has potential to interact with drilling fluids or soils within well leases, or water storage ponds.	Yes	No
<i>Phascolarctos cinereus</i>	Koala	V	V	Fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW, it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. A population is known in the Pilliga, predominantly in the west.	Associated with both wet and dry Eucalypt forest and woodland with a canopy cover of approximately 10 – 70% (Reed, Lunney, & Walker, 1990), that contains acceptable eucalypt food trees. Primary feed tree in study area: <i>Eucalyptus camaldulensis</i> (River Red Gum). Secondary food trees in the study area: <i>E. albens</i> (White Box), <i>E. blakelyi</i> (Blakely's red gum), <i>E. chloroclada</i> (Dirty gum), <i>E. conica</i> (Fuzzy Box), <i>E. dealbata</i> (Tumbledown Gum), <i>E. dwyeri</i> (Dwyer's red gum), <i>E. macrocarpa</i> (Western Grey Box), <i>E. meliodora</i> (Yellow Box), <i>E. pilligaensis</i> (Pilliga box) and <i>E. populnea</i> (Poplar Box). Supplementary food tree in study area: <i>Eucalyptus macrorhyncha</i> (Red Stringybark), <i>Callitris glaucophylla</i> (White Cypress Pine) is common, and is listed as a tree species used for daytime shelter.	High	Known	Koala forages in woodland and forest within canopy layer. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	Found throughout eastern inland NSW. On the South-western	Inhabits box-gum woodland, Box-Cypress-pine and Boree Woodlands	Moderate	Potential	Superb Parrot forages in woodland and	No	No

Scientific name	Common name	TSC Act	EPBC Act	Distribution (OEH, 2014b)	Habitat (OEH, 2014b)	Availability of habitat in the study area	Likelihood of occurrence in the study area	Assessment of likely interaction with drilling fluids or soils at well leases, or storage ponds	Forest areas	Pasture areas
				Slopes their core breeding area is roughly bounded by Cowra and Yass in the east, and Grenfell, Cootamundra and Coolac in the west. Birds breeding in this region are mainly absent during winter, when they migrate north to the region of the upper Namoi and Gwydir Rivers. The other main breeding sites are in the Riverina along the corridors of the Murray, Edward and Murrumbidgee Rivers where birds are present all year round.	and River Red Gum Forest. Populations that migrate to the Namoi region in winter forage and roost in forests and woodlands dominated by <i>Callitris glaucophylla</i> (White Cypress Pine) and Box-gum. Previous sightings of Superb Parrot in the Pilliga Forest have been associated with drainage lines, foraging in Eucalypt canopy and grassland and flying through the landscape (OEH, 2014a).			forest within the mid and canopy layers. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.		
<i>Pseudomys pilligaensis</i>	Pilliga Mouse	V	V	Distribution restricted to the Pilliga region of New South Wales. Fox and Briscoe first described this species in 1980 (Fox & Briscoe, 1980). There is still some conjecture on its specific status.	Occurs in Pilliga Scrub on an isolated area of low-nutrient deep sand. They seem to prefer areas with a high species diversity and dense low shrub layer.	High	Known	Pilliga Mouse forages on the ground and lives in burrows in sandy soil. As such this species has potential to interact with drilling fluids or soils within well leases, or water storage ponds.	Yes	No
<i>Rostratula australis</i> (syn. <i>Rostratula benghalensis australis</i> )	Australian Painted Snipe	E1	E, Mar	Recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia.	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low	Potential	Australian Painted Snipe forages and nests in well-structured vegetated wetlands. As such this species is unlikely to interact with drilling fluids or soils within well leases, or water storage ponds.	No	No

#### **5.3.4.1 Transport of Chemicals to Well Leases**

Workers involved with loading and offloading activities may be exposed to the products during the use and transfer of products. If the products are transported in enclosed containers, the workers would not be potentially exposed to the products; however, if the workers fill tanks or containers at either the supplier or storage warehouse or upon delivery at the well lease, there is the potential for occupational exposure to chemicals to occur.

In addition to workers handling the products, exposures have the potential to occur as a result of accidents during transit (i.e., traffic accident or failure of containment equipment). Under such circumstances, exposures may occur to workers responsible for transport and to emergency first responders, as well as terrestrial and aquatic ecological receptors. Should an accident occur that results in the release of products to the environment, chemicals may come into contact with soils in proximity to the point of release, or create temporary liquid pools or flow into nearby surface water bodies. There is insignificant and low potential for exposure to agricultural workers/residents, recreational and trespasser receptors because the scope of such exposure is limited to the size of the spill and the speed at which releases will be addressed by Santos (spill response procedures and equipment have already been established and are working in the Project Area). In addition, as noted previously in **Section 5.3.3.2.1**, the potential for spills and releases to affect groundwater is considered incomplete.

Potential receptors identified for the transport phase of the life cycle of the transport of chemicals to the well lease include:

- Workers transporting products in contact with soils or liquids/water
- First responders responding to an accident in contact with soils or liquids/water
- Terrestrial and aquatic ecological receptors in contact with soils or liquids/water

#### **5.3.4.2 Drilling and Completion Operations**

Given the occupational nature of the well lease activities, workers involved with well lease operations could be exposed to the chemicals through various activities, and emergency first responders may be exposed if a spill or release occurs. Whilst perimeter fencing will limit recreational and agricultural worker access to the well lease, there is the potential for trespassers to enter the well lease and potentially be exposed to recovered products managed in lined pits or tanks. In addition to trespassers, wildlife or livestock (cattle) may access the lease through fencing or unsecured gates. Exposures to trespassers, livestock and wildlife is expected to be limited as fencing and operations hinder likelihood and duration.

During the course of operations, there is the potential for an accidental release of products at the well lease to migrate off the lease to the surrounding environment, including surface water bodies proximal to the well lease. There is insignificant and low potential for exposure to agricultural workers/residents, recreational and trespasser receptors because the scope of such exposure is limited to the size of the spill and the speed at which releases will be addressed. In addition, as noted previously in **Section 5.3.3.2.1**, the potential for spills and releases to affect groundwater is considered incomplete.

Potential receptors identified for the pad operations phase of the life cycle of products utilised in well construction and completion include:

- Workers and first responders in contact with chemicals
- Trespassers in contact with drilling fluids
- Terrestrial wildlife or livestock that have limited access into fenced areas in contact with drilling fluids
- Aquatic receptors in contact with surface water in the event of an accidental release moving to surface water.



### **5.3.4.3 Management of Drill Cuttings**

There is the potential for workers to be exposed to residual chemicals in the drill cuttings during the mix, turn, and burial on these materials on the well lease. The rehabilitated well lease will be fenced for a period of 20 years post rehabilitation; however, as a conservative measure, the potential for agricultural workers to be exposed to constituents retained on the cuttings will be evaluated in the event of the land is given back to landholders prior to the end of the 20-year period. Therefore, agricultural workers, trespassers and terrestrial ecological receptors have the potential to come into contact with drill cuttings used in rehabilitation of the well pad using the mix, turn and bury strategy. As the well pads, will be fenced, incidental contact by recreational users is considered an incomplete exposure pathway.

The potential for migration of chemicals within the drilling cuttings to adjacent surface water bodies is considered incomplete due to the minimal liquids in the drill cuttings and low moisture content of the soils. In addition, as noted previously in **Section 5.3.3.2.1**, the potential for the drill cuttings application to affect groundwater is considered incomplete.

The potential receptors associated with the treatment and beneficial reuse include:

- Workers involved in beneficial reuse drill cuttings
- Agricultural worker and trespassers who come into contact with surface soils within a rehabilitated well pad
- Terrestrial ecological receptors in contact with surface soils within a rehabilitated well pad.

The transport of drill cuttings containing high percentage of coal fines off-site for disposal may result in potential release similar to the transport of used drilling fluid.

Potential receptors identified for the transport phase of the life cycle of the transport of drill cuttings with high coal fines to off-site disposal facilities include:

- First responders responding to an accident in contact with soils or liquids/water
- Terrestrial and aquatic ecological receptors in contact with soils or liquids/water.

### **5.3.4.4 Transport of Chemicals to Leewood WMF**

The WMF utilises a number of bulk chemicals for produced water treatment and therefore, similar to the transport of products to the well head, potential receptors are workers, first responders, and, terrestrial and aquatic ecological receptors. Workers involved with loading and offloading activities may be exposed to the products, dependent upon transfer of products. If the products are transported in enclosed containers, the workers would not have potential exposures to these products. However, if the workers fill tanks or containers at either the supplier or storage warehouse or upon delivery at the WMF, exposure is possible. In addition to workers handling the products, exposures have the potential to occur as a result of accidents during transit (i.e., traffic accident or failure of containment equipment). Should an accident occur that results in the release of products to the environment, chemicals may come into contact with soils in proximity to the point of release, or create temporary liquid pools or flow into nearby surface water bodies. There is insignificant and low potential for exposure to agricultural workers/residents, recreational and trespasser receptors because the scope of such exposure is limited to the size of the spill and the speed at which releases will be addressed. In addition, as noted previously in **Section 5.3.3.2.1**, the potential for spills and releases to affect groundwater is considered incomplete.

Potential receptors identified for the transport phase of the life cycle of the transport of chemicals to the well lease include:

- Workers transporting products in contact with soils or liquids/water
- First responders responding to an accident in contact with soils or liquids/water
- Terrestrial and aquatic ecological receptors in contact with soils or liquids/water.

#### **5.3.4.5 Produced Water Pipelines to WMF**

Produced water is to be collected from each gas well through water gathering lines and would pass through in-field balance tanks, prior to being transferred to the Leewood WMF for treatment and beneficial reuse (EIS Chapter 6). These pipelines would extend throughout the Project Area and have the potential for leaks and releases. Chemicals from leaks or releases may come into contact with soils in proximity to the point of release, or create temporary liquid pools or flow into nearby surface water bodies; therefore, potential receptors are first responders and terrestrial and aquatic ecological receptors. There is insignificant and low potential for exposure to agricultural workers/residents, recreational and trespasser receptors because the scope of such exposure is limited to the size of the spill and the speed at which releases will be addressed. In addition, as noted previously in **Section 5.3.3.2.1**, the potential for spills and releases to affect groundwater is considered incomplete. It should be noted that the drilling chemicals are unlikely to be detectable within the produced water based on the volumes of water produced per well relative to the residual chemicals in the formation.

Potential receptors identified for the pipeline transport of produced water to the WMF include:

- First responders responding to an accident in contact with soils or liquids/water
- Terrestrial and aquatic ecological receptors in contact with soils or liquids/water.

#### **5.3.4.6 Leewood Water Management Facility**

After conveyance to the WMF, produced water would be treated and would generate a treated water stream, a brine stream, and a solids stream. Following treatment, treated water would be temporarily stored either at the WMF or in third party dams off-site prior to reuse. The WMF would be constructed within the existing footprint of Leewood and therefore there would be minimal ecological impact to vegetation and fauna habitats across the Project Area.

As the WMF will be a controlled environment, exposures would be limited to on-site workers. Trespassers, and livestock are unlikely exposure receptors given the security controls and ongoing operations of the facility. Further the activity at the plant and cleared areas around the WMF will limit the potential for the area to be core habitat for ecological receptors. Potential receptors in this area are therefore limited to workers responding to spills, operations, accidents and routine maintenance. As noted previously in **Section 5.3.3.2.1**, the potential for spills and releases to affect groundwater is considered incomplete.

#### **5.3.4.7 Reuse of Treated Water for Irrigation, Dust Suppression, and Stock Watering**

One of the beneficial reuses proposed of treated produced water is for the application to soils for irrigation and dust suppression, and to provide source water to stock tanks and troughs for livestock, with the incidental occasional access by wildlife. Once treated water has been applied to land for irrigation (i.e., agricultural) or dust suppression purposes, it is likely to be integrated and retained in the surface soils. Therefore, the surface soils will be a potential exposure medium for agricultural workers/residents as part of their daily activities, or trespassers and recreational users traversing areas. Additionally, water utilised for irrigation will be applied at rates such that treated water will not runoff to surface water bodies and the irrigated land will be developed such that surface drainage is minimised (BeneTerra, 2015). Therefore, potential exposure for aquatic receptors to treated water utilised for irrigation, dust suppression, and stock water is considered insignificant or low potential. Livestock, wildlife and terrestrial flora and fauna are also expected to be in contact with potentially impacted soils. As noted, the stock water tanks and troughs also could be accessed by wildlife, as well as the intended livestock.

Potential receptors include:

- Livestock and wildlife that come in contact with soils from irrigation or dust suppression, or water for stock watering

- Agricultural workers/residents, recreational users, and trespassers who would have incidental contact with soils where irrigation or dust suppression water has been applied
- Terrestrial flora and fauna that have contact with soils where irrigated or dust suppression water has been applied.

The trespasser is expected to be a similar or more sensitive receptor than a recreator. Therefore, the trespasser will be utilised to evaluate potential exposures to recreators as well as trespassers.

While groundwater is identified as a potentially impacted media, as noted previously in **Section 5.3.3.2.1**, the potential for releases to affect groundwater is considered incomplete. The probability of irrigation water migrating to groundwater is insignificant given the water needs of applied crops.

#### **5.3.4.8 Direct Discharge of Treated Water to Bohena Creek**

Managed release of treated water to Bohena Creek would have the potential to affect surface water within the creek. As Bohena Creek meanders through large areas that are uncontrolled, exposures could potentially occur to downstream agricultural workers and recreational users. As released treated water would become part of the regional surface water resource (i.e., Bohena Creek water quality and flow), ecological resources (livestock and native flora and fauna) are potential receptors.

Potential receptors and pathways include:

- Agricultural workers/residents and recreational users who may have contact with Bohena Creek downstream of the WMF
- Aquatic ecological receptors within Bohena Creek downstream of the WMF
- Livestock and wildlife that may access Bohena Creek surface water.

#### **5.3.5 *Assessment of Complete Exposure Pathways***

The complete pathways discussed in the preceding sections and presented in **Figure 5-2** through **Figure 5-4** will be qualitatively or quantitatively assessed further in the hazard assessment. The COPCs identified as risk drivers will be assessed to determine risk management measures required to minimise or eliminate the potential risks to human health and ecological receptors. As the well leases will be in either forested or pasture areas, **Table 5-4** provides the relative potential for ecological species to be potentially exposed to the chemicals throughout the lifecycle process. The ecological species classified in **Table 5-4** for either the pasture or forested lands (or both) that may be potentially exposed to the chemicals identified in this CEM include:

- Pasture Lands:
  - Great Egret
  - White Egret
  - Cattle Egret
  - Sharp-tailed Sandpiper
  - Rainbow Bee-eater.
- Forested Lands:
  - Sharp-tailed Sandpiper
  - Rainbow Bee-eater
  - South-eastern Long Eared Bat / Corben's Long-eared Bat
  - Pilliga Mouse.

Whilst, the habitat of the Pilliga Mouse is forested lands, the Pilliga Mouse will be utilised as a surrogate species for small mammal exposures in pasture lands. The assessment of these species as potential ecological receptors will be evaluated in the Exposure Assessment based on life history and potential exposure point concentrations (EPCs). In addition, as noted in the above discussions, there is the potential for livestock (e.g., cattle) and wildlife (e.g., kangaroo, dingo) to access the project area, as well as other species. Irrigation utilising treated water will only be conducted on areas where there is

no protected vegetation. A detailed evaluation of irrigation as a beneficial use is provided in the Irrigation General Concept Design (BeneTerra, 2015) detailing methodology (i.e., irrigation rates, specific crops for irrigation) and monitoring plans to ensure potential affects to the environment are minimised.

## 6.0 HAZARD ASSESSMENT

The hazard assessment evaluates the human health and environmental hazard of the chemicals identified in the problem formulation and issue identification step specific to the Project (i.e. drilling and well completion fluids and water treatment) identified previously.

The assessment of hazards is based on a qualitative and quantitative evaluation of the potential risks. The qualitative assessment includes assessing the potential for impact to occur from an exposure to chemicals utilised in well construction and water treatment if such exposure was to occur. These potential exposures are primarily focused on the chemicals used in the drilling process during transportation and drilling preparation activities, as well as transportation of the recycled drilling fluids to other drill sites. The quantitative assessment includes exposure to the chemicals that may occur during activities during the recovery, storage, and treatment and beneficial reuse of a mixture of the chemicals, where operational activities include greater exposure to the environment including direct releases to the environment (e.g., management of drill cuttings on well pad using mix, turn and bury strategy).

The specific steps in the hazard assessment combine the hazard identification in NEPM (2012) and enHealth (2012a). The steps included in the hazard assessment are provided in the following:

- Human health and environmental hazards – the toxicology of the chemicals and the calculation of toxicological endpoints are assessed and calculated in the toxicity assessment. The proprietary nature of the drilling chemicals requires that a rigorous research and analyses are conducted to prepare the risk assessment dossiers that are used in the hazard assessment. This research and analyses follow the best practice risk assessment methodology defined in the EPBC Act Additional Requirements.
- Persistent, Bioaccumulative and Toxic (PBT) assessment – chemical-specific information is compiled and compared to established Australian and EU Registration, Evaluation, Authorisation and Restriction of Chemical Substances (REACH) criteria to provide an assessment of the overall hazard presented by the chemical utilising databases established by OECD. This relative ranking enables a comparison of chemicals based on the PBT findings and may facilitate the evaluation of alternative chemicals for use in a fluid system.
- Soil and water guidelines – the development of the guidelines utilises the human health and environmental hazard information compiled in the risk assessment dossiers to calculate risk-based criteria for assessing human health and ecological exposure to the chemicals. The risk-based criteria are conservative guidelines to assess the degree of hazard of the chemical when released into the environment at a point of exposure for a human or ecological receptor.
- Qualitative and quantitative assessment – activities that may result in accidental exposures to human and ecological receptors are assessed qualitatively and focus on the vendor chemicals. This assessment provides information to be used as a complement to the PBT assessment to provide a summary of human and ecological hazards that may occur from exposure to the chemicals; typically, this information informs first responders and health and safety personnel to the hazards that may be present when an accidental exposure occurs. In addition, some activities that may result in exposure are quantitatively evaluated in the hazard assessment by comparing concentrations of the chemicals in the environment resulting from these activities to the risk-based criteria. This screening enables a quick determination of the magnitude and severity of the potential exposure, and whether it warrants additional assessment in the detailed exposure assessment and risk characterization phases of the chemical risk assessment.

In the following sections, the qualitative and quantitative toxicological information to assess the potential risks is presented. The drilling fluid chemicals are assessed either qualitatively based on appropriate safety, handling, and transportation guidance, or quantitatively based on applicable screening standards to evaluate the potential risks throughout the lifecycle process.

## 6.1 Toxicity Assessment

Risk assessment dossiers were prepared for the chemicals contained in the products used in the basic mud formulation for drilling and well completion (see **Table 5-2**) and the water treatment processes (see **Table 5-3**). The chemicals contained within the primary drilling fluids and water treatment processes used in the Project activities discussed in Problem Formulation and Issue Identification will be carried through the qualitative and quantitative risk assessment process. In addition to the primary drilling fluids, two additional mud formulations (loss control muds, LCM Pill 1 and LCM Pill 2) may also be utilised during the drilling process. The purpose of the LCM is to plug fractures encountered in the formation during drilling to prevent loss of drilling fluids into the fractures. However, as discussed in **Section 6.3.2**, the LCM drilling muds are considered insignificant relative to the volume of drilling fluids used as the primary mud systems used to complete the drilling process. They will be addressed in the qualitative risk assessment process.

In general, the risk assessment dossiers include chemical identification, physical and chemical properties, environmental fate properties, human health and environmental hazard assessments, derivation of non-cancer and cancer screening levels, a PBT assessment, classification, labelling, handling and safety information. Additionally, treatment and disposal management, as well as regulatory status, are presented in the dossiers.

In addition to the guidance noted in **Section 5.0**, the data sources for the risk assessment dossiers included the Inventory Multi-Tiered Assessment and Prioritisation (IMAP) framework through NICNAS. The risk assessment dossiers were prepared in accordance with the Hazard Assessment – Gathering and Evaluating Existing Information and Assessing the Hazards and Exposure Assessment – Environmental Fate and Pathways Steps in OECD (OECD, 2014). The EPA-Expo-Box (USEPA, 2016a) does not have a specific toxicity or hazard assessment tool, as it deals primarily with the exposure assessment process in the risk assessment framework. **Appendix D** presents the risk assessment dossiers specific to the Project drilling and completion fluids and the water treatment process. **Table D-1** provides a salient summary of each of the drilling fluid and well completion chemicals in the dossiers; **Table D-2** presents a summary of each of the water treatment chemicals in the dossiers. These dossiers will be updated as new or revised toxicological, regulatory, and physio-chemical information becomes available.

The primary source of information for physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data has been obtained from databases linked to the OECD eChemPortal ([www.echemportal.org](http://www.echemportal.org)), which is part of the OECD Environmental Risk Assessment toolkit. In addition, data has been obtained from the following sources:

- Chemical and physical properties data:
  - TOXNET
  - SDSs
  - Modelled data from USEPA (2011a) EPI SUITE™ including full outputs.
- Environmental and human health drinking water guidelines:
  - Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection of aquatic ecosystems and stock watering (ANZECC and ARMCANZ, 2000)
  - Australian Drinking Water Guidelines (NHMRC and NRMCC, 2011, Update 2016)
  - World Health Organisation (WHO, 2006) Guidelines for Drinking-water Quality (Third Edition)
  - USEPA National Recommended Water Quality Criteria (2009) for protection of aquatic life and human health.
  - Drinking-water Standards for New Zealand 2005 (Revised 2008, Ministry of Health).
- Human health toxicity data:
  - U.S. Toxic Substances Control Act Test Submissions 2.0 (TSCATS 2.0) database <https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0>



- Literature search (using PubMed and ToxLine)
- Internet search (i.e., Google Scholar).
- Ecological toxicological and environmental fate and transport data:
  - NEPM (2013)
  - USEPA ECOTOX database
  - Canada Screening Assessment Reports
  - USEPA TSCATS database
  - Google Search (for regulatory agency documents such as USEPA RED (Re-registration Eligibility Decision) documents for pesticide applications)
  - Comprehensive literature searches of peer-review journals
  - QSAR modelling (i.e., EPI Suite and PetroTox).

The ecological toxicological data was based on guidance provided by the European Chemicals Bureau (ECB) (2003) and by National Environmental Protection Council (NEPM, 2013). Through this process, soil and water guideline values protective of ecological receptors was used as indicators of toxicity and therefore hazards, if they are based on toxicological data. Databases and guidance that were searched included:

- NEPM (2013)
- Risk Assessment Information System (RAIS)
- USEPA Eco Soil Screening Levels (2011b)
- National Institute for Public Health and Environmental Protection (RIVM) Target and Intervention levels (1994)
- Soil guidelines (such as predicted no effect concentration [PNEC] values) derived as part of a chemical assessment (e.g., International Uniform Chemical Information Database [IUCLID])
- Concise International Chemical Assessment Document [CICAD]).

To ensure the reliability of the data, physico-chemical properties, environmental fate and transport mechanisms, and ecotoxicity and toxicology were evaluated for data quality to address data quality requirements (i.e., reliability) using the Klimisch scoring system (Klimisch et al., 1997). For in vitro studies and studies that do not have internationally accepted guidelines, the software tool ToxRTool (Schneider et al., 2009) has been used.

### **6.1.1 Human Health Toxicity Assessment**

For human receptors, included in the risk assessment dossiers is a toxicity assessment to determine the relationship between the dose of a COPC taken into the body, and the probability that an adverse effect will result from that dose. Quantitative estimates of the potency of COPCs include two sets of toxicity values, one for genotoxic carcinogens and one for other non-genotoxic carcinogens and non-carcinogenic effects. For the assessment of genotoxic carcinogenic effects, a non-threshold toxicological mechanism was assumed and there was no level of exposure that does not pose a probability that an adverse effect will result from that dose. For toxicity criteria for non-genotoxic carcinogens and non-carcinogenic effects, it was assumed that there is a threshold effects level, below which adverse health effects are not expected to occur.

The assessment of carcinogenic effects was conducted following the review of the available data (utilising a weight of evidence approach) in relation to genotoxicity. Genotoxic carcinogens were evaluated on the basis of a non-threshold dose-response relationship, quantified through the use of a unit reference factor (URF) for inhalation exposures and/or slope factor (SF) for oral and dermal exposures. The URF (expressed as 1/microgram per cubic metre [ $\mu\text{g}/\text{m}^3$ ]) or SFs (expressed as 1/milligram per kilogram per day [ $\text{mg}/\text{kg}/\text{day}$ ]) evaluated were upper-bound estimates of the excess cancer risk due to continuous exposure to a COPC averaged throughout the course of a 70-year lifetime. The referenced bases of URF and SFs were data from lifetime animal bioassays, although human data are used when available.

Where carcinogenic effects were associated with a non-genotoxic mode of action (or where the insufficient weight of evidence was available to support a genotoxic mode of action), these effects were characterised on the basis of a threshold. Other non-carcinogenic effects, such as organ damage, endocrine inhibitors, or reproductive effects, were evaluated on the basis of a threshold. The risk assessment dossiers provide the chemical-specific mode of action and non-carcinogenic effect used in the assessment of toxicology of each of the drilling chemicals. These threshold values were defined as reference concentrations (RfC) or tolerable concentrations (TCs) for inhalation exposures and reference doses (RfDs) or acceptable daily intakes (ADIs)/tolerable daily intakes (TDIs) for oral and dermal exposures. These threshold values may be available for different durations of exposure ranging from acute to chronic exposures), with the focus of the assessment presented in this report on chronic exposures. A chronic RfC/TC or RfD/ADI/TDI was defined as the concentration or intake that all members of the public may be exposed to every day for a lifetime with no adverse health effects.

The threshold value was commonly derived from a point of departure (POD), defined as the lowest concentration that is associated with no (or the lowest) observed adverse health effects (no observed adverse effect level [NOAEL] or lowest observed adverse effect level [LOAEL] or a benchmark dose), determined from experimental animal studies (most common) or human studies (less common). The POD was then divided by a safety/uncertainty factor to obtain the threshold toxicity value. Uncertainty factors were typically factors of 10 that account for interspecies variation and sensitive human populations. Additional factors of 10 were included in the uncertainty factor if the RfC is based on the LOAEL instead of the NOAEL, or an experiment that included a less-than-lifetime exposure.

The assessment of toxicity of the COPCs was used to develop initial screening criteria for human health exposure scenarios and is presented in **Appendix D**.

No carcinogenic compounds are present in the drilling fluids injected into the subsurface and as a result, only non-carcinogenic oral RfDs were calculated. A detailed discussion of the derivation of the oral reference dose and drinking water guideline values is presented in this appendix. A summary of the derivation of oral RFD and Drinking Water Guideline Values for the COPCs identified for the drilling system is presented on **Tables 1a** and **1b**. The summary for the COPCs identified for the water treatment process is presented on **Tables 1c** and **1d**.

### **6.1.2 Characterisation of Ecological Effects**

To evaluate the assessment endpoints and ecological values, measures of effects (or measurement endpoints) were developed that represent the COPC exposure levels that are conservative thresholds for adverse ecological effects. The Toxicity reference values (TRVs) were selected as measurement endpoints (conservative thresholds) for the evaluation of potential risks to aquatic and terrestrial ecological receptors that were potentially exposed to the chemicals in the drilling fluids. An effects evaluation was not conducted on the potential ecological effects of landscape maintenance activities, such as mowing, vehicle travel or agricultural activities. Physical stressors that are unrelated to the COPCs in the drilling fluid water are not the focus of this assessment. The adverse ecological effects framework is consistent with the OECD and the environmental exposure assessment methods Exposure Assessment – Environmental Exposure Assessment Strategies for Existing Industrial Chemicals in Member Countries and Manual for the Assessment of Chemicals (Chapter 6) steps in OECD (OECD, 2014), as well as exposure assessments and potential hazards identified by OECD (1989) for extrapolating ecological effects from basic toxicological data.

The TRVs are based on COPC levels that imply no adverse effects or levels that represent the lowest concentration at which adverse effects may occur. The ecological risk assessment used two types of TRVs. The first toxicity reference value (TRV) is a concentration-based TRV to evaluate the concentration of the selected COPC in the surface water and direct exposure by the aquatic ecological receptor. The second TRV is a dose-based TRV to evaluate the intake dose of the selected COPC from exposure to surface water by ingestion. These TRVs were selected based on the evaluation of the

concentrations of COPCs in the drilling fluids and permeate that would be representative of releases to environmental media and the nature of the exposure to the ecological receptors. For example, the potential risks to aquatic ecological receptors exposed to concentrations of the COPCs spilled into a surface water resource was assessed by comparing the exposure point concentration in the surface water to a concentration-based TRV (e.g.,  $PNEC_{water}$ ). Alternatively, if the potential exposure was based on a terrestrial ecological receptor drinking from a source of drilling fluid COPCs (e.g., an engineered fluid storage pits), then the potential risks were assessed based on a dose-based TRV.

The sources for ecotoxicological information used in the ecological risk assessment followed ecological risk assessment guidance. Where available, guidance specific to NSW utilised; if specific NSW guidance not available, a hierarchy of sources was used to compile the TRV information as follows:

- Department of Environmental and Resource Management. Approval of Coal Seam Gas Water for Beneficial Use. Environmental Protection (Waste Management) Regulation 2000. Queensland Government. March 2010.
- Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) guidelines for fresh and marine water quality.
- Western Australia (WA) Department of Environment and Conservation. Assessment Levels for Soil, Sediment and Water. February 2010. Contaminated Site Management Series.
- International Guidance including USEPA, American Petroleum Institute and Oak Ridge National Laboratory/Risk Assessment Information System (ORNL/RAIS).

Where possible, existing water quality guidelines for protection of aquatic life were researched and compiled using the hierarchy outlined above. Where water quality guidelines are available, information on aquatic toxicity has been acquired from reported values that had already been through a screening process such as the OECD-Screening Information Data Set (SIDS) program or through a European Union (EU) existing substances risk assessment. The data from these programs will be considered sufficiently reviewed as to not require further evaluation. Data reported as part of other equivalent peer-reviewed risk assessment programs (e.g. Human and Environmental Risk Assessment<sup>1</sup>; USEPA High Production Volume (HPV) Challenge Program) was also considered in a similar fashion, although a certain level of expert judgement was required to evaluate the quality of these programs.

Aquatic toxicity information was also obtained via the European Chemicals Agency (ECHA) CHEM database. This database provides electronic public access to information on chemical substances manufactured or imported in Europe. The information originates from the registration dossiers submitted by companies to ECHA in the framework of REACH Regulation. If no data were available from the above sources or the available data were considered insufficient for TRV determinations, then toxicity information on SDSs was used, as well as read-across from available experimental data on structurally related substances, and predicted values from quantitative structure-activity relationship (QSAR) models.

#### **6.1.2.1 Calculation of PNEC**

The determination of TRVs was conducted according to the predicted no-effects concentration (PNEC) guidance in the Environmental Risk Assessment Guidance Manual for Industrial Chemicals prepared by the Australian Environmental Agency (AEA, 2009).

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<sup>1</sup> [www.heraproject.com/](http://www.heraproject.com/)

### Calculation of PNEC for freshwater

The determination of PNECs for freshwater was conducted according to the guidance in the EU TGD (EU, 2003) and in the Environmental Risk Assessment Guidance Manual for Industrial Chemicals prepared by the AEA (2009).

The PNECs were determined by dividing the lowest toxicity value from a laboratory test by the relevant assessment factor. Results of long-term tests (expressed as EC<sub>10</sub> or NOEC) are preferred to those of short-term tests (EC<sub>50</sub>/LC<sub>50</sub>) because the results give a more realistic picture of effects on the organisms during their entire life cycle.

An assessment factor of 1,000 was applied to the lowest concentration if only acute toxicity data are available. As specified in the Environmental Risk Assessment Guidance Manual for Industrial Chemicals (AEA, 2009), the assessment factor was reduced to 100 if the following situations were applicable:

- Availability of data from a wide variety of species including those that are considered to represent sensitive species
- Information from structurally similar compounds or QSAR, to suggest that the acute to chronic ratio is likely to be low
- Information to suggest that the chemical acts in a non-specific or narcotic manner, with little interspecies variation in toxicity
- Information to suggest that the release of the chemical is short-term or intermittent and that the chemical would not be persistent in the environment.

If chronic toxicity studies have been conducted on the test substance in addition to acute toxicity studies, then the NOEC or EC<sub>10</sub> would be divided by assessment factors of 100, 50, or 10 depending on the following conditions:

- As assessment factor of 100 was used when a chronic NOEC was available from at least one species of fish or invertebrate representing one trophic level. The derived PNEC is the lowest value from either the lowest acute data or from the one derived from the chronic data.
- An assessment factor of 50 was used when a chronic NOEC was available from at least two species representing two trophic levels. The derived PNEC is the lowest value from either the lowest acute data or from the one derived from the chronic data.
- An assessment factor of 10 was used when chronic NOECs were available from three species representing three trophic levels.
- An assessment factor of 10 was applied to the lowest NOEC from two species representing two trophic levels if the data shows that the most sensitive species for which acute toxicity data was available have been tested chronically.

In the case of algae studies, the 72-hour (or longer) EC<sub>50</sub> value was considered as equivalent to a short-term result and that a 72-hour (or longer) EC<sub>10</sub> or NOEC value was the long-term result.

In cases when there were limited or no data are available or the measured data for a species was inappropriate, values were estimated using QSAR.

The statistical extrapolation method was used if there was a large data set from long-term tests for different taxonomic groups.

### Calculation of PNEC for sediment

If toxicity studies were available on sediment organisms, the PNEC was derived using the general approach described for calculating the PNEC for freshwater organisms.

If there were no toxicity data on sediment organisms, the equilibrium partitioning method was used to derive a PNEC. This method uses the  $PNEC_{water}$  for aquatic organisms and the sediment/water partitioning coefficient as inputs. It is only applicable to non-ionic organic chemicals.

The following equation was used to estimate the  $PNEC_{sed}$  using the equilibrium partitioning method:

$$PNEC_{sed} = (K_{sed-water}/BD_{sed}) \times 1000 \times PNEC_{water}$$

Where:

- $K_{sed-water}$  = suspended matter-water partition coefficient ( $m^3/m^3$ )
- $BD_{sed}$  = bulk density of sediment ( $kg/m^3$ ) = 1,280 [default in Australia]
- $PNEC_{water}$  = Predicted no effect concentration in water (mg/L)

The suspended matter-water partition coefficient was estimated by first adjusting the organic carbon partition coefficient ( $K_{oc}$ ) to the organic carbon content of natural sediments. This was accomplished using the following equation:

$$Kp_{sed} = K_{oc} \times f_{oc}$$

Where:

- $Kp_{sed}$  = solid-water partition coefficient (L/kg).
- $K_{oc}$  = organic carbon partition coefficient (L/kg).
- $f_{oc}$  = fraction of organic carbon suspended sediment = 0.04 [recommended default from Mackay Level III].

The makeup of the sediment was assumed to be 80% water and 20% solids based on the Mackay Level III Fugacity Model. So, the suspended matter-water partition coefficient ( $K_{sed-water}$ ) was estimated from  $Kp_{sed}$  using the following equation:

$$K_{sed-water} = 0.8 + (0.2 \times Kp_{sed})/1000 \times BD_{solid}$$

Where:

- $K_{sed-water}$  = suspended matter-water partition coefficient ( $m^3/m^3$ )
- $Kp_{sed}$  = solid-water partition coefficient (L/kg).
- $BD_{solid}$  = bulk density of the solid phase ( $kg/m^3$ ) = 2,400 [default]

#### Calculation of PNEC for soil

If toxicity studies were available on soil organisms, the PNEC was derived using the general approach described for calculating the PNEC for freshwater organisms. Prior to deriving the PNEC value for soil, the  $L(E)C_{50}$  or NOEC value was corrected for bioavailability of the test substance in soil by normalising the organic carbon content in soil using the following equation:

$$L(E)C_{50(std)} \text{ or } NOEC_{(std)} = L(E)C_{50(exp)} \text{ or } NOEC_{(exp)} \times Fom_{soil(std)}/Fom_{soil(exp)}$$

Where:

- $Fom_{soil(std)}$  = the fraction of organic matter in standard soil
- $Fom_{soil(exp)}$  = the fraction of organic matter in experimental soil

The fraction of organic matter in standard soil in Australia is 1%<sup>2</sup>.

The PNEC for soil was determined by dividing the lowest toxicity value from a laboratory test by the relevant assessment factor. If only acute toxicity tests are available, an assessment factor of 1,000 was applied to the lowest L(E)C<sub>50</sub> value. If long-term studies were available, an assessment factor of 100 was applied to the lowest NOEC for one test; 50 for additional tests on two species of two trophic levels; or 10 for additional tests for three species of three trophic levels.

If there were no toxicity data on soil organisms, the equilibrium partitioning method was used to derive a PNEC. This method uses the PNEC<sub>water</sub> for aquatic organisms and the soil/water partitioning coefficient as inputs. It is only applicable to non-ionic organic chemicals.

The following equation was used to estimate the PNEC<sub>soil</sub> using the equilibrium partitioning method:

$$\text{PNEC}_{\text{soil}} = (\text{Kp}_{\text{soil}}/\text{BD}_{\text{soil}}) \times 1000 \times \text{PNEC}_{\text{water}}$$

It is preferable to use actual measured data in effects assessment and in the estimation of PNECs. However, when limited or no data were available (e.g. data for only one test species) or when the measured data for a species were inappropriate, then estimation using QSARs was considered. **Tables 2a** and **2b** present the COPC, the endpoint, NOEC (mg/L), assessment factor, and the aquatic PNEC (mg/L). The calculate PNEC concentrations for the residual COPCs on drill cuttings mixed with soils and water treatment chemicals on soils effected by a release or irrigation activities are presented in **Tables 3a** and **3b**.

#### 6.1.2.2 Dose-Based TRV

The basic principles applied in human health toxicity assessments also apply to ecological toxicity assessments, however, carcinogenicity is rarely considered because of a lack of methodologies and the understanding of the modes of action of potential carcinogens on ecological receptors. The sources of TRVs are from the published literature, or the application of dose-response equations incorporating the relationship of the size of the selected receptor to the test species for the dose-response data.

An extensive literature review was conducted for COPC-toxicological endpoints for the selected ecological receptor. With few exceptions, as noted in **Appendix D** for avian toxicological endpoints, the only COPC toxicological endpoints found were mammalian laboratory test species (e.g., rat). Therefore, where avian toxicological endpoints not available, mammalian toxicity values were used as toxicological surrogates. The use of these surrogates is discussed in the uncertainty analysis.

For ecological receptors, the TRVs are calculated based on body weight (BW) scaling methodology that uses the NOAELs and LOAELs, which are daily dose levels normalised to the BW of the test animals (e.g. milligrams of chemical per kilogram BW/day). The NOAELs and LOAELs are presented in the risk dossiers (**Appendix D**) for each COPC. The use of toxicity data on a mg/kg/day basis allows the comparisons across toxicity tests and across test species with appropriate consideration for differences in body size. Studies have shown that numerous physiological functions such as metabolic rates, as well as responses to toxic chemicals, are a function of body size. Smaller animals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification. After a review of various dose-response models for wildlife, the allometric scaling method was developed using linear regression models of lethal dose versus body weight for a variety

<sup>2</sup> [www.scew.gov.au/node/941](http://www.scew.gov.au/node/941)



of chemicals to extrapolate toxicity between species (Sample and Arenal, 1999). To assess the sensitivity of the model, residuals from the allometric scaling were analysed using regression models. The patterns of sensitivity among mammalian species were relatively constant across chemical classes. The development of this allometric scaling model improved the extrapolation of toxicity effects between species, thus providing a more accurate assessment of potential ecological risks when data are limited for the specific species being assessed. The allometric scaling method was used to estimate the population-level effects on wildlife based on individual level of exposures (Sample et al., 1996).

If a NOAEL (or LOAEL) is available for a test species (NOAEL), then the equivalent NOAEL (or LOAEL) for an assessed wildlife species (NOAEL) can be calculated by using an adjustment factor for differences in body size (USEPA, 2012). The dose for the selected ecological receptor is a function of the BW of the test species divided by the BW of the selected ecological receptor to the  $\frac{1}{4}$  power and then is multiplied times the dose of the test species.

$$NOAEL_w = NOAEL_t \left( \frac{bw_t}{bw_w} \right)^{1/4}$$

The calculated TRVs for each of the mammalian and avian ecological receptors evaluated in the ecological risk assessment are presented in the species-specific ecological risk models in the tables.

The calculation of TRVs for other potential ecological receptors was considered in the ecological risk assessment; however, the quantitative assessment is based on the availability of ecotoxicological data to calculate TRVs. Mayfield et al. (2014) reference the lack of amphibian and reptile toxicological data and limited laboratory reptile models as challenges for calculation of TRVs.

The USEPA (2008) uses the model T-HERPS to estimate potential risks to terrestrial amphibians and reptiles from pesticide use. In conducting their ecological risk assessments, the USEPA uses birds as surrogates for terrestrial-phase amphibians and reptiles. However, reptiles and amphibians are poikilotherms (i.e., body temperature varies with environmental temperature), but birds are homeothermes (i.e., body temperature regulated, and independent of environmental temperature). Consequently, reptiles and amphibians generally have much lower metabolic rates and lower caloric intake requirements than birds or mammals, and birds would therefore consume more food than amphibians or reptiles on a daily dietary intake basis (assuming similar caloric content of the food items). The T-HERPS model uses a food intake allometric equation for reptiles and amphibians that incorporates an iguanid lizard allometric equation to estimate potential exposure to amphibians and reptiles because allometric equations specific for terrestrial-phase amphibians have not been identified. In addition, other uncertainties identified in the T-HERPS model (USEPA, 2008) include:

- T-HERPS evaluates exposures to terrestrial amphibians and reptiles based on consumption of terrestrial prey, not aquatic prey that may have a bioaccumulation component. The model also does not evaluate potential for dermal exposures that may be more significant for terrestrial species.
- The use of avian toxicity data as a surrogate; the lack of a robust toxicity data base for amphibians and reptiles precludes an evaluation of toxicological differences such as sensitivity; which will result in either an overestimation or underestimation of the potential risks.
- T-HERPS calculates the exposure estimate based on consumption prey that conservatively assumes chemical uptake is linear, without consideration of depuration by excretion or metabolism, or bioaccumulation of chemicals not readily degraded or excreted. The resulting exposure estimates could be either overestimates or underestimates of the total chemical exposure on a daily basis. In addition, the mammal prey item assessment assumes consumption of a 35-g deer mouse; therefore, use of larger or smaller size prey would result in an overestimation or underestimation of the potential risks.

**Table 5-4** did not identify any amphibians or reptiles as potential receptors with exposure to drilling and completion operations. Therefore, given the absence of identified potential receptors, the uncertainties in extrapolation of mammalian and avian risk models to amphibians and reptiles and the lack of toxicological data for reptiles and amphibians, the potential risks to these potential ecological receptors will not be assessed further in the risk assessment.

## 6.2 PBT Assessment

A PBT substances assessment based on the Australian and EU REACH Criteria methodology was conducted on all chemicals (ECHA, 2008; enHealth, 2012a) as part of the hazard assessment.

The primary source of information for physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data was obtained from databases linked to the OECD eChemPortal ([www.echemportal.org](http://www.echemportal.org)), which is part of the OECD Environmental Risk Assessment toolkit. In addition, data was obtained from the sources presented in **Table 6-1**.

**Table 6-1: Sources of PBT Assessment**

Data	Sources
Chemical and physical properties data	TOXNET The Safety Datasheet (SDSs) Modelled data from USEPA (2011a) EPISUITE™
Environmental and human health drinking water guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection of aquatic ecosystems and stock watering (ANZECC and ARMCANZ, 2000) Australian Drinking Water Guidelines (NHMRC and NRMCC, 2011, Update 2016) World Health Organisation (WHO, 2006) Guidelines for Drinking-water Quality (Third Edition) USEPA National Recommended Water Quality Criteria (2009) for protection of aquatic life and human health Drinking-water Standards for New Zealand 2005 (Revised 2008, Ministry of Health)
Human health toxicity data	U.S. Toxic Substances Control Act Test Submissions 2.0 (TSCATS 2.0) database <a href="https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0">https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0</a> Literature search (using PubMed and ToxLine) Internet search (i.e., Google Scholar)
Ecological toxicological and environmental fate and transport data	USEPA ECOTOX database Canada Screening Assessment Reports USEPA TSCATS database Google Search (for regulatory agency documents such as USEPA RED (Re-registration Eligibility Decision) documents for pesticide applications) Literature search of peer-review journals SDSs QSAR modelling (i.e., EPI Suite and PetroTox)

Data	Sources
Ecological toxicological data (soil and water guidelines)	European Chemicals Bureau (ECB) (2003) National Environmental Protection Council (NEPM) (2013) Risk Assessment Information System (RAIS) USEPA Eco Soil Screening Levels (2011b) National Institute for Public Health and Environmental Protection (RIVM) Target and Intervention levels (1994) International Uniform Chemical Information Database [IUCLID], Concise International Chemical Assessment Document [CICAD]

**Tables 4a and 4b** present a summary of the PBT Assessment for the COPCs.

### 6.3 Data Used in Risk Assessment

This section presents a description of the data used in the risk assessment.

#### 6.3.1 Geogenic Chemicals within Residual Drilling Fluid

Santos has undertaken a comprehensive assessment of the chemistry of geogenic chemicals in drilling fluids (drill cuttings and returned muds). The results from this testing program are included in **Appendix E, Tables E-1 through E-3**.

This empirical data is considered representative of geogenic chemicals in drilling fluids that would be returned to the surface through drilling activities based on the geological conditions and proposed drilling fluids for the Project Area. Drilling records indicate that the typical mass balance of fluids recovered from drilling is approximately 70% solids / cuttings and 30 percent fluids (at field saturation). These solids have a density of approximately 1.7 gram per cubic centimetre (g/cc; wet weight) with approximately 20% water content and a net dry solids mass of 1.36 g/cc. Therefore, on a mass basis the dry solids make up 40.8% of the total mass in the returned drilling fluids (1.36g/cc x 30% of original volume). These solid geogenic chemicals in the drilling fluids are made up of primarily clays and silts sourced from the sedimentary geological formation. Assuming 100% of the chemicals are returned to surface in the muds, which is unlikely considering the potential for minor losses to the formation of chemicals with high solubilities and the potential for ion exchange, the mass of chemicals in the liquid have been multiplied by 0.6 (60%) to account for the additional mass of silts and clays removed from the formation during drilling.

#### 6.3.2 Vendor Chemicals in Drilling Fluids

The list of vendor chemicals in the drilling fluid is presented in **Section 5.3.2**. The following methodology was used to develop the concentration of the material in the recovered drilling fluids to be evaluated for the potentially complete exposure pathways.

Utilising vendor disclosure statements, a quantitative mass balance calculation was undertaken to identify the amount of each chemical additive in the four drilling fluid systems (5% KCl/Polymer/PHPA, KCl/Polymer, Inhibited KCl/Polymer Mud with BORE-HIB, Inhibited KCl/Polymer Mud with Glycol). As the specific drilling fluid formulation to be used at an individual well lease will be adapted / determined based on specific geology encountered during drilling, the maximum concentrations for each COPC in the four mud systems were used to calculate a mass in the liquids for a composite of the four mud systems. This composite mud approach was used to conservatively estimate the concentration of exposure; therefore, to assess all possible scenarios and, subsequently, all potential chemical additives utilised in the drilling fluids.

Similar to the drilling fluids in the geogenic material dataset, 100% of the mass of chemicals in the liquids was conservatively assumed to be partitioned into the dry solids (accounting for the additional mass of native silts and clays introduced into the fluid during drilling – a conversion) by applying a factor of 0.6 to the estimated fluid mass to calculate a solids estimated concentration. **Table 6-2** presents the calculated chemical additive concentrations of the drilling fluids. Methylisothiocyanate (MITC) is not a chemical additive; however, tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione breaks down through hydrolysis to MITC relatively rapidly. Therefore, MITC was retained as a COPC for the residual drilling fluids.

**Table 6-2: Mass Balance Estimates for Drilling Fluid COPCs**

Drilling Fluid	Chemical Name	CASs Number	Water Maximum Estimated Concentration (mg/L)	Solids Maximum Estimated Concentration (mg/kg)
Inhibited Mud V4 Bore-HIB	Potassium Chloride	7447-40-7	69,200	41,520
KCL Polymer Mud V4	Starch	9005-25-8	5096	3057.6
KCL Polymer Mud V4	Sodium carboxymethyl cellulose	9004-32-4	5194.8	3116.88
Inhibited Mud V4 Bore-HIB	Xanthan Gum	11138-66-2	5100	3060
KCL Polymer Mud V4	Copolymer of acrylamide and sodium acrylate	25085-02-3	1170	702
Inhibited Mud V4 Bore-HIB	Sodium Hydroxide	1310-73-2	500	300
Inhibited Mud V4 Bore-HIB	Sodium carbonate	497-19-8	130	78
Inhibited Mud V4 Bore-HIB	Glutaraldehyde	111-30-8	500	300
KCL Polymer Mud V4	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	0
Inhibited Mud V4 Bore-HIB	Glyoxal	107-22-2	51	30.6
Inhibited Mud V4 Bore-HIB	Methanol	67-56-1	5	3
KCL Polymer Mud V4	Ethylene oxide/propylene oxide copolymer	9003-11-6	40	24
Inhibited Mud V4 Glycol	Polyalkylene	9038-95-3	30000	18000
Inhibited Mud V4 Bore-HIB	Polypropylene glycol	25322-69-4	80	48
Inhibited Mud V4 Bore-HIB	Silicic acid, potassium salt	1312-76-1	37000	22200
Inhibited Mud V4 Bore-HIB	Sodium Chloride	7647-14-5	76000	45600
KCL Polymer Mud V4	Sodium polyacrylate	9003-04-7	1820	1092
KCL Polymer Mud V4	Methylisothiocyanate (MITC)	556-61-6	0	30

As discussed in **Section 6.1**, two additional drilling fluids formulations may also be utilised. The LCM drilling muds were not included in this quantitative mass balance calculation because the of the limited amount of material used to plug fractures (e.g., 1 to 50 barrels) and is considered *de minimis* relative to the volume used for the 4 other drilling fluids systems.

### 6.3.3 Produced Water

The produced water data utilised in the risk assessment is consistent with the RO system design basis expected water quality prior to treatment of production water (Santos, 2015). **Appendix F (Table F-1)** presents the expected concentrations of the geogenic chemicals in produced water conveyed from the well leases to Leewood. In addition to a potential release of production water to a surface water body, there is the potential for released production water to occupy pore space in soils in the vicinity of the release. An estimate of the constituent concentration in soils was estimated using the following assumptions: a release occurs in an area of soil with porosity of 30 percent, drainage capacity of the soil, reduces the retained water to 10 percent. Therefore, the estimates of COPCs in soils as a result of releases as a result of a leak in the pipeline are 10 percent of the original aqueous concentration. **Table 6-3** summarises the geogenic COPC concentrations for production water and potential residual COPCs in soils.

**Table 6-3: Expected Produced Water Concentrations**

Chemical Name/Use	Produced Water COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Produced Water (mg/kg)
Total Dissolved Solids (TDS)	23800	NA
pH	8.57	NA
SAR	> 100	NA
Bicarbonate (as calcium carbonate equivalent)	12400	NA
Carbonate	730	NA
Total Alkalinity	12600	NA
Chloride(Cl)	2100	210
Sodium (Na)	6500	650
Sulphate (SO4)	18	1.8
Calcium (Ca)	15	1.5
Magnesium (Mg)	9.2	0.92
Potassium (K)	81	8.1
Strontium (Sr)	4.6	0.46
Barium (Ba)	15	1.5
Fluoride (F)	6.4	0.64
Silica (SiO2)	24	2.4
Boron (B)	1.3	0.13
Iron (Fe, dissolved)	0.52	0.052
Cyanide	0.004	0.0004
Manganese	0.18	0.018
Aluminium	6.1	0.61
Ammonia	16	1.6

Chemical Name/Use	Produced Water COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Produced Water (mg/kg)
Nitrate as N	0.1	0.01
Copper Sulphate	0.14	0.014
Nickel Sulphate	0.013	0.0013
Arsenic	0.036	0.0036
Cadmium	0.036	0.0036
Mercury	0.015	0.0015
Selenium	0.054	0.0054
Zinc	0.15	0.015
Chromium	0.04	0.004
Hexavalent Chromium	< 0.05	< 0.005
Molybdenum	0.0069	0.00069
Antimony	0.0011	0.00011
Tin	0.0027	0.00027
Uranium	0.0007	0.00007
Lead	0.013	0.0013
Beryllium	0.001	0.0001
Cobalt	0.0035	0.00035
Iodide	0.2	0.02
Lithium	2.9	0.29
Thallium	0.0005	0.00005
Vanadium	0.016	0.0016
Phosphorus	0.63	0.063
Nitrite	0.04	0.004

NA = not applicable

mg/L = milligrams per litre

mg/kg = milligrams per kilogram

>= greater than

<= less than

### 6.3.4 Treated water reused for Irrigation, Dust Suppression, and Stock Watering

The COPCs present within the treated water (permeate) reused for beneficial reuse include both the geogenic COPCs present within the production water and the vendor COPCs discussed in **Section 5.3.2.2**. Further description of the use, quantities, chemical concentrations is provided in **Table F-1**.

#### 6.3.4.1 Geogenic COPCs

The following methodology was used to develop the concentration of the permeate to be evaluated for the potentially complete exposure pathways. Per specifications, the RO system is assumed to remove 97% percent of chemical mass from the produced water. Conservatively, an effective treatment rate of 90% was assumed; therefore, 10% of the chemical mass remains in the treated water (permeate) piped to the treated water storage tank and 90% of the mass is piped to the brine pond. **Table 6-4 (Table F-**



1) presents the expected geogenic COPC concentrations in the permeate, in soil as a result of a spill, and the brine. A summary of these concentrations is presented in **Table 6-4**.

**Table 6-4: Estimated Geogenic COPC Concentrations in Permeate, Residual Soil and Brine**

Chemical Name/Use	Expected Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)
Total Dissolved Solids (TDS)	< 650	NA	108403
pH	6-8.5	NA	8.88
SAR	< 5	NA	>100
Bicarbonate (as calcium carbonate equivalent)	260	NA	99200
Carbonate	2	NA	21261.43
Total Alkalinity	262	NA	38718.8
Chloride(Cl)	< 100	< 4.0	10277.31
Sodium (Na)	131	5.18	36914.75
Sulphate (SO <sub>4</sub> )	< 5	< 0.20	42.7
Calcium (Ca)	< 50	< 1.98	38.62
Magnesium (Mg)	0.04	0.002	35.65
Potassium (K)	< 5	< 0.20	838.78
Strontium (Sr)	< 0.02	< 0.001	10.33
Barium (Ba)	< 0.1	< 0.004	36.18
Fluoride (F)	< 0.3	< 0.01	33.17
Silica (SiO <sub>2</sub> )	< 0.9	< 0.04	111.39
Boron (B)	0.7	0.03	4.2
Iron (Fe, dissolved)	< 0.1	< 0.004	4.16
Cyanide	< 0.001	< 0.00004	0.032
Manganese	~ 0.02	~ 0.0008	1.14
Aluminium	~ 0.02	~ 0.0008	48.8
Ammonia	6-10	1680.24	128
Nitrate as N	< 0.1	< 0.004	1.17
Copper Sulphate	< 0.01	< 0.0004	1.12
Nickel Sulphate	< 0.01	< 0.0004	0.104
Arsenic	< 0.01	< 0.0004	0.288
Cadmium	< 0.002	< 0.00008	0.288
Mercury	< 0.001	< 0.00004	0.12
Selenium	< 0.01	< 0.0004	0.432
Zinc	< 0.01	< 0.0004	1.2
Chromium	< 0.01	< 0.0004	0.32
Hexavalent Chromium	< 0.01	< 0.0004	0.4

Chemical Name/Use	Expected Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)
Molybdenum	< 0.005	< 0.00020	0.0552
Antimony	< 0.001	< 0.00004	0.0088
Tin	< 0.001	< 0.00004	0.0216
Uranium	< 0.001	< 0.00004	0.0056
Lead	< 0.001	< 0.00004	0.104
Beryllium	< 0.001	< 0.00004	0.008
Cobalt	< 0.001	< 0.00004	0.028
Iodide	< 0.05	< 0.002	1.6
Lithium	< 0.01	< 0.0004	23.2
Thallium	< 0.0005	< 0.00002	0.004
Vanadium	< 0.01	< 0.0004	0.128
Phosphorus	< 0.05	< 0.002	5.04
Nitrite	< 0.04	< 0.002	0.32

The concentrations provided in **Table 6-4** will be utilised to evaluate potential exposures to receptors potentially exposed to COPCs in permeate via direct exposure routes.

#### 6.3.4.2 Vendor Chemicals utilised in Water Treatment

The list of vendor chemicals at the Leewood facility is presented in **Section 5.3.2**. Utilising dosage rates in process flow diagrams (**Appendix F**), a quantitative mass balance calculation was undertaken to identify the amount of each treatment chemical additive that would remain in treated water post RO system (permeate). For those COPCs that dissociate to ions, the concentrations will be consistent with geogenic background concentrations. The COPCs utilised as flocculants and coagulants will only be present in the solid streams; therefore, no concentrations were presented for these COPCs. Consistent with the approach to estimate the potential COPC concentrations retained in soils after an accidental release to soils, a factor of 0.1 was applied to the expected concentrations of COPCs in the permeate.

**Appendix F (Table F-1)** presents the derivation of the vendor chemical COPC estimates in permeate (both aqueous and in soils as a result of a release). **Table 6-5** presents the vendor chemical masses in the permeate and the brine pond as well as the CCL calculations for soil after 20 years of irrigation.

**Table 6-5: Mass Balance Estimates for Water Management Facility Chemicals**

Chemical Name	Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)
Proprietary Polymer A	0.49	0.04	Will dissociate and degrade
Proprietary Ester A	0.098	0.008	Refer to geogenic concentrations

Chemical Name	Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)
Aluminium Chlorohydrate	Dissociates to Al and Cl concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Sodium Meta Bisulphite	Dissociates to Na and SO <sub>4</sub> concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Sodium Hypochlorite	Dissociates to Na and Cl concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Sodium Hydroxide	Dissociates to Na and OH concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Citric Acid	Dissociated and rapidly breaks down to TOC	NA	Refer to geogenic concentrations
Hydrochloric Acid	Dissociates and reacts to water and chloride concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Calcium Chloride	47.2 – Dissociates and reacts to calcium and chloride concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Ethylene diamine tetraacetic acid, EDTA	0.29	0.02	18
Polydadmec	NA	NA	NA
Acrylamide homopolymer	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	0.50	NA	NA
2 methyl-isothiazolin-3 one	0.1	NA	NA
Proprietary Mixture D1	0.065	NA	NA
Proprietary Mixture D2	0.065	0.03	NA
Sodium Chloride	Dissociates and reacts to sodium and chloride concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Sodium dodecyl sulfate	Dissociates and reacts to sodium and sulfate concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Proprietary Mixture A2	Dissociates and reacts to sodium and sulfate concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations

Chemical Name	Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)
Magnesium nitrate	Dissociates to magnesium and nitrate concentration consistent with geogenic background	Refer to geogenic concentrations	Refer to geogenic concentrations
Proprietary Mixture A3	Reaction product with sodium hypochlorite. Will dissociate to sulfate, chloride, and ammonia consistent with geogenic background.	Refer to geogenic concentrations	Refer to geogenic concentration
Homopolymer of maleic acid	COPC present in solids stream; therefore, not present in permeate	NA	COPC present in solids stream; therefore, not present in brine
Polyacrylate	COPC present in solids stream; therefore, not present in permeate	NA	COPC present in solids stream; therefore, not present in brine

mg/l = milligrams per litre  
mg/kg = milligrams per kilogram  
NA = not applicable

### 6.3.5 Direct Discharge of Treated Water to Bohena Creek

As discussed in **Section 4.4.1**, direct discharge of permeate to Bohena Creek will occur on an intermittent basis. For the quantitative risk assessment of this pathway, the anticipated COPC concentration (geogenic and vendor chemical breakdown products) were calculated by assuming a dilution factor of 40 to account for mixing with upstream surface water. The dilution factor is based on the discharge to Bohena Creek at specified flow of 100 ML/day in Bohena Creek. For the vendor chemicals, degradation based on residence time in the system and effluent tanks were calculated. No degradation was included for the geogenic chemicals. The COPC concentrations are presented in **Appendix F (Table F-1)** and summarised below in **Table 6-6**.

**Table 6-6: Estimates of COPCs in Direct Discharge of Permeate to Bohena Creek**

Chemical Name/Use	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l)
Geogenic Compounds	
Total Dissolved Solids (TDS)	< 16.25
pH	6-8.5
SAR	< 5
Bicarbonate (as calcium carbonate equivalent)	6.5
Carbonate	0.05

Chemical Name/Use	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l)
Total Alkalinity	6.55
Chloride(Cl)	< 2.5
Sodium (Na)	3.275
Sulphate (SO <sub>4</sub> )	0.125
Calcium (Ca)	< 1.25
Magnesium (Mg)	0.001
Potassium (K)	< 0.125
Strontium (Sr)	< 0.0005
Barium (Ba)	< 0.0025
Fluoride (F)	< 0.0075
Silica (SiO <sub>2</sub> )	< 0.0225
Boron (B)	0.0175
Iron (Fe, dissolved)	< 0.0025
Cyanide	< 0.000025
Manganese	0.0005
Aluminium	0.0005
Ammonia	6-10
Nitrate as N	< 0.0025
Copper Sulphate	< 0.00025
Nickel Sulphate	< 0.00025
Arsenic	< 0.00025
Cadmium	< 0.00005
Mercury	< 0.000025
Selenium	< 0.00025
Zinc	< 0.00025
Chromium	< 0.00025
Hexavalent Chromium	< 0.00025
Molybdenum	< 0.000125
Antimony	< 0.000025
Tin	< 0.000025
Uranium	< 0.000025
Lead	< 0.000025
Beryllium	< 0.000025
Cobalt	< 0.000025
Iodide	< 0.00125
Lithium	< 0.00025
Thallium	< 0.0000125

Chemical Name/Use	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l)
Vanadium	< 0.00025
Phosphorus	< 0.00125
Nitrite	< 0.001

## 6.4 Lifecycle Component Assessment

The lifecycle component assessment includes a qualitative assessment of the drilling fluids from the transportation to the well lease, mixing and use at the well lease, and transport of used drilling fluid to the approved drilling fluid treatment facility. The quantitative assessment of lifecycle components includes the recovery of drilling fluids and cuttings through treatment and beneficial reuse of production water and management of drill cuttings through mix, turn, and bury on the well lease.

### 6.4.1 Qualitative Assessment

The qualitative assessment includes exposure to the vendor chemicals that may occur during activities that do not intentionally result in a release to the environment, but where a potential release may occur. These potential releases primarily are focused on the vendor chemicals used in the drilling and water treatment process during transportation, drilling and water treatment preparation activities. Potential exposure to vendor chemicals may occur as a result of release from shipping containers and storage tanks either during transport from supplier or storage warehouse to well lease or WMF, storage and preparation of products on the lease for drilling operations or at the WMF for treatment activities, during transport of the used drilling fluids to the drilling fluid treatment facility, transport of drill cuttings containing a high percentage of coal fines to off-site disposal facility or during use of the treated water for beneficial purposes.

**Table 6-7** presents a summary of potential human health and ecological hazards that should be considered for the potential receptors identified in **Section 5.3.5**. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and SDSs are available to emergency responders, health and safety managers, and environmental hazard clean-up teams. In addition, **Tables 1a, 1b, 1c and 1d** present the Oral Reference Dose and Drinking Water Guideline Values, and **Tables 2a and 2b** present the ecological endpoint, NOEC, and the aquatic PNEC. Note that the level of toxicity was obtained from the risk assessment dossiers.



**Table 6-7: Summary of Human and Ecological Hazards**

Chemical name	CAS Number	Human Hazard			Ecological Hazard
		Explosive (E) Flammable (F) Oxidiser (O)	Australian Dangerous Goods Code	Acute or Chronic Toxicity (oral -O, dermal – D, inhalation – I)	Aquatic and Terrestrial
Drilling Chemicals					
Copolymer of Acrylamide/Sodium Acrylate/ Copolymer of Acrylamide/Potassium Acrylate	25085-02-3/ 31212-13-2	NA	NA	No studies, low toxicity	Low toxicity
Sodium carbonate	497-19-8	NA	NA	Low toxicity; eye irritant	Low toxicity
Glutaraldehyde	111-30-8	NA	Danger	Moderate to high toxicity (O, I) and low to moderate toxicity (D); skin sensitizer, respiratory sensitizer, serious eye damage, corrosive, and respiratory irritant	Slight to moderate toxicity to fish and invertebrates; moderate to highly toxicity algae; low toxicity to terrestrial invertebrates and plants
Methanol	67-56-1	F	Danger	Low toxicity (0.1 to 1 percent)	Low toxicity
Polyalkylene	9038-95-3	NA	NA	Low toxicity	Low toxicity
Glyoxal	107-22-2	NA	NA	Moderate toxicity (I) and low toxicity (D, O); skin sensitizer, skin/eye/respiratory irritant	Low toxicity
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	NA	Low toxicity	Low toxicity
Potassium chloride	7747-40-7	NA	NA	Low toxicity	Low toxicity
Silicic acid, potassium salt	1312-76-1	NA	NA	Low toxicity	Low toxicity
Polypropylene glycol	25322-69-4	NA	NA	Low toxicity	Low toxicity
Sodium carboxymethyl cellulose	9004-32-4	NA	NA	Low toxicity	Low toxicity
Sodium chloride	7647-14-5	NA	NA	Low toxicity	Low toxicity

Chemical name	CAS Number	Human Hazard			Ecological Hazard
		Explosive (E) Flammable (F) Oxidiser (O)	Australian Dangerous Goods Code	Acute or Chronic Toxicity (oral -O, dermal – D, inhalation – I)	Aquatic and Terrestrial
Sodium hydroxide	1310-73-2	NA	Danger	Limited studies, concentrated solutions corrosive, irritating, and affect skin, eyes, and respiratory gastrointestinal tracts	In unbuffered aquatic media, high toxicity due to increase in pH
Starch	9005-25-8	NA	NA	Low toxicity	Low toxicity
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)/methylisothiocyanate (MITC)	533-74-4/556-61-6	NA (MITC – F)	NA	Moderate to acute toxicity (O); low toxicity (D, I); MITC: Highly acute toxicity (O, I) and low to high toxicity (D); severely irritating to skin and eyes, skin sensitizer, respiratory irritant (Note: dazomet and MITC present at 0.1 to 1 percent)	Aquatic Acute Category 1 and Aquatic Chronic Category 1 (high toxicity and long-term effects); MITC: high toxicity; moderate toxicity to earthworms
Xanthan gum	11138-66-2	NA	NA	Low toxicity	Low toxicity
Calcined petroleum coke	64743-05-1	NA	NA	Low toxicity	Low toxicity
Calcium carbonate	471-34-1	NA	NA	Low toxicity	Low toxicity
Crystalline silica, cristobalite	14464-46-1	NA	NA	High toxicity (I); low toxicity (O,D)	Low toxicity
Crystalline silica, quartz	14808-60-7	NA	NA	High toxicity (I); low toxicity (O,D)	Low toxicity
Crystalline silica, tridymite	15468-32-3	NA	NA	High toxicity (I); low toxicity (O,D)	Low toxicity
Bentonite	Mixture	NA	NA	Low toxicity	Low toxicity
Walnut hulls	Mixture (1756)	NA	NA	Low toxicity	Low toxicity
Wood fibre	Mixture (1757)	NA	NA	Low toxicity	Low toxicity
Almond Hulls	NA	NA	NA	Low toxicity	Low toxicity
Cellophane	9005-81-6	NA	NA	Low toxicity	Low toxicity

Chemical name	CAS Number	Human Hazard			Ecological Hazard
		Explosive (E) Flammable (F) Oxidiser (O)	Australian Dangerous Goods Code	Acute or Chronic Toxicity (oral -O, dermal – D, inhalation – I)	Aquatic and Terrestrial
Water Treatment Chemicals					
Proprietary Polymer A	PolymerA-CASRn	NA	NA	Low toxicity	Low toxicity
Proprietary Ester A	EsterA-CASRn	NA	Danger	Moderate toxicity (O, D)	Low toxicity
Aluminium Chlorohydrate	1327-41-9	NA	NA	Low toxicity	Low toxicity
Sodium Meta Bisulphite	7681-57-4			Moderate (O, D)	Moderate (aquatic)
Sodium Hypochlorite NaOCl	7681-52-9	NA	Danger	Moderate toxicity	High toxicity (aquatic), low toxicity (terrestrial)
Citric Acid, C6H8O7	77-92-9	NA	NA	Low toxicity	Low toxicity
Hydrochloric Acid, HCl3	7647-01-0	NA	Danger	Corrosive, irritating (O,I)	Low toxicity
Calcium Chloride, CaCl24	10043-52-4	NA	NA	Low toxicity	Low toxicity
Ethylene diamine tetraacetic acid, EDTA (C10H16N2O8)	13235-36-4	NA	NA	Low toxicity	Low toxicity (except algae due to nutritional deficiency)
Polydadmac	26062-79-3	NA	NA	Low toxicity	Moderate toxicity
Polyacrylamide	9003-05-8	NA	NA	Low toxicity	Low toxicity
Sodium polyacrylate	9003-04-7	NA	NA	Low toxicity	Low toxicity
14% 5-chloro-2-methyl-4- isothiazolin-3-one	26172-55-4	NA	Danger	Moderate to high toxicity	Moderate toxicity (terrestrial), high toxicity (aquatic)
Proprietary Mixture D1	MixtureD1-CASRn	NA	Danger	High toxicity (O, I)	High toxicity
Proprietary Mixture A2	MixtureA2-CASRn	NA	NA	Low toxicity	Moderate (aquatic, plants), low (fish, invertebrates), low (terrestrial)

Chemical name	CAS Number	Human Hazard			Ecological Hazard
		Explosive (E) Flammable (F) Oxidiser (O)	Australian Dangerous Goods Code	Acute or Chronic Toxicity (oral -O, dermal – D, inhalation – I)	Aquatic and Terrestrial
Sodium dodecyl sulfate	151-21-3	F	Danger	Moderate (O, D)	Moderate toxicity
Proprietary Mixture D2	MixtureD2-CASRn	NA	NA	Low toxicity	Low toxicity
Homopolymer of maleic acid	26009-09-2	Unknown	Unknown	Unknown	Unknown
Magnesium nitrate	10377-60-3	NA	NA	Low toxicity	Low toxicity

## 6.4.2 Quantitative Assessment

The quantitative assessment determines the exposure to the vendor chemicals that may occur during activities associated with the storage, treatment, disposal, and beneficial reuse of the vendor chemicals. In addition to vendor chemicals, chemicals in the produced water are also evaluated in the quantitative risk assessment. These exposures may include operational activities where planned direct releases to the environment may occur (e.g., managed release of treated water, irrigation, land application). To evaluate the potential for human and environmental hazards associated with the geogenic and vendor chemicals, the empirical and theoretical datasets discussed in **Section 6.3** were first compared to applicable risk-based screening criteria.

### 6.4.2.1 Geogenic Chemicals in Drilling Fluids

As discussed in **Section 6.3.1** the analytical data from other coal seam gas projects were used to assess the risk posed by geogenic constituents within the drill cuttings and fluids. The maximum concentrations of geogenic chemicals were compared to risk-based human health and ecological screening criteria as a conservative assessment. Risk-based screening levels (RBSLs) for potentially complete exposure pathways and various receptor scenarios presented above were selected using a hierarchical approach. The primary sources of screening levels for use in the evaluation are from the National Resource Management Ministerial Council (NRMMC) for aqueous data and the NEPM for solids data.

The need for screening levels sourced from multiple regulatory environments was required as screening values are not available in the NRMMC or the NEPM for all potential chemicals present in the residual drilling material for all the potential exposure or migration pathways. It is noted that the NRMMC and the NEPM guidance criteria were not developed for waste classification. However, the use of these screening values is considered appropriate as the screening is being performed to assess the potential for harm. The hierarchy of screening criteria includes Australian sources, then international sources with the screening criteria presented in **Appendix E**.

The screening criteria hierarchy utilised the following for aqueous residual drilling material was as follows:

- Human Health:
  - National Water Quality Management Strategy (NRMMC) Australian Drinking Water Guidelines (2016)
  - WHO Drinking-water Quality, Fourth Edition (2011)
  - USEPA Regional Screening Levels (RSLs) for tap water (May 2016 update) (2016b).
  - USEPA Maximum Contaminant Levels (MCLs, 2009).
- Environmental and Ecological:
  - ANZECC & ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality
  - American Petroleum Industry (API) RBSLs for the Protection of Livestock Exposed to Petroleum Hydrocarbons (2004)
  - Republic of South Africa (1993) South African Water Quality Guidelines
  - USEPA National Recommended Water Quality Criteria for Priority Pollutants (2009)
  - USEPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks (2011c).

The screening criteria hierarchy utilised the following for solid residual drilling material was as follows:

- The NEPM 1999 as amended 2013 (NEPM, 2013)
- Human health environmental and ecological (including phytotoxicity):
  - Direct Contact Soil Health Screening Levels (Friebel and Nadebaum, 2011, CRCCARE, Table B4)
  - USEPA May 2016 RSLs (RSL TR =  $1 \times 10^{-6}$ , THQ = 0.1)

- API Stock API 4733 2004, RBSLs for the Protection of Livestock Exposed to Petroleum Hydrocarbons.

In the context of the NEPM guidance, the primary health investigation levels (HILs), health screening levels (direct contact HSLs), ecological screening levels (ESLs), USEPA RSLs, and API RBSLs for solids considered suitable in the context of the site setting are presented in the tables in **Appendix E** below and comprise:

- Human Health:
  - NEPM Residential A and Recreational C for HILs
  - Direct Contact Soil Health Screening Levels (Friebel and Nadebaum, 2011, CRCCARE) for HSLs.
  - USEPA RSLs for residential soil.
- Ecological:
  - NEPM Schedule B5a – Areas of Ecological Significance and Urban Residential and Open Public Space for ESLs
  - API RBSLs for the Protection of Livestock Exposed to Petroleum Hydrocarbons.

In addition, regulatory criteria for residual drilling materials being beneficially reused in well pad rehabilitation using the mix, turn busy strategy, were used as screening criteria. No criteria have been developed in NSW for the management of drilling cuttings. However, criteria have been developed in Queensland leveraging international guidelines and best practices, these criteria have been used as generic screening criteria. These generic criteria are documented in the Department of Environment and Heritage Protection (DEHP) Guideline (*Environmental Protection Act* [1994]): Streamline model conditions for Petroleum Activities Version 2.01 (05 May 2016), which is the available guidance for this method.

Several constituents, primarily inorganics, in the aqueous drilling fluids were recorded above the applied screening levels. It should be noted that drinking water levels were utilised for the screening evaluation of incidental contact by the trespasser with drilling fluids stored in lined pits on the well lease. Drinking water levels are considered very conservative as the trespasser incidental contact is significantly less than exposure via ingestion of potable water. **Appendix E, Tables E-4, E-5, and E-6**, presents the descriptive statistics for the analytical data including minimum, maximum, average, detection frequency and frequency of exceedance of relevant criteria.

As presented in **Table E-4**, the exceedance of the criteria in the geogenic aqueous portion of the drilling fluids was observed at a high frequency, with approximately 60 percent or more of the samples exceeding their respective criterion. The exception was a 20 percent exceedance frequency for 2-methylnaphthalene. Therefore, additional statistics (95% upper confidence limit [UCL] on the mean) were calculated for 2-methylnaphthalene only. The USEPA ProUCL (version 5.1, USEPA, 2015) software was used to estimate 95% UCL on the mean of the dataset to determine if the estimated UCL was less than relevant screening criteria. The 2-methylnaphthalene data were gamma distributed and the recommended UCLs range from 0.00837 mg/L to 0.0114 mg/L. The 95% UCLs exceed the drinking water criteria for 2-methylnaphthalene is 0.0036 mg/L; however, as indicated in the groundwater modelling discussed in **Section 5.3.5**, it is unlikely that the geogenic chemicals in drilling fluids would migrate to a groundwater receptor. In addition, as previously discussed incidental contact by the trespasser with drilling fluids is significantly less exposure than that of a landowner using the drilling fluids as a potable source. Therefore, the geogenic chemicals in the drilling fluids recovered during the drilling process do not represent a hazard to human health or the environment.

The concentration of the C10-C16 Fraction (minus naphthalene, F2) (198 mg/kg) exceeded both the ESLs for Areas of Ecological Significance (25 mg/kg) and urban residential and open public spaces (120 mg/kg) in one sample from the geogenic solid portion of the drilling fluids. The analytical results did not exceed any other relevant screening criteria. The ProUCL software was used to estimate 95% UCL on the mean of the dataset to determine if the estimated 95% UCLs were less than relevant



screening criteria. The C10-C16 data in the calculated spent mud solids dataset were lognormally distributed at 5 percent significance and the recommended UCL of 198 mg/kg exceeded the screening criteria (**Appendix G**). Whilst estimated UCLs exceeded the screening level for Areas of Ecological Significance, the drilling fluid will be containerized for transport to an off-site treatment facility. Therefore, it is unlikely that a potential release of the drilling fluids represents a hazard to human health or the environment.

Similar to the residual drilling material solids, the C10-C16 fraction (minus naphthalene) also exceed the ESL for Areas of Ecological Significance in two cuttings samples. This fraction was only detected in two samples; therefore, as there were not enough detections to generate a reliable statistic, the UCL was not calculated for this fraction. Chromium slightly exceeded the residential HIL of 100 mg/kg in one sample (103 mg/kg). The data distribution for the chromium dataset was determined to be non-parametric, with a 95% UCL of 35.12 mg/kg. The calculated UCLs for chromium and copper do not exceed their respective screening levels of 100 mg/kg; therefore, under typical conditions, it is not anticipated that the chromium or copper concentrations would exceed RBSLs. The analytical results did not exceed any other relevant screening criteria.

Instances, where an RBSL was exceeded by a concentration in the drilling fluid chemicals in the solid material, will be addressed through management controls, the Field Development Protocol, and occupational health and safety plans. Therefore, any constituents that exceed screening criteria in the geogenic material will not be further evaluated in the quantitative risk assessment.

#### **6.4.2.2 Assessment of Impacts on Soil Salinity, Plant Growth and Soil Structure**

The ANZECC (2000) guidelines provide a framework for the assessment of potential effects of the application of drill cuttings on soil salinity and sodicity. The ANZECC values are specific to soil types and crop types with no values provided for native vegetation. The areas are very dry, with evaporation rates far exceeding participation rates, which would tend to a higher natural soil salinity. In addition, vegetation (particularly in inland areas) can typically be considered salt tolerant to very salt tolerant as defined by ANZECC (2000) in **Table 6-8** below.

**Table 6-8: Soil and Water Salinity Criteria Based on Plant Salt Tolerance Groupings Based on a Loam Clay Soil with an Average Leaching Zone Fraction of 0.31**

Plant salt tolerance groupings	Water salinity rating	Average rootzone salinity (ECse) (dS/m)
Sensitive crops	Very low	<0.95
Moderately sensitive crops	Low	0.95-1.9
Moderately tolerant crops	Medium	1.9-4.5
Tolerant crops	High	4.5-7.7
Very tolerant crops	Very high	7.7-12.2
Generally, too saline	Extreme	>12.2

Sourced from ANZECC (2000 Chapter 1) Table 4.2.4.

ECse = electrical conductivity of a saturated extract

dS/m = deciSiemen per metre

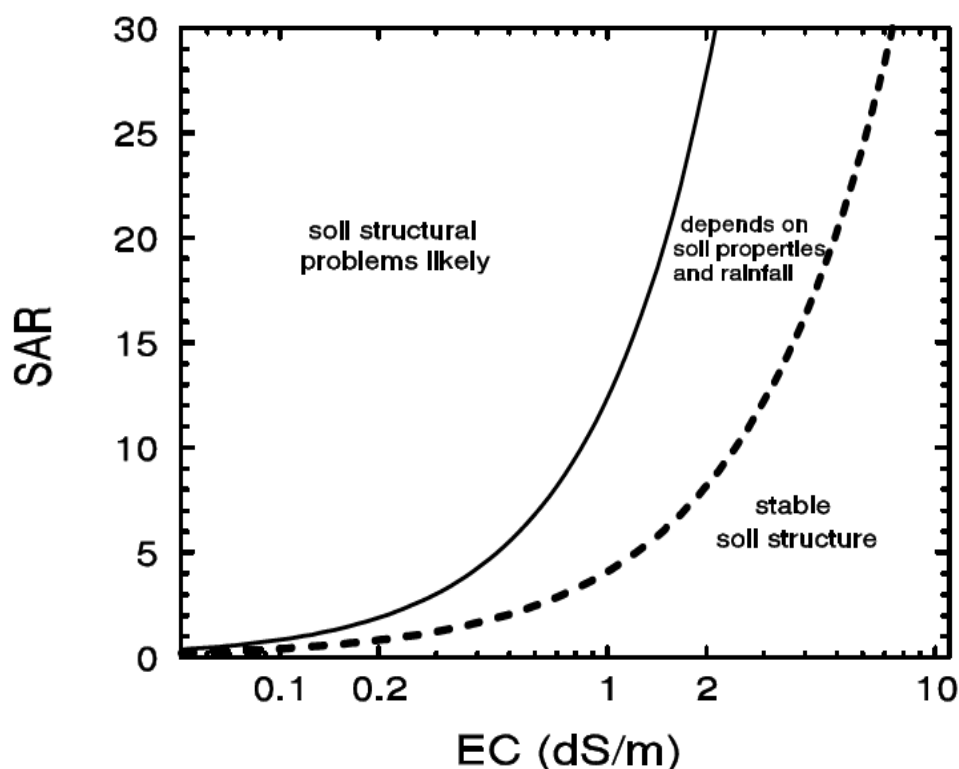
The use of sodium chloride and potassium chloride in drilling fluids elevates the electrical conductivity (EC) of the drilling fluids and residual drilling materials, with aqueous values typically in the range of 30 – 80 (deciSiemen per metre; dS/m).

Without adequate management controls in place, these materials have the potential to impact on plant growth. The retention of drilling materials on the well lease, in accordance with the EIS and EPL conditions, and integration of drill cuttings into the soil using the mix, turn, bury strategy mitigates the

potential for harm. Runoff from well leases into the receiving environment may lead to some transportation of dissolved ions, however, after integration into the soil profile, concentrations are considered similar to background levels within soils and therefore considered insignificant.

In addition, without adequate management controls in place, the potential also exists for soil stability issues. ANZECC (2000) guidance assesses the potential impacts on soil structure by assessment of soil salinity and sodicity against the stability fields for soils as provided in **Figure 6-1** below. The SAR is a measure of the sodicity of soil, with ion exchange occurring between monovalent ions (sodium) and divalent ions (calcium and magnesium) resulting in either structural stability or instability in the soil. The theory for potassium adsorption ratio and soil stability / instability is the same as for SAR.

The presence of elevated concentrations of sodium and potassium within the drill cuttings (sodium and potassium adsorption ratios of  $> 500$ ), when beneficially reused in rehabilitation of the well pad, provides an opportunity for structural instability to occur in soils. The application of drill cuttings at well pads would be carried out with regard to the volume and characteristics of the drill cuttings, the characteristics of the receiving soil, and the volume and nutrient requirements of growth media. A balance of these factors would be implemented to ensure successful rehabilitation.



**Figure 6-1: Relationship between SAR and EC for Prediction of Soil Structural Stability**  
(Adapted from DNR, 1997 from ANZECC 2000 Figure 9.2.3)

#### 6.4.2.3 Chemicals in Drilling Fluids

For the quantitative assessment, the mass balance of the COPCs in the four drilling fluids systems, as presented in **Table 6-2**, were used to estimate the potential concentrations within the aqueous phase of residual drilling materials. The drill cuttings would be stockpiled until they are required for use in well pad rehabilitation. Therefore, the concentration of select COPCs within any residual drilling fluids mixed in with the drill cuttings will decrease over time through biodegradation and photolytic degradation. 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. **Table 5** presents the environmental fate information that was used to assess biodegradation of COPCs, and that was applied at the time periods of 0, 3, and 7 days from initial recovery. The water quality data derived using these assumptions for the theoretical COPCs are presented in **Table 6**.

As discussed in **Section 5.3.3.2.1** there is no potentially complete exposure pathway to sources of drinking water; however, as a conservative measure, the theoretical concentrations for the three exposure scenarios (0, 3, and 7 days) were compared to human health toxicity-based screening levels to screen for potential effects as a result of a release from the well lease that may migrate to groundwater used as a drinking water source. The results of this comparison, including the ratio of exceedance of screening levels, is presented in **Table 7**.

If the ratio of screening levels is greater than 1.0, the exceedances of risk threshold levels is associated with this exposure scenario. Several chemicals exceeded the screening levels for all three exposure scenarios (days 0, 3, 7). **Table 6-9** presents a summary of the chemicals exceeding the screening criteria. The potential for chemicals to migrate from the well lease to a landowner bore was evaluated in a detailed fate and transport model summarised in **Section 5.3.5** and included in **Appendix C**. As noted in the model summary, the chemical additives used during drilling are unlikely to migrate to a potable water source due to the chemical and physical properties of the additives, the geology of the Project Area and distances to water bores. Therefore, potential exposure of receptors to chemical additives used in the drilling fluids will not be further evaluated in this risk assessment.

**Table 6-9: Summary of Chemical Additives in Residual Drilling Materials Exceeding Relevant Screening Criteria**

Chemical Name	Cas Number	Exceed Drinking Water Guideline	Exceed PNEC <sub>water</sub>	Exceed PNEC <sub>soil</sub>
Potassium chloride	7447-40-7	X	X	
Copolymer of acrylamide and sodium acrylate	25085-02-3			
Glyoxal	107-22-2	X	X	X (a)
Methanol	67-56-1			
Pentanedial / Glutaraldehyde	111-30-8		X	X
Sodium carbonate	497-19-8	X		
Sodium carboxymethyl cellulose	9004-32-4		X	
Sodium hydroxide	1310-73-2	X		
Starch	9005-25-8		X	
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	X	X	
Methylisothiocyanate (MITC)	556-61-6	X	X	X
Xanthan gum	11138-66-2	X		
Ethylene oxide/propylene oxide copolymer	9003-11-6		X	
Polyalkylene	9038-95-3	X	X	
Polypropylene glycol	25322-69-4	X	X	X

Chemical Name	Cas Number	Exceed Drinking Water Guideline	Exceed PNEC <sub>water</sub>	Exceed PNEC <sub>soil</sub>
Silicic acid, potassium salt	1312-76-1	X		
Sodium chloride	7647-14-5	X		
Sodium polyacrylate	9003-04-7	X	X	X

a/ COPC/PNEC<sub>solid</sub> ratio only exceeded by spent drilling muds concentration. Cuttings (surficial and buried) COPC/PNEC<sub>solid</sub> ratio not exceeded.

To screen for a potential release of drilling fluids to surface water, the theoretical concentrations of the three exposure scenarios were also compared to the PNEC for aquatic receptors. **Table 8** presents the results of this comparison, including the ratio of exceedance of screening levels. Several chemicals exceeded the screening levels for each exposure scenario on day 0, 3, and 7 (refer to **Table 6-9** for a list of COPCs exceeding the PNEC for aquatic receptors). Based on the screening, there is a potential for adverse impacts to surface water resources and associated aquatic flora and fauna from a potential release of residual drilling fluids.

As discussed in **Section 5.3.5**, there is the potential for exposure of workers, agricultural worker, and trespassers to residual drilling materials COPCs prior to or during beneficial reuse of drill cuttings for rehabilitation of well pads. To evaluate the potential exposure of the receptors to residual drilling material, three scenarios were considered:

- a conservative scenario that addressed the full concentration of COPCs released to the environment due to an accident during transport of spent drilling muds transported off the well lease to the drilling mud treatment facility
- a conservative scenario that addressed the full concentration of the COPCs retained on the drilling cuttings
- and a post-application scenario that considered the resultant concentrations on the well lease after utilising mix, turn, bury techniques.

As discussed in **Section 4.3**, the spent drilling muds are sent to an approved treatment facility for treatment and reuse on other well leases; therefore, the majority of the spent drilling fluid will be separated from the cuttings on the well lease. To estimate the concentration of the residual vendor chemicals retained with the drill cuttings, a factor of 0.1 was applied to the spent drilling fluid. The drill cuttings will subsequently be incorporated into the soil using mix, turn, bury techniques. A factor of 0.5 was applied to the residual vendor chemical concentration on the drill cuttings to quantify the COPC concentrations with the buried cuttings (to account for mixing with clean fill).

**Table 9** presents the theoretical estimates of the residual COPC concentrations on the recovered drilling fluids, surface cuttings, and buried cuttings. The ratio of estimated concentrations with the recovered drilling fluids and cuttings (both surficial and buried) to PNECs for soil exceeded the risk threshold level of 1.0. Refer to **Table 6-9** for the list of COPCs exceeding the soil PNECs.

The potential significant risk drivers (**Table 6-9**) from exposures to COPCs in recovered drilling fluids and drill cuttings are the biocides. The biocide MITC is a hydrolysis product of tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione, and due to its high volatility in water, MITC will likely evaporate in the aqueous phase soil, and therefore, will not be a risk driver. Glutaraldehyde, the other biocide that is a risk driver, readily biodegrades in soil, with an aerobic soil half-life of 1.7 days, indicating rapid degradation in soil by microbial biotransformation. In addition, photolytic degradation in water has a half-life of 18 days, and it is considered readily biodegradable in an aerobic aquatic environment with a half-life of 10.6 hours in the water/sediment system. Therefore, very low persistence exists for the biocides, either due to volatility (MITC) or biodegradation (glutaraldehyde). This would result in a low potential for exposure to terrestrial receptors.

Polypropylene glycol and sodium polyacrylate were two other non-biocide COPCs that were potential risk drivers. Polypropylene glycol rapidly biodegrades, does not bioaccumulate, and exhibits low toxicity to human and ecological receptors. Sodium polyacrylate is a relatively large polymer that does not biodegrade or bioaccumulate, but is not readily bioavailable; and has a low toxicity to human and ecological receptors. Therefore, the potential risk for terrestrial ecological exposure to COPCs in residual drilling materials will not be further evaluated in the risk assessment.

There are no RBSLs for the potentially complete exposure pathway of direct contact with COPCs in drill cuttings (either surficial or buried). Therefore, these potentially complete exposure pathways were carried further through further in risk assessment.

#### **6.4.2.4 Chemicals in Produced Water**

For the quantitative assessment of potential exposures to geogenic COPCs in produced water as a result of a release from the transport pipeline network, the concentrations of the COPCs in the produced water, as presented in **Table 6-3**, were used to estimate the potential concentrations within the produced water piped to the Leewood WMF for treatment. The screening criteria utilised for the produced water is consistent with the human health and ecological screening criteria utilised for the aqueous drilling fluids as the potentially complete exposure pathways are similar. **Appendix F (Table F-3)** presents the comparison of the production water COPC concentrations to the relevant screening criteria. Several geogenic COPCs in the produced water exceeded the drinking water guideline values; however, as noted in **Section 5.3.3.2.1** and the Irrigation General Concept Design (BenneTerra, 2015) it would take approximately 50 to 500 years for water to migrate to groundwater. Therefore, potential exposures to geogenic COPCs in produced water via drinking water will not be further evaluated in the risk assessment. Several constituents exceeded the RBSLs for stock watering and two constituents exceeded the RBSLs for aquatic ecosystems: pH and barium. The potential duration of a release of produced water is anticipated to be relatively short due to the monitoring protocols in place to minimise leakage of produced water from the pipeline network. Produced water is not planned to be beneficially reused prior to treatment at Leewood. Therefore, the anticipated potential risks associated with this pathway are considered minimal.

The theoretical residual produced water COPC concentrations in soil were compared to the same RBSLs as the theoretical drill cuttings. **Appendix F; Table F-4** presents the comparison of the residual COPC concentrations to these RBSLs. No COPCs exceeded the relevant RBSLs for human health or ecological receptors. Therefore, the potential risk for human and ecological exposure to COPCs in soils effected by a release from produced water flowlines/pipelines will not be further evaluated in the risk assessment.

#### **6.4.2.5 Chemicals in Treated Water Utilised for Irrigation, Dust Suppression, and Stock Watering**

The permeate includes the produced water as well as the vendor supplied chemicals for water treatment applied throughout the treatment process. For the quantitative assessment, the mass balances calculated for the permeate (presented in **Table 6-5** and **Table 6-6**) were utilised to evaluate the potentially complete exposure pathways in **Section 5.3.4**. In addition to the estimated concentrations of the permeate the mass balance of the COPCs in the aqueous permeate, estimates of residual permeate COPC concentrations soils were also utilised to evaluate potential risk to human and ecological receptors.

The production water COPCs in the permeate were compared to the RBSLs for stock watering and irrigation. **Appendix F, Table F-3**, presents this comparison. The majority of the COPCs are expected to be less than detectable concentrations; those COPCs that were detected did not exceed the RBSLs. The vendor chemicals were compared to PNECs for water developed as discussed in **Section 6.1.2.1**. This comparison is presented in **Table 11**. The majority of the vendor chemicals will dissociate to geogenic chemicals and are captured in **Table F-3**; the remaining COPCs are at levels below

concentrations that would exceed the risk threshold level except 5-chloro-2-methyl-4-isothiazolin-3-one and Proprietary Mixture D1 in the permeate. The permeate concentration presented in **Table 11** does not account for potential degradation of COPCs within the system and storage within the effluent tanks. These organics rapidly degrade. Releases of pure permeate (i.e., no degradation) to the aquatic environment may occur as a result of a failure of the containment system. Given management controls proposed by the Proponent, this is unlikely and, should it occur, would be rapidly addressed to limit the effect on aquatic environments. Therefore, the potential risk for ecological exposure to geogenic COPCs in permeate through consumption of permeate utilised for stock water will not be further evaluated in the risk assessment. A PNEC is not available for ingestion by terrestrial receptors of stock water; therefore, these COPCs will be further evaluated in the risk assessment for this exposure pathway.

To evaluate the potential for exposure to human and ecological receptors identified in **Section 5.3.4** to COPCs in permeate that remain in soil after beneficial reuse (e.g., irrigation), the CCL of each geogenic COPC calculated were compared to relevant soil RBSLs identified in **Section 6.4.2.1 (Appendix F; Table F-3)**.

The theoretical concentrations of geogenic and vendor COPCs retained on soils as a result of a release or irrigation activities were compared to RBSLs (**Table F-4**) and PNECs (**Table 12**). There were no exceedences of the RBSLs and the cumulative risks based on the PNECs were within risk threshold levels. Therefore, these will not be carried further through the risk assessment.

#### **6.4.2.6 Chemicals in Treated Water Directly Discharged to Bohena Creek**

The theoretical values for COPCs in permeate discharged to Bohena Creek during periods of heavy flow were compared to RBSLs for aquatic ecosystems (**Table F-3**) and PNECs (**Table 11**). No chemicals exceeded the RBSLs and the cumulative calculated risks for the vendor chemicals utilised in water treatment did not exceed the risk threshold level of 1.0. Therefore, this exposure pathway will not be further evaluated in the quantitative risk assessment.



## 7.0 EXPOSURE ASSESSMENT

The exposure assessment comprises an evaluation of surface and subsurface exposure pathways and mass balance calculation to identify the amount of each chemical used in the process, and the estimated or actual potential exposure point concentration in the affected media (e.g., soil, groundwater, air). For the chemicals selected as COPC, fate and transport modelling was used to characterise the degradation of chemicals over time and their potential transport (e.g., in groundwater) or partitioning into other phases. The assessment of exposure in the qualitative risk assessment process involves the evaluation of the data available for the project, the details associated with the surrounding environment, the nature of the exposure identified, and the potential mobility of the COPC.

For an exposure pathway to be considered complete, there must be all of the following:

- Source of COPC – how the chemical got into the environment and which environmental media are affected
- A transport media – how the chemical moves or migrates through the environment from one location to another, or from one environmental medium to another
- An exposure point – how organisms can come into contact with the chemicals (e.g., direct contact or via the food web)
- An exposure route – how the chemical could enter the organism (e.g., inhalation, ingestion or dermal contact).

For each potential complete exposure pathway for both human health and environmental receptors (i.e., terrestrial and aquatic), each of the above steps is evaluated. If any one of these steps (source, transport media, exposure point or route) was not present, the exposure pathway was incomplete and further assessment of risks was not required. The assessment of potential risks is evaluated further if there is a complete exposure pathway. Thus, even if the COPC was a PBT, if there is no threshold concentration at the point of exposure, the potential risk to environmental and human receptors does not result in exceedances of risk threshold levels and would not require mitigation measures.

The exposure assessment information was compiled from the enHealth (2012b) Australian Exposure Factors Guidance. In addition, as noted in enHealth guidance (2012a), guidance from WHO and USEPA will be used to supplement the Australian guidance, as appropriate. The exposure assessment calculations presented in the enHealth guidance (2012a) will be used to estimate intake of the COPCs by the receptors. The exposure assessment also utilised the tools presented in the Routes – Ingestion and Dermal, Tiers and Types – Aggregate and Cumulative, and Lifestages and Populations – General Population, Residential, Occupational, or Potentially Highly Exposed Populations steps in Expo-Box (USEPA, 2016) and in the Exposure Assessment – General Guidance for Exposure Assessment step in OECD (OECD, 2014).

As discussed in the CEM, the potentially complete exposure pathways for exposure to chemicals within drill cuttings, produced water, and water treatment processes are as follows:

- Exposure to chemicals in drilling fluid products as a result of release from storages (i.e., tanks) either during transport from supplier or storage warehouse or drilling fluid treatment facility to the well lease or a release from storages of products on the well lease migrating to the environment through direct contact (incidental ingestion and dermal contact) by landholders, recreational users or terrestrial or aquatic receptors.
- Exposure to vendor chemicals in recovered drilling fluids stored in pits on the well lease to trespassers through incidental ingestion or dermal contact or uptake by terrestrial receptors (wildlife and livestock).
- Exposure to residual chemicals within the drill cuttings by direct contact of workers, and direct contact by landholders or trespassers; and uptake by terrestrial wildlife.
- Exposure to geogenic chemicals in produced water conveyed to Leewood WMF via pipelines with produced water released to the environment through a release from the pipeline by first responders, landholders, trespassers, terrestrial and aquatic receptors.

- Exposure to residual chemicals in treated water utilised for irrigation/stock watering or dust suppression through contact with soil by workers, trespassers or agricultural workers, or uptake by ecological receptors (wildlife or livestock).
- Exposure to residual chemicals in treated water directly discharged to Bohena Creek by recreational users or trespassers or aquatic receptors.

Potential exposures to chemicals additives during transport and storage on the well lease or treatment facility of raw materials utilised in the drilling and treatment processes were evaluated qualitatively in **Section 6.4.1**. The potential for exposure to COPCs via direct contact with recovered drilling fluids in lined pits or storage ponds by trespassers and/or terrestrial receptors (e.g., livestock, wildlife), potential exposures to residual COPCs in drill cuttings via direct contact by trespassers, workers and uptake by wildlife (Pilliga Mouse, Rainbow Bee-eater and Cattle Egret), and potential exposures to residual COPCs in soils irrigated with permeate via direct contact by workers, trespassers, agricultural workers and uptake by wildlife (Pilliga Mouse and avian receptors) will be evaluated quantitatively in the following sections.

## 7.1 Exposure Point Concentrations

As presented above, the exposure scenarios are based on anticipated conditions and the potential for exposure to the theoretical estimate of exposure. Exposure point concentrations (EPCs) for the exposure assessment were calculated using the results of theoretical fate and transport modelling calculations and the existing environmental conditions within the recovered drilling fluids storage ponds, surface and buried drill cuttings applied to the rehabilitated well leases, and irrigated land. To assess the potential flux of drilling fluid chemicals to the environment, vendor disclosures for the drilling fluid systems and water treatment additives were reviewed, and the chemical concentrations of key inputs were determined.

The exposure scenarios for the quantitative risk assessment are based on anticipated conditions and the potential for exposure to the theoretical estimate of exposure. As discussed in **Section 6.4.2.3**, theoretical concentrations were calculated (**Table 6** and **Table 9**) for initially injected materials and after a time period of 3 and 7 days and surface and buried drill cuttings. The concentrations of residual COPCs in soils as a result of the use of permeate for irrigation purposes are presented in **Appendix F**. These concentrations will be used as the EPC for each exposure scenario.

The initial EPC (i.e., day 0) for MITC was assumed to be 0 mg/L in the spent drilling fluids because it is a degradation chemical. However, based on the half-life (five hours) of tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione, an EPC for MITC was calculated by assuming complete hydrolysis of tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione to MITC. The EPC for MITC for day 3 and day 7 were calculated based on a ratio of residual tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione to generated MITC. For the application of the spent drilling muds to the well lease, the ratio of tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione to MITC would result in an MITC concentration representative of complete hydrolysis. Therefore, tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione is assumed to not be present as a COPC in the residual drilling fluids.

## 7.2 Exposure Equations

In accordance with the guidance, calculation of intake of COPCs in the composite drilling cuttings and permeate was performed for the potentially complete exposure pathways using the equations presented below (enHealth, 2012; NEPM, 2012; USEPA, 2016):

- Ingestion of soil:
  - $$\text{Intake (mg/kg-day)} = \frac{CS \times IR_S \times EF \times ED \times RBA \times CF_{soil}}{BW \times AT}$$
- Dermal contact with soil:
  - $$\text{Intake (mg/kg-day)} = \frac{CS \times EF \times ED \times SA_{exp} \times AF \times ABS \times CF_{soil}}{BW \times AT}$$

- Ingestion of water:
  - Intake (mg/kg-day) =  $\frac{CW \times IR_W \times EF \times ED \times ET_{swim}}{BW \times AT}$
- Dermal contact with water:
  - For inorganics:
    - Intake (mg/kg-day) =  $\frac{CW \times EV \times EF \times ED \times SA_{body} \times Kp \times ET_{swim} \times CF_{water}}{BW \times AT}$
  - For Organics:
    - Intake (mg/kg-day) =  $\frac{DA_{event} \times EF \times ED \times EV \times SA_{body}}{BW \times AT}$
    - Where:
      - If  $ET \leq t^*$ , then
        - $DA_{event} (\mu g/cm^2\text{-event}) =$ 

$$2 \times FA \times Kp \times CW \times CF_{water} \times \sqrt{\frac{6 \times \tau_{event} \times ET_{swim}}{\pi}}$$
      - If  $ET > t^*$ , then
        - $DA_{event} (\mu g/cm^2\text{-event}) =$ 

$$FA \times Kp \times CW \times CF_{water} \times \left[ \frac{ET_{swim}}{(1 + B)} + 2 \times \tau_{event} \times \left( \frac{1 + 3B + 3B^2}{(1 + B)^2} \right) \right]$$

Where:

CS = concentration in soil (mg/kg)  
 IR<sub>s</sub> = ingestion rate of soil (mg/day)  
 RBA = relative bioavailability factor (unitless)  
 EF = exposure frequency (day/year)  
 ED = exposure duration (years)  
 CF<sub>soil</sub> = conversion factor for soil (1 x 10<sup>-6</sup> kg/mg)  
 AT = averaging time (days)  
 BW = body weight (kg)  
 AF = soil adherence factor (mg/cm<sup>2</sup>)  
 ABS = absorption factor (unitless)  
 EV = event frequency (events/day)  
 SA<sub>exp</sub> = exposed skin surface area available for contact (cm<sup>2</sup>/d)  
 CW = concentration in water (mg/l)  
 IR<sub>w</sub> = ingestion rate of water (l/hr)  
 SA<sub>body</sub> = total body skin surface area (cm<sup>2</sup>/d)  
 Kp = dermal permeability factor (Kp – cm/hr)  
 ET<sub>swim</sub> = exposure time (hr/day or hours/hours)  
 CF<sub>water</sub> = correction factor (1 x 10<sup>-3</sup> l/cm<sup>3</sup>)  
 t\* = time to reach steady state (hours)  
 τ<sub>event</sub> = lag time per event (hours/event)  
 B = dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

Terrestrial receptors evaluated in the ecological risk assessment for potential exposures to COPCs in drilling muds stored in pits on the well lease include domesticated livestock, large mammalian wildlife and small mammalian wildlife. Beef cattle were used to evaluate domesticated livestock, kangaroos evaluated for large mammalian wildlife, and dingos for small mammalian wildlife.

The estimate for dose-based or intake rates for the assessment endpoints for wildlife representing domestic livestock and native mammalian species exposed to COPCs in drilling fluids used the following general equation:

$$TI = \frac{CW \times IR_W \times EF \times ED}{BW \times ED \times 365 \text{ days/year}}$$

Where:

TI = Total intake of COPC (mg/kg/day)  
 CW = Concentration of COPC in water (mg/l)  
 IR<sub>W</sub> = Ingestion rate (litres/day)  
 EF = Exposure frequency (days/year)  
 ED = Exposure duration (years)  
 BW = Body weight (kg).

To estimate the intake for the assessment endpoint for wildlife representing secondary and tertiary consumers (Pilliga Mouse and avian receptors), the following general equation was used:

$$TI = \frac{[(C_{soil} \times IR_{soil}) + (C_{food} \times IR_{food} \times PR_{food}) + (C_{water} \times IR_{water})] \times HR}{BW}$$

Where:

TI = Total intake of substance (mg/kg/day)  
 C<sub>soil</sub> = Concentration of substance in soil (mg/kg)  
 IR<sub>soil</sub> = Soil ingestion rate (kg/day)  
 C<sub>food</sub> = Concentration of substance in food (mg/kg)  
 IR<sub>food</sub> = Food ingestion rate (kg/day)  
 PR<sub>food</sub> = Prey ratio (unitless)  
 C<sub>water</sub> = Concentration of substance in water (mg/l)  
 IR<sub>water</sub> = Water ingestion rate (l/day)  
 HR = Home range ratio (unitless)  
 BW = Body weight (kg)

As COPC concentrations are not anticipated to be present in drinking water for ecological receptors, the water component of the intake equation above is effectively zero. Therefore, intake of COPCs in soils will be estimated based on consumption of soil and food by ecological receptors.

### 7.2.1 Exposure Assumptions

The following sections present the exposure assumptions utilised to estimate potential exposures for both human health and ecological receptors. The exposure assumptions are presented in **Tables 13** through **20** for both human and ecological receptors.

#### 7.2.1.1 Human Health

Human health exposure assumptions were determined by review of enHealth Exposure Factors (enHealth, 2012b) and NEPM (2013). Where default exposure assumptions were not available in enHealth and NEPM guidance, USEPA (EPA-Expo-Box; USEPA, 2016) and the OECD (2014) exposure factor defaults were used to supplement the enHealth and NEPM recommendations. Where default values were not available, best professional judgement and site-specific knowledge were utilised to provide anticipated exposure assumptions.

**Table 13** presents the exposure assumptions for the trespasser scenario. The trespasser receptor exposure pathway includes a small child to teenager that may come in contact with the above grade fluid exposure scenario for approximately 20 days/year for a 10-year period with potential incidental ingestion (of 25 millilitres [mL] of fluids) and dermal contact for one half hour.

In addition, the trespasser may contact buried and redistributed soils and cuttings on the well lease once partially or completely decommissioned and rehabilitated or with soils irrigated with permeate. It should

be noted this scenario does not occur concurrently with the direct contact with recovered drilling fluids in the mud pits. An incidental ingestion rate of the soil of 100 milligrams/day (mg/day) and dermal contact with exposed surface area (e.g., the time-weighted average of the child surface area of the head, forearms, hands, lower legs, and feet) is assumed for this scenario. The weighted soil adherence factor was calculated for these body parts for this receptor using equations from enHealth (2012b) and EPA-Expo-Box (2016):

Surface Area Weighted Soil Adherence Factor:

$$\text{Weighted AF} = \frac{(AF_1)(SA_1) + (AF_2)(SA_2) + \dots + (AF_i)(SA_i)}{SA_1 + SA_2 + \dots + SA_i}$$

Where:

AF = Adherence factor of soil to skin (mg/cm<sup>2</sup>-event)

AF<sub>i</sub> = Overall adherence factor of soil to skin (mg/cm<sup>2</sup>-event)

SA<sub>i</sub> = skin surface area available for contact with body part “i” (cm<sup>2</sup>)

Workers exposure pathway includes an adult mixing, turning burying drill cuttings on well leases that may come into contact with soils during application for and exposure frequency (EF) of 2 days/year, an exposure duration (ED) of 1 year with potential incidental ingestion (330 mg/day) and dermal contact with soils on exposed skin area. The workers are assumed to have exposed faces, forearms, and hands; it is assumed a worker applying treated soils would wear long pants and shoes. Using these body parts, weighted soil adherence factors were calculated for the worker. **Table 14** presents the worker exposure scenario assumptions.

The agricultural worker exposure pathway includes potential contact with blended soils (once drill cuttings have been incorporated into the soil) through agricultural activity. Based on the size of the rehabilitated well lease, the agricultural worker is assumed to potentially come into contact with blended soils for an EF of 4 days/year, for an ED of 35 years with potential incidental ingestion (100 mg/day; **Table 15**). Similar to the worker, the agricultural worker is assumed to wear shoes and long pants whilst working the soil; therefore, the surface area and weighted soil adherence factor were calculated for exposure to the face, forearms, and hands.

Chemical-specific parameters utilised in the intake equations are presented in **Table 16**. Several chemical-specific parameters were calculated based on equations presented in the enHealth and EPA-Expo-Box guidance (enHealth, 2012; USEPA, 2007). The equations utilised and results of the calculations are presented in **Appendix H**.

### 7.2.1.2 Ecological Receptors

The exposure assumptions for kangaroo, dingo, Pilliga Mouse, avian receptors (Rainbow Bee-Eater and Cattle Egret) and livestock cattle are presented in **Table 17, 18, 19, 20, and 21** respectively. Water ingestion and BW were obtained from the following: livestock cattle from CSIRO (2007); kangaroo from Dawson (1995); and dingo from Fleming et al. (2001). The water ingestion rate (IR) for kangaroo assumed that although they may go extended periods without water (getting water from the grasses they eat); they would conservatively take advantage of the presence of surface water to replenish themselves, up to three litres per event. Dingoes in general drink one litre of water a day in the summer and about half a litre a day in winter (Dawson, 1995), a rate of 0.75 litres per day was selected as an average.

The EF and ED were based on professional judgement that incorporated operational considerations for the frequency and duration of the potential for exposure to the gas site in the three scenarios, and a conservative estimate of potential for mammalian wildlife to be exposed. The use of EF and ED replaced the use of a home range ratio that is commonly used in intake modelling equations for ecological

receptors. Home range is used appropriately when the exposure is within the habitat of the potentially exposed species. However, these species would not normally forage and breed in the operational areas.

The exposure assumptions also recognise that the storage of drilling fluids at individual well lease sites will be a temporary activity, with operational controls and activities at the well sites likely limiting the occurrence of wildlife entry and exposures. The receptors were assumed to obtain drinking water from the lined pits only on occasions when they inadvertently entered on to the operational area of a unique modelled gas well site as follows:

- Kangaroo – this receptor exposure pathway includes kangaroos that may come in contact with the above grade water exposure scenarios for an EF of 1 to 7 days/year for a 1-year period with the potential for incidental ingestion (watering).
- Dingo – this receptor exposure pathway includes dingos that may come in contact with the above grade water exposure scenarios for an EF of 1 to 7 days/year for a 1-year period with the potential for incidental ingestion (watering).

The Pilliga Mouse, Rainbow Bee-Eater and Cattle Egret would not likely enter the well lease to drink from the lined pits during drilling operations, due to the occupational nature of the activity. These species would tend to remain within their preferred habitat that surrounds the well leases, and would not preferentially forage on the well lease because of the lack of suitable habitat and vegetation, and because of the industrial nature of the operations.

The Pilliga Mouse, Rainbow Bee-Eater and Cattle Egret were selected as ecological endpoints for potential exposure to COPCs in soils on the well lease (residual drilling fluid COPCs with soils) or on land irrigated with permeate from the Leewood facility. The habitat of the Pilliga Mouse is forested areas; however, the Pilliga Mouse was used as a surrogate for small mammal exposures in pasture areas. The Cattle Egret habitat is primarily pasture areas, while the Rainbow Bee-Eater is found in both pasture and forested areas. The Great Egret and White Egret primarily found in wetlands which are not representative of site characteristics; therefore, they will not be evaluated further. Life history input values for ingestion rates, body weight, home range and dietary composition are presented below. **Table 19** summarises the assumptions for the Pilliga mouse; **Table 20** presents the assumptions for the cattle egrets.

The diet of the Pilliga Mouse consists of seeds and leaf matter (Jefferys & Fox 2001). Seeds are the primary portion (95%) of the diet in spring and summer, decreasing to 62 percent in winter. Leaf matter makes up the remainder of the diet. For this evaluation, the diet is assumed to be comprised entirely of seeds. Based on the PBT assessment, the COPCs do not bioaccumulate in seeds; therefore, soil ingestion accounts for the total intake of residual COPCs in soils. The ingestion rate of soil is assumed to be 3.8 mg/day (USEPA, 1993). Tokushima and Jarman (2008) measured average movement distances of 40 m (range 0–181 m) for recaptured individuals; however, larger movement patterns cannot be disregarded. Therefore, a home range of 1 is assumed to be a reduced range.

Rainbow Bee-Eaters feed primarily on insects (mainly bees), but will occasionally ingest other animals, including earthworms, spiders and tadpoles (Cleland et al., 1918). The majority of the prey is captured in flight, although some food is taken from the ground, including snatching items from below the surface of rivers and dams. For this evaluation, the diet is conservatively assumed to be comprised 50 percent of earthworms (corresponding to a prey ratio of 0.5) to link the potential COPCs in the soil and the feeding habits of the Rainbow Bee-Eater. Food consumption in avian receptors is assumed to correspond to body weight and was calculated utilising the following equation (USEPA, 1993):



$$F = \frac{(0.648 \times BW^{0.651})}{(1 - W)}$$

Where:

F = food intake in grams of fresh weight per day (g/day)

BW = body mass of animal (g)

W = mass fraction of water in the food (0.8 for herbivores)

Based on a body weight of 0.034 kg, an ingestion rate of 32 g/day (or 0.032 kg/day) was calculated for the Rainbow Bee Eater. Consumption of soil is assumed to be 20 percent of the food ingestion rate; therefore, the soil ingestion rate for the Rainbow Bee Eater is 0.006 kg/day.

Habitat for the Rainbow Bee-Eater includes open forests, woodlands and shrublands, and cleared areas usually near water. The rainbow bee-eater forages in woodland and forest within the mid and canopy layers, but will occasionally take earthworms. The Rainbow Bee-eater breed in burrows in the ground. As such this species has the potential to interact with drilling fluids or soils within well leases, or water storage ponds. The Rainbow Bee-Eater is known to migrate, but the home range is unknown; therefore, the home range is assumed to be 0.5.

Cattle Egrets feed mostly on grasshoppers during the breeding season. They are, however, known to consume other insects including cicadas, centipedes, spiders, cattle ticks, frogs (including cane toads), lizards (particularly skinks) and small mammals (Marchant & Higgins 1990). Similar to the Rainbow Bee-Eater, the prey ratio of earthworms is assumed to be 50 percent. Using an ingestion rate of 157 g/day (0.157 kg/day) calculated based on body weight; the 20 percent soil ingestion rate equals 31 g/day (0.031 kg/day) soil.

The cattle egret occurs in grasslands, wooded lands and terrestrial wetlands, and it has been observed in low-lying poorly drained pastures with an abundance of high grass. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (Marchant & Higgins 1990; Morton et al. 1989). Based on the variability of the habitat consisting of grasslands, wood lands and wetlands, the home range ratio was conservatively estimated to be 0.5.

The receptor exposure pathway for use of permeate for stock watering includes livestock cattle that may come in contact with the permeate for an EF of 365 to 7 days/year for a 1-year period with the potential for ingestion of stock water.

## 8.0 RISK CHARACTERISATION

The purpose of the risk characterisation is to provide a conservative estimate of the potential risk resulting from exposure to COPCs identified in the residual composite muds utilised in drilling and the water treatment chemicals utilised in treating production water. This step includes characterising environmental and human health risk-based on the identification of the following:

- Complete exposure pathways and hazard identification for each of the processes involving chemicals and exposure assessment (**Section 5.3.4**).
- The level of risk for COPCs by exposure pathway, route, and cumulative.
- Uncertainty in quality and estimates of risk are included in the step.

The risk characterisation evaluates the toxicity of the individual substances and characterises the cumulative risks of the potential exposure pathways identified in the CEM.

The cumulative risk will be calculated and specifically refers to the summation of risks for each receptor across exposure pathways, routes of exposure (e.g., ingestion, inhalation, dermal contact), and chemicals. The time is factored into the exposure over the ED specified in the exposure assessment. This methodology will be consistent with the requirements outlined in the National Water Quality Management Strategy (NWQMS). The ANZECC (2000) methodologies and international guidance on risk assessment will be used for assessment of risks to aquatic receptors, and NEPM (2013) guidance for terrestrial receptors. These methodologies include identification of the hazards posed by constituents in media that potentially come into contact with receptors. Risks to workers from undertaking the activities are specifically addressed through Health and Safety Plans and work safety procedures and will not be discussed within the risk assessment.

Threshold risk estimates will be based on the ratio of the intake of each COPC for each exposure pathway and exposure route divided by the appropriate toxicity criteria to produce a hazard quotient (HQ). The HQs for all exposure pathways for each COPC are summed for each receptor to produce a hazard index (HI). The target hazard level of threshold risk estimates is an HI of 1.0 (enHealth, 2012a; NEPM, 2013); cumulative HI greater than 1.0 indicate the potential for an adverse health effects. If the HQ or HI exceeds 1.0 indicating a potential risk, and depending on the magnitude of the potential risk, additional risk assessment methods may be employed to reduce the uncertainties inherent in the risk estimate. For non-threshold risk estimates, risks are identified as the additional probability of an individual developing cancer over a lifetime as a result of exposure. However, there were no non-threshold (i.e., carcinogenic) potential risks identified.

The risk characterisation will also identify the main or significant contributors to the overall risk assessment by the relevant exposure pathways. It will include an evaluation of the overall quality of the assessment and the degree of confidence in the estimates of risks and the conclusions from the results. This will be based on an uncertainty analysis and sensitivity analysis.

### 8.1 Human Receptors

The following sections discuss the risk characterisation for the potentially complete exposure pathways for human receptors identified in **Section 5.3.5**.

#### 8.1.1 Trespasser

The results of the theoretical assessments for composite drilling fluid system and water treatment chemicals for the trespasser exposure scenarios are summarised in **Tables 22** through **27**. As discussed above, the theoretical assessment was only conducted at the well lease sites and areas where permeate utilised for irrigation or dust suppression purposes. The exposure scenarios include the theoretical concentrations of residual drilling fluid additives present in the drilling fluids stored in lined pits, as presented in **Table 5** for scenarios day 0, day 3, and day 7 (**Tables 21, 22** and **23**). **Tables 24** and **25**

present the risk calculations for potential exposure to drill cuttings applied to the land surface well pad using mix, turn bury techniques. The potential risks associated with exposures to COPCs in soils irrigated with permeate are presented in **Table 26**. **Table 8-1** presents the cumulative HI for each scenario evaluated.

**Table 8-1: Summary of Cumulative HI for the Trespasser Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Recovered Drilling Fluids, Day 0	3.1
Recovered Drilling Fluids, Day 3	3.2
Recovered Drilling Fluids, Day 7	3.2
Residual drill cuttings – (surface)	0.0054
Residual drill material – (buried)	0.0027
Soils irrigated with permeate	0.00000071

The potential exposure of a trespasser to residual COPC concentrations in drilling fluids stored in pits resulted in levels of risk above the risk threshold (HI ranging from 3.0 to 3.2). The primary risk driver for these exposure scenarios was silicic acid, potassium salt (HI of 2.5) via the incidental ingestion of fluids, which accounts for 86 percent of the cumulative HI in day 0 and 78 percent on days 3 and 7. The calculated HI for exposures to COPCs in drilling fluids via dermal contact whilst swimming did not exceed the risk threshold level, ranging from 0.13 to 0.24. It is noted that exposure to the drilling fluids stored in pits is very conservative, as the drilling fluids pits are confined and are an active part of the drilling process, and the relatively short duration of the time the pit would be accessible to the trespasser.

Using the theoretical concentrations of COPCs in the drill cuttings applied to the land surface (both surficial and buried) and soils irrigated with permeate, no adverse effects were predicted on trespassers. Drilling fluids would only be present on the well pad during construction and the well pad would be fenced.

### 8.1.2 Worker

The estimated risks for the potentially complete exposure pathways for residual COPCs in the residual drilling materials on drill cuttings are presented in **Tables 28, 29** and **30**. The cumulative HI are presented in **Table 8-2**. No adverse effects are predicted for the worker based on the potentially complete exposure pathways identified and the theoretical concentrations.

**Table 8-2: Summary of Cumulative HI for the Worker Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Residual drill cuttings (surface)	0.00089
Residual drill materials (buried)	0.00044
Soils irrigated with permeate	0.00000012

### 8.1.3 Agricultural Worker

The risks for the potentially complete exposure scenarios for the agricultural worker to residual COPCs in the residual drilling materials were estimated based on previously discussed exposure assumptions (**Tables 31, 32** and **33**). No adverse effects are predicted for the worker based on the potentially complete exposure pathways identified and the theoretical concentrations (**Table 8-3**).

**Table 8-3: Summary of Cumulative HI for the Agricultural Worker Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Residual drill cuttings (surface)	0.001
Residual drill cuttings (buried)	0.00052
Soils irrigated with permeate	0.00000013

## 8.2 Ecological Receptors

The following sections discuss the risk estimates for the ecological receptors identified in the CEM.

### 8.2.1 Kangaroo

The risk estimates calculated for the kangaroo are presented in **Tables 34, 35** and **36**. **Table 6-9** presents the summary of the cumulative HI for this receptor for the day 0, 3 and 7 exposure scenarios. The estimated cumulative HI in the three scenarios slightly exceeded the risk threshold level of 1.0. The primary risk driver for the kangaroo is silicic acid, potassium salt with an HI of 1.2 in all exposure scenarios. The remaining COPCs did not individually exceed an HI of 1.0; however, the cumulative HI of the remaining COPCs did exceed the risk threshold levels. As discussed, drilling fluids would only be present on the well pad during construction and the well pad would be fenced.

**Table 8-4: Summary of Cumulative HI for the Kangaroo Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Recovered Drilling Fluids, Day 0	3.1
Recovered Drilling Fluids, Day 3	3.5
Recovered Drilling Fluids, Day 7	3.5

### 8.2.2 Dingo

**Tables 37, 38** and **39** present the calculated risk estimates for the dingo for potential exposures to COPCs in recovered drilling fluids via ingestion from drinking the water during storage in lined pits on the well lease. The cumulative HI for the dingo in the three exposure scenarios (1.2 to 1.4) slightly exceeded the risk threshold level (**Table 8-5**). No individual COPC resulted in the exceedance of the risk threshold level; however, the following COPCs accounted for greater than 90 percent of the risk on day 0, 3 and 7: pentanedial/glutaraldehyde, polyalkene, silicic acid, potassium salt, and tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet) (day 0) and MITC (days 3 and 7). As discussed, drilling fluids would only be present on the well pad during construction and the well pad would be fenced.

**Table 8-5: Summary of Cumulative HI for the Dingo Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Recovered Drilling Fluids, Day 0	1.3
Recovered Drilling Fluids, Day 3	1.4
Recovered Drilling Fluids, Day 7	1.4

### 8.2.3 Pilliga Mouse

**Tables 40, 41** and **42** present the calculated risk estimates for the Pilliga Mouse for potential exposures to residual COPCs in drill cuttings on the surface of the well lease, buried on the rehabilitated well lease, or soils irrigated with permeate. The cumulative HI for the mouse in the three exposure scenarios did not exceed the risk threshold levels (**Table 8-6**).

**Table 8-6: Summary of Cumulative HI for the Pilliga Mouse Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Residual drill cuttings (surface)	0.0021
Residual drill cuttings (buried)	0.001
Soils irrigated with permeate	0.0000000018

#### 8.2.4 Avian Receptors

Tables 43, 44 and 45 present the calculated risk estimates for the avian receptors for potential exposures to COPCs in drilling cuttings via ingestion of soil and prey on the rehabilitated well lease and ingestion of soil and prey on lands irrigate with permeate. The cumulative risk for the three exposure scenarios for the rainbow bee-eater and cattle egret are summarised in Table 8-7. The calculated risks for the rainbow bee-eater slightly exceeded the risk threshold levels for the potential exposure to cuttings on the surface (5.6) and buried cuttings (2.8). The primary risk drivers for these scenarios are pentanediol/glutaraldehyde, polyalkene, silicic acid, potassium salt, and MITC. The potential exposure for the cattle egret to drill cuttings on the surface of the well lease (1.6) slightly exceeded the threshold hazard of 1.0.

**Table 8-7: Summary of Cumulative HI for the Avian Receptor Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
<i>Rainbow Bee-Eater</i>	
Residual drill cuttings (surface)	5.6
Residual drill cuttings (buried)	2.8
Soils irrigated with permeate	0.0000064
<i>Cattle Egret</i>	
Residual drill cuttings (surface)	1.6
Residual drill cuttings (buried)	0.97
Soils irrigated with permeate	0.0000064

The potential risks presented in the above table are considered to be relatively low. The exposure assumptions for dietary intake assume consumption of earthworms as 50 percent of their food intake, which is not their typical dietary prey selection. In addition, surface exposure of the earthworms to the drill cuttings assumes no mix, turn and bury management, which results in an approximately 50 percent reduction in COPC concentration due to mixing with clean soil. Therefore, the relatively low HI of 2.8 for the Rainbow Bee-Eater would be the most realistic potential risk based on the process of mix, turn and bury for the drill cuttings, but would still overestimate the potential risks due to dietary considerations.

#### 8.2.5 Livestock Cattle

Table 46 presents the calculated risk estimates for the cattle for potential exposures to COPCs in permeate via ingestion of permeate utilised for stock watering. There were no exceedance of risk threshold level for the cattle via this exposure scenario (Table 8-8).

**Table 8-8 Summary of Cumulative HI for the Cattle Scenario**

Scenario	Cumulative HI (Target HI = 1.0)
Permeate utilised for stock water	0.056

### 8.3 Sensitivity Analysis

As discussed in **Section 6.3.2**, the data utilised in the quantitative risk characterisation estimates for the vendor chemicals in the drilling fluids was the maximum concentration from the four-primary potential drilling fluid systems that may be used in the Project Area. A sensitivity analysis was conducted to assess the range of potential risks in each of the individual drilling fluids, and then to compare the range of potential risks to the composite drilling fluid. This method provides a conservative estimate of potential risks associated with the individual drilling fluids as all the chemicals in the composite drilling fluid are not present in an individual drilling mud system.

To evaluate the potential risks associated with an individual drilling fluid system, the risks for each were calculated. The exposure pathways, assumptions, and toxicity values used in this sensitivity analysis evaluation of the individual drilling fluid system were the same as the composite drilling fluid system. **Appendix I** presents a summary table comparing the composite chemical drilling fluid risk characterisation results in **Sections 8.1** and **8.2** to the individual drilling fluids risk results (**Table I-1**) and the individual risk calculation tables for each mud system (**Tables I-2 through I-85**).

The following presents a brief summary of the risk threshold levels for each fluid system:

- 5% KCL Polymer PHPA – no risks above threshold were identified
- Inhibited Mud V4 Bore-HIB – risks above threshold were identified for trespasser and kangaroo exposure to fluids in storage ponds/tanks
- Inhibited Mud V4 Glycol – risks above threshold were identified for kangaroo exposure to fluids in storage ponds/tanks
- KCL Polymer – risks above threshold were identified for kangaroo exposure to fluids in storage ponds/tank.

Generally, if a chemical was identified as a risk driver in the composite mud system, it was identified as a risk driver for the individual drill fluid system. The primary risk drivers include:

- Glutaraldehyde
- Silicic acid, potassium salt
- Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)
- MITC
- Polyalkylene.

In addition to the sensitivity analysis for the different mud compositions, a sensitivity analysis was performed for the prey ratios of the avian receptors (rainbow bee-eater and cattle egret). The use of 0.5 was considered over conservative because documented feeding habits of the avian receptors included primarily flying insects and other prey species not associated with ingestion of soil. However, the assumption that 50 percent of the prey species included earth worms was conservative association with the presences of COPCs in the soil. To evaluate the uncertainty in this assumption and to provide a range of potential risk associated with this assumption, a sensitivity analysis was conducted with a range of prey ratios. **Appendix J** presents this analysis; the results, including those reported in **Section 8.2.4**, are summarised below in **Table 8-9**.

**Table 8-9 Summary of Prey Ratio Sensitivity Analysis**

Prey Ratio	Cumulative HI (Target HI = 1.0)		
	Surface Cuttings	Buried Cuttings	Irrigated Soils
<i>Rainbow Bee-Eater</i>			
0.25	4.1	2.0	0.0000046
0.5	5.6	2.8	0.0000064
0.75	7.2	3.6	0.0000082



Prey Ratio	Cumulative HI (Target HI = 1.0)		
	Surface Cuttings	Buried Cuttings	Irrigated Soils
1.0	8.7	4.4	0.00001
<i>Cattle Egret</i>			
0.25	0.89	0.55	0.0000019
0.5	1.6	0.97	0.0000064
0.75	2.2	1.4	0.0000024
1.0	2.9	1.8	0.0000061

The results of the sensitivity analysis indicate that there is less than a two-fold difference in the range of prey ratios selected. A sensitivity ratio (SR) to evaluate the sensitivity of the prey ratio. An SR equal to one would indicate that for a one-unit increase in the input variable of interest, the model output increases by one unit. An SR equal to zero indicates that changes in the input variable do not change the model output.

The equation for the SR is:

$$SR = \frac{\frac{Y_2 - Y_1}{Y_2}}{\frac{X_2 - X_1}{X_2}}$$

Where:

Y1 = baseline value of the output variable using baseline values of input variables;

Y2 = value of the output variable after changing the value of one input variable;

X1 = baseline point estimate for an input variable; and

X2 = value of the input variable after changing X1.

The SR for the prey ratio ranges from 0.7 to 0.92 for a range of input options for both species. Therefore, the prey ratio is a sensitive variable for the calculation of the potential risks to exposure to COPCs in the drill cuttings.

## 8.4 Uncertainty Analysis

The procedures and assumptions used to assess potential human health risks in this and similar human health risk assessments 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 chemicals in environmental media to the assessment of exposure and toxicity, and risk characterisation. The NEPM (2013) risk assessment guidance notes that uncertainty results from the lack of knowledge about the correct value, such as specific exposure assumptions or estimates of EPCs. The term “uncertainty” is often used in risk assessment to describe what are, in reality, two conceptually different terms: uncertainty and variability. Uncertainty can be described as the lack of a precise knowledge resulting in a fundamental data gap. Variability describes the natural heterogeneity of a population. Uncertainty can sometimes be reduced or eliminated through further measurements or study. By contrast, variability is inherent in what is being observed. Although variability can be better understood, it cannot be reduced through further measurement or study, although it may be more precisely defined. However, the additional cost of further data collection may become disproportional to the reduction in uncertainty.

The human health risk assessment approach to presenting the potential risks is consistent with the goal of representing the high end of the possible risk distribution, which is generally considered to be greater

than the 90<sup>th</sup> percentile. Further, these estimates are based on numerous and often conservative assumptions and, in the absence of definitive information, assumptions are used to ensure that actual site risks are not underestimated. The cumulative effect of these assumptions can result in an analysis with an overall conservativeness greater than the individual components.

Accordingly, it is important to note that the risks presented here are based on numerous conservative assumptions in order to be protective of human health and to ensure that the risks presented here are more likely to be overestimated rather than underestimated.

The following discussion provides an evaluation of uncertainty throughout the data acquisition and evaluation process and analysis and estimate of risk. The analysis of uncertainty follows the guidelines in NEPM (2012a) and enHealth (2012) as includes the following:

- What aspects of the problem formulation, and specifically the CSM, are uncertain and how has that uncertainty been accounted for
- Evaluation of the uncertainty and variability in the data used in the chemical risk assessment
- The degree of risks relative to the exposure assumptions with potential risks close to or slightly exceeding indicating a higher degree of uncertainty in the analysis
- The extent of missing or incomplete information and factors affecting exposure assumptions and parameters.

**Table 8-10: Evaluation of Uncertainty**

<b>Risk Assessment Section</b>	<b>Description of Uncertainty</b>	<b>Magnitude of Uncertainty</b>	<b>Effect on Risk Assessment</b>
Problem Formulation			
Hazard Assessment – Sample Collection	Representativeness of sample based on collection methods	Low	Low potential to underestimate risks.
Hazard Assessment – Sample Analysis	Uncertainty related to accuracy/precision of laboratory analytical methods	Low	Low potential to underestimate risks.
Hazard Assessment – Non Detected constituents	Evaluated using detection limits	Low	Low potential to overestimate or underestimate risks.
Hazard Assessment – Chemical additive COPC concentrations	The concentrations of residual COPCs in residual drilling materials were estimated based on drilling records from previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with the Proponent 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 Assessment Section	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment – Chemical additive COPC concentrations	Concentrations of residual COPCs evaluated in the quantitative risk assessment were assumed to be 100 percent of the injected mass. This is a conservative assumption for chemicals that may degrade rapidly or volatilise. For example, tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) rapidly transforms to MITC through hydrolysis (half-life of 5 days); however, the initial concentration of the tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) evaluated is assumed to be 100 percent of the injected material. Additionally, MITC was conservatively assumed to be present in soil; however, as this chemical is a volatile the concentrations of MITC present in soil are expected to decrease.	Medium	This assumption may overestimate the calculated risks to receptors.
Fate and Transport Groundwater Model	Use of conservative model assumptions and scenarios and dilution as the primary mechanism of decreasing concentrations of chemical additives	Low to Medium	Low to medium potential to overestimate risk
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
Exposure Assessment	The location and activity of the receptors assume that the trespasser receptors will be in contact with material the lined pits for 10 years. It is unlikely that drilling activities will commence within the vicinity of the same trespasser for 10 concurrent years. The typical period of construction (drilling, completion and work over) is 30 days, with drilling comprising a 3 to 7-day period.	Medium	Medium to high potential to overestimate risks.
Exposure Assessment – Chemical-Specific Parameters	Empirical data were not available for certain chemical-specific parameters (e.g., dermal permeability coefficient). These parameters were estimated based on equations in literature reviews.	Low	Low potential to overestimate or underestimate risks

Risk Assessment Section	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Exposure Assessment – assumptions for ecological receptors	Life-history data for all assumptions were not available for the Pilliga Mouse, Rainbow Bee-Eater, and Cattle Egret; surrogate species were used to provide assumptions based on similarity of species characteristics	Low	Low potential to overestimate or underestimate risks
Exposure Assessment – exposure point concentration	As a conservative measure, the exposure point concentration of the management of the drilling cuttings on the project site assumed spreading on the surface soils; however, the mix, turn and bury process used for the management of the drill cuttings will eliminate this conservative soil exposure pathway	Moderate	Moderate potential to overestimate risks.
Toxicity Values	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 Values	The use of mammalian toxicity values as surrogates for avian receptors is due to limited toxicological data for COPCs.	Medium	Medium to potential underestimate or overestimate risks
Cumulative Risk	The assessment for all receptors considers the maximum concentration in days 0, 3, and 7 in any one year and does not evaluate further degradation of residual concentrations	Medium	Medium to high potential to overestimate risks.
Cumulative Risk	Use of the HI for ecological receptors may not accurately assess the range of dose-response relationships (i.e. slopes and intercepts) and modes of action	Low	Low potential to underestimate or overestimate risk

## 9.0 RISK MANAGEMENT

Risk management provides recommendations for mitigation, management, monitoring and reporting. This section will firstly assess the adequacy of existing controls (used in **Section 5.0** to address issue identification), and provide recommendations for additional mitigation and management if required. A framework for inspection and monitoring will be provided including activities conducted to verify and validate the assumptions contained within the risk assessment and the potential for impacts on other environmental media.

A weight of evidence approach has been used to evaluate the potential risks to human health and ecological receptors (including MNES) both qualitatively and quantitatively. The key findings are presented in the risk assessment and are summarised in **Section 10.0**. The life cycle of the drilling and WMF chemicals was assessed specifically for the proposed operations including:

- Transportation of chemicals from the supplier or storage warehouse to the well lease
- Transportation of chemicals from the supplier or storage warehouse to the WMF
- Storage, usage, and recovery of chemicals throughout operations on the well lease
- Beneficial reuse of recovered drill cuttings for well lease rehabilitation except when containing high percentage of coal fines that will be transported off-site for disposal
- Transport of drilling fluids to and from the drilling fluid treatment facility.
- Produced water conveyance and treatment at the WMF
- Beneficial reuse of treated water.

The drilling and WMF chemicals and associated operations within the life cycle (i.e., transportation, storage, usage, and recovery) may result in potential exposure to human receptors and the environment through accidental releases. These potential releases are considered to have a very low probability of occurrence based on the Proponent's commitment to managing risk, existing legislative requirements and the engineering controls and management systems being implemented as part of this project. Key plans applicable to the management and mitigation of risks associated with chemical usage were summarised in **Section 2.3**.

The Proponent will develop and implement a range of systems and plans to control the transportation and storage of chemicals during field development and operational activities. This includes effective traffic management and routing to minimise the potential for accidents and spill management planning and response equipment. These systems and processes are considered effective in lowering the probability of occurrence of consequence associated with storage and transportation incidents.

To address the rare potential release of the drilling chemicals during transportation, storage, usage, and recovery, a qualitative assessment was conducted during the transportation, storage, and usage of the drilling chemicals. Critical health and ecological hazards were compiled for the drilling chemicals to indicate which of the drilling chemicals required special consideration with regard to the potential to be a hazard if accidentally released. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and SDS is available to emergency responders, health and safety managers, and environmental hazard clean-up teams.

The operations of the WMF will also be under the plans and protocols to be developed and will include plant operations, monitoring and maintenance. The general operating philosophy of the plant is designed to ensure that all regulatory EHS requirements are met and integrity standards are maintained and that operational improvements are continually made. The WMF would be located within the Leewood facility and will be housed within bunded areas thereby reducing the contact between treatment components and the underlying soils. Both the treated water storage tank and the produced water storage ponds can be used for storage to facilitate beneficial use of treated water. The water and brine treatment plants are designed to operate within a specified envelope and operations would trigger an automated response if deviations occur. Electrical conductivity and pH will be measured on a

continuous basis. If the electrical conductivity or pH set point are not met and maintained, an alarm will trigger resulting in reprocessing.

Analysis of sodium and calcium levels will occur on a weekly basis and water quality sampling and testing at an accredited laboratory will be undertaken on a monthly basis for other elements in accordance with environment protection licensing requirements.

Treated water will be used for beneficial purposes such as drilling and construction, dust suppression, irrigation and stock watering or for release to Bohena Creek. The later stages of the treatment process include ammonia removal, dechlorination and pH adjustment and amendments to adjust the sodium adsorption ratio to improve water quality for irrigation purposes.

Episodic releases to Bohena Creek would only occur when natural flows in the creek equal or exceed 100 ML/day which is projected to occur only 44 days per year (Eco Logical, 2016). Eco Logical (2016) report that the creek has a naturally low nutrient status due to its sand-dominated substrate which lacks organic matter. An Ecological Risk Assessment (ERA) was undertaken to assess the potential for chemical contaminants in treated water released to Bohena Creek to adversely affect aquatic and riparian ecosystems including water and soil processes, flora, and fauna (invertebrates and vertebrates). Eco Logical (2016) stated that the ecological risks from the low levels of physicochemical and chemical stressors and toxicants that may be present in treated water are considered low when released to a flowing stream, where flows are in excess of 100 ML/day. The current condition of Bohena Creek along with the Managed Release Protocol would limit the impact and environmental risks associated with discharge to Bohena Creek.

The human health and ecological hazard mitigation information provided in the risk assessment dossiers and SDS primarily focuses on safe handling, transportation, and worker protection. Therefore, the potential for accidental exposure to the drilling fluids in lined pits or from releases from storage tanks was evaluated. Direct exposure to the pits by trespassers, livestock (cattle) or wildlife would result in risks above threshold level. In addition, the accidental release of the drilling fluids from the lined pits (e.g., overflowing or breach of containment) or from the storage tanks (e.g., malfunctioning valve) would result in risks above threshold risk levels to aquatic ecological receptors if the fluids entered a surface water resource. As noted in the risk assessment, the biocides used in the drilling fluids either have very short half-lives or are highly biodegradable; therefore, the potential exposure to these drilling chemicals is limited in duration. In addition, as noted above, comprehensive management plans would be implemented to ensure that the drilling operations are conducted safely and with minimal potential for accidental exposures to human receptors or the environment to occur.

The management of the recovered drill cuttings as part of the well lease rehabilitation activities will involve a mix, turn, bury strategy. The storage and drying of materials prior to their reuse would further the decomposition/degradation process of biocides. Incorporation of the materials into the soil profile provides further degradation and reduction of the potential concentration at the point of exposure.

Both the chemical constituents of the drilling fluids and geogenic materials were evaluated using risk-based screening criteria, and exposure intake modelling, for human health and the environment, including the potential for MNES resources and other environmental values. Based on this comprehensive risk assessment, the findings indicated that there was a low potential risk from the management of drill cuttings on the well pad. For the avian receptors that slightly exceeded the risk threshold, the low potential risk is based on the conservative exposure assumptions for dietary intake that assume consumption of earthworms as 50 percent of their food intake, which is not their typical dietary prey selection. In addition, surface exposure of the earthworms to the drill cuttings assumes no mix, turn and bury management, which results in an approximately 50 percent reduction in COPC concentration due to mixing with clean soil. Therefore, the relatively low HI of 2.8 for the Rainbow Bee-Eater would be the most realistic potential risk based on the process of mix, turn and bury for the drill cuttings, but would still overestimate the potential risks due to dietary considerations.



Integral to the management of risks is effective implementation of management controls (including Santos Environmental Health and Safety Management Systems -EHSMS) and implementation of the Field Development Protocol and other key management plans. The Field Development Protocol micro-siting process would aim to avoid or minimise impacts to MNES as much as practicable while the management plans and design of infrastructure will avoid, mitigate and manage potential impacts. The EHSMS includes a broad range of management systems including requirements for occupational, health and safety (OH&S) monitoring (to ensure compliance with worker safety and standard practice of operations), operational risk assessments, engineering design and specifications and incident response and reporting.

As detailed in Chapter 30 of the EIS a range of management plans would be developed for the project with key plans comprising:

- The Erosion and Sediment Control Plan which provides strategies and methodologies to control runoff (and associated sediment) from well pad sites and the WMF.
- The Soil Management Plan which includes guidance of soil stripping, handling, stockpiling, spreading and rehabilitation (including the management of drill cuttings). Effective mixing, burial and cover will limit direct contact exposures with the drill cuttings.
- The Traffic Management Plan which will speed restrictions and warning signs for areas where potential safety risk issue (including high potential for vehicle accidents) occur and use of In-vehicle monitoring systems.
- The Produced Water Management Plan which will include management methods for irrigation, dust suppression, which will mitigate potential runoff into the surrounding environment, and a Managed Release Protocol which will control releases of treated water to Bohena Creek.
- The Waste Management Plan which documents the processes to manage generation, handling, placement and transport of wastes during all phases of the project

In conjunction with these management plans, the design of the well pad layout, water gathering and transfer pipelines and WMF includes:

- Establishment of designated chemical storage areas
- Provision of bunding or an alternative containment system for all tanks containing material that is likely to cause environmental harm in accordance with legislative requirements and Australian Standards
- Inclusion of safety showers and eye wash stations for workers where chemicals are stored and handled
- Establishment of pressure monitoring systems to enable detection of leaks and shutdown of operations to facilitate repairs
- Engineering of lined pits and ponds to limit the potential for leakage and in the unlikely event of leakage from ponds, early detection to facilitate repairs.

An ongoing monitoring program will be implemented for early identification and rectification of potential environmental issues. This will be supported by monitoring plans for surface water and groundwater (refer Appendix G3) and rehabilitation (refer Appendix W). These monitoring programs aim to:

- Detect environmental change and, specifically, identify those changes resulting from the project
- Determine actual versus predicted change
- Contribute to the assessment of the effectiveness of environmental management procedures
- Provide data for the assessment of adherence to the environmental management plans, approval and licence conditions

## 10.0 SUMMARY AND CONCLUSIONS

This risk assessment was conducted to specifically cover chemical usage within the Narrabri Gas Project Area in accordance with the EPBC Act Additional Requirements. This risk assessment provides a detailed assessment of proposed drilling and water treatment chemicals.

The risk assessment evaluates the potential human health and environmental effects of chemicals proposed to be used in gas extraction activities associated with Narrabri Gas Project. The goal of the chemical risk assessment is to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially expose human receptors and MNES and other ecological values (including terrestrial and aquatic ecological receptors), as well as water resources. To achieve this goal, Australian risk assessment guidance enHealth (2012a) and NEPM (2013) were utilised.

The EPA-Expo-Box and the OECD Environmental Risk Assessment Toolkit were used in the risk assessment to provide a compendium of risk assessment tools that links to guidance, databases, models, key references and related resources. These tools provided input throughout the risk assessment and ensured the uncertainty in the risk assessment is minimised.

The life cycle of the drilling chemicals and water treatment chemicals was assessed specifically for the Project and included:

- Transportation of chemicals from the supplier or storage warehouse to the well lease and the Leewood Water Management facility
- Storage, usage (e.g., blending, injection), and recovery of chemicals throughout operations on the well lease and at Leewood
- Management of recovered drilling cuttings on the well lease during rehabilitation activities except when containing high percentage of coal fines, these will be transported off-site for disposal
- Transportation of production water to Leewood
- Beneficial reuse of permeate for stock watering, irrigation, dust suppression
- Direct discharge of permeate to Bohena Creek.

The exposure pathways included human and environmental receptors (including MNES) were evaluated qualitatively and quantitatively. The following paragraphs summarise the key findings of the risk assessment.

A conservative groundwater modelling approach was conducted to assess the fate and transport of key chemical constituents in groundwater during the loss of drilling fluids, and the maximum lateral extent at which exceedances of risk-based criteria could potentially occur. The modelling indicates that under this highly conservative scenario that potential exceedances of threshold water quality criteria within aquifer systems (the Alluvials and Pilliga Sandstone units) is confined to the immediate vicinity of the wells (less than 70 metres of the well). The greatest lateral extent of impacts was observed for organic constituents, glutaraldehyde and MITC, which have the lowest criterion values. However as noted above, the Field Development Protocol prohibits the location of project infrastructure within 200 metres of an occupied residence (where potable water bores are most likely to be located) and as such impacts to landholder bores is unlikely.

The potential for impacts to water bores in the vicinity of a well is considered to be very low. The Field Development Protocol siting criteria sets out that unless a written agreement is in place with the relevant landholder, no project infrastructure will be located within 200 m of an occupied residence on that property. Furthermore, the siting of all infrastructure on a landholder's property would occur in consultation with the landholder under a land access agreement. Existing infrastructure, such as water supply bores, would be taken into consideration in siting wells.

The potential for releases of chemicals to groundwater as a result of the storage and conveyance of produced water, brine and treated water is considered negligible due to the limited mass of these chemicals in the production water, the mass loss mechanisms (biotic and abiotic decay), and the design, engineering and monitoring of operations in pipelines and ponds. Beneficial uses of treated water have a limited potential to contain chemicals of concern and are unlikely to lead to infiltration to groundwater due to the short-term nature of the activity (dust suppression and construction water) and application methods which are designed to limit leaching into the deeper soil profile. On this basis, the potential for impacts to groundwater from chemicals associated with drilling and water treatment as a result of project activities is considered limited.

A qualitative assessment of the potential for exposure during transport of the drilling chemicals from the warehouse to the well lease or to the WMF, preparation of the chemicals for use in the drilling or water treatment activities and transport of used drilling fluids or drill cuttings containing high percentage of coal fines was conducted and listed the critical human and ecological hazards that warrant consideration. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and SDS for use by emergency responders, health and safety managers, and environmental hazard clean-up teams. A PBT (Persistent, Bioaccumulative and Toxic) substances assessment was conducted on the drilling chemicals proposed for use in the drilling program and for water treatment. There were no PBT substances identified in this assessment.

Quantitative assessment of geogenic drill muds and cuttings were utilised to evaluate potential hazards associated with material returned to the surface. Data for other CSG projects was used to assess the risk posed by geogenic constituents within the drill cuttings. Several constituents, primarily inorganics, in the aqueous drilling fluids were potentially present above the relevant screening levels and organic constituents above screening criteria may be present in the mud and cuttings due to the presence of coal fines. It is noted, well leases will not be typically located adjacent to a residence and these materials will be constrained to the well lease. Therefore, it is unlikely that a potential release of the drilling fluids represents a hazard to human health or the environment. Any instances where a screening level is exceeded by a concentration in drill cuttings (due to geogenic compounds or drilling chemicals), will be addressed through the Field Development Protocol, proposed mitigation measures and management plans identified in the EIS and occupational health and safety plans, as outlined in Problem Formulation.

To address salinity and phytotoxicity concerns, ANZECC values specific to soil types and crop types were used for concentrations of sodium chloride and potassium chloride as these materials have the potential to impact on plant growth and soil structure. The retention of drilling materials on the well lease will be conducted in accordance with the best practice and the mixing and burial process will mitigate the potential for excessive salinisation and potential for impacts on MNES flora and fauna.

For the quantitative assessment of the drilling fluids, the mass balance of the COPC (constituents of potential concern) concentrations in a composite four mud systems were used to assess three exposure scenarios (0, 3, and 7 days) which considered a potential release from storage tanks or lined pits on the pad. Several chemicals exceeded the drinking water screening levels, but the potential for chemicals to migrate from the drilling site to a landowner bore is unlikely due to the limited volume of any potential release and distance from landholder infrastructure.

The potential for migration of COPCs in drilling fluids, cuttings, produced water or permeate to surface water resources including MNES flora and fauna was assessed by comparing the theoretical concentrations to the predicted no-effects concentration (PNEC) for aquatic receptors. Several chemicals exceeded the screening levels; however, the Field Development Protocol limits the establishment of non-linear infrastructure and large ponds and dams from riparian areas to limit potential releases to water bodies and aquatic receptors. In addition, Dazomet is rapidly hydrolysed to MITC, and MITC has a high volatility in water. Therefore, MITC will likely evaporate in the water phase during a release, and therefore, will not be a risk driver. Glutaraldehyde, both photolytic degraded and readily biodegradable, has a half-life of 10.6 hours in the water/sediment system. Therefore, the

biocides are not expected to be significant risk drivers with regards to exposure to surface water resources and MNES.

The potential for exposure of project or agricultural workers, and trespassers to COPCs retained within the drill cuttings during management of the materials on the well lease was assessed in two scenarios: a conservative scenario that addressed the full concentration of the COPCs in the residual drill cuttings and a realistic scenario that considered the mixing of the residual drill cuttings in the well lease soils utilising mix, turn, bury techniques. The theoretical concentrations were compared to PNECs for solids for ecological receptors potentially exposed to residual COPC concentrations in drill cuttings. The ratio of estimated concentrations in both surficial and buried cuttings to PNECs for soil exceeded the threshold level of 1.0. Additionally, the theoretical concentrations in the drilling fluids were compared to PNECs to evaluate the potential exposures to ecological receptors should a release occur during transport of the drilling muds to the treatment facility. Similar to the drill cuttings, the ratio of estimated COPC concentration in the drilling muds exceeded the threshold level of 1.0. The potential significant risk drivers are the biocides. As noted earlier, the biocide MITC has high volatility in water, and glutaraldehyde readily biodegrades in soil and this would result in insignificant potential for exposure to terrestrial resources including MNES.

The quantitative exposure scenario modelled for the human receptors showed some potential non-carcinogenic risks; there were no carcinogenic risks identified. For the trespasser, risks from exposure to the drilling fluid chemicals in lined pits were identified, with the primary risk driver being the silicic acid and potassium salt via incidental ingestion of fluids. It is noted that this is a very highly conservative scenario based on fencing and signage and operational monitoring. Dermal exposure risk was below criteria, as was the exposure to theoretical concentrations of the drilling fluids in the drill cuttings applied to the well lease areas during well pad rehabilitation (both blended and unblended). For the project worker and agricultural worker, there are no adverse effects predicted based on the potentially complete exposure pathways identified and the theoretical concentrations.

The modelled quantitative potential risks from the drilling fluid chemicals within the drilling mud storages were no exceedances of risk threshold levels for the kangaroo, dingo. For the kangaroo, the HI was exceeded, with the primary risk driver silicic acid and potassium salt, the remaining COPCs (glutaraldehyde, polyalkene, silicic acid, potassium salt, Dazomet [Day 0] and MITC [days 3 and 7]) exceed the cumulative risk threshold levels. The dingo slightly exceeded the cumulative risk threshold levels, with no individual COPC resulted in the exceedance of risk threshold levels. As noted above, Dazomet rapidly hydrolysed to MITC (half-life of 5 hours), and MITC has a high volatility in water. Therefore, MITC will likely evaporate in the water phase during a release, and therefore, will not be risk driver. For glutaraldehyde, photolytic degradation in water has a half-life of 18 days, and it is considered readily biodegradable in an aerobic aquatic environment with a half-life of 10.6 hours in the water/sediment system. Therefore, the biocides are not expected to be significant risk drivers to ecological receptors.

The calculated hazards for exposure to COPCs in drilling cuttings or soils irrigated with permeate by the Pilliga Mouse did not exceed risk threshold levels. The cumulative HI for the Rainbow Bee-Eater for the potential exposure to the drill cuttings also slightly exceeded the threshold level of 1.0. The calculated hazard for the Cattle Egret was also slightly above the threshold level at 1.6. The assumptions utilised to calculate the potential hazards for this receptor were highly conservative and therefore the estimated risk is likely less than the threshold level of 1.0. For the avian receptors that slightly exceeded the risk threshold, the low potential risk is based on the conservative exposure assumptions for dietary intake that assume consumption of earthworms as 50 percent of their food intake, which is not their typical dietary prey selection. In addition, surface exposure of the earthworms to the drill cuttings assumes no mix, turn and bury management, which results in an approximately 50 percent reduction in COPC concentration due to mixing with clean soil. Therefore, the relatively low HI of 2.8 for the Rainbow Bee-Eater would be the most realistic potential risk based on the process of mix, turn and bury for the drill cuttings, but would still overestimate the potential risks due to dietary considerations.

No exceedances of risk threshold levels were identified with the management of brine and the storage of chemicals at the WMF. Any exposures would be short term in nature and insufficient for chronic (long term) exposures to occur.

Potential risks from permeate were limited. Qualitative assessment identified no risks to cattle, kangaroos and dingos or to aquatic receptors within Bohena Creek (after discharge). No further quantitative assessment of these receptors was conducted. Quantitative assessment of risks to small mammals (Pilliga Mouse used as a surrogate) and avian receptors (Rainbow Bee-Eater used as a surrogate for small insectivores) and identified no exceedances of risk threshold levels. The exposure assumptions utilised for these scenarios were conservative; therefore, the residual water treatment chemicals present on soils irrigated with permeate are not expected to result in adverse effects for ecological receptors.

## 11.0 REFERENCES

- American Petroleum Industry (API). (2004). Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons, Regulatory Analysis and Scientific Affairs No. 4733 July 2004.
- Australian and New Zealand Environment Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection of aquatic ecosystems and stock watering.
- Australian Environmental Agency. (2009). Environmental Risk Assessment Guidance Manual for Industrial Chemicals, Commonwealth of Australia.
- Australian Government Department of the Environment. 2015. “Pseudomys pilligaensis”. Available online at [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=99](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=99) . Retrieved 2 June 2015.
- BeneTerra (2015). Irrigation Concept Design, Narrabri Gas Project. For Santos. 10 November 2015.
- Concise International Chemical Assessment Document (CICAD), World Health Organisation. Accessed at: <http://www.who.int/ipcs/publications/cicad/en/index.html>
- CSIRO. 2007. Nutrient requirements of domesticated ruminants.
- Dawson, Terence J. (1995). Kangaroos: Biology of the Largest Marsupials. Cornell University Press, Ithaca, New York. Second printing: 1998. ISBN 0-8014-8262-3.
- Department of Environment and Heritage Protection (DEHP). (2016). Guideline Environmental Protection Act (1994): Streamline model conditions for Petroleum Activities Version 2.01 (05 May 2016).
- Department of Environmental and Resource Management. (2010). Approval of Coal Seam Gas Water for Beneficial Use. Environmental Protection (Waste Management) Regulation 2000. Queensland Government. 2010.
- Department of Water Affairs and Forestry. (1993). South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering. Republic of South Africa. 1993. ISBN 0-7988-5343-3.
- Eco Logical. (2016a). Managed Release Study: Bohena Creek, Narrabri Gas Project. Prepared for Santos NSW (Eastern) Pty Ltd. August 2016.
- EcoLogical. (2016b). Narrabri Gas Project, Ecological Impact Assessment. Prepared for Santos NSW (Eastern) Pty Ltd. October 2015
- enHealth. (2012a). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- enHealth. (2012b) Australian exposure factor guidance, enHealth Subcommittee (enHealth) of the Australian Health Protection Principal Committee, Canberra, Australia



- Environment Protection and Heritage Council (EPHC). (2009). Environmental Risk Assessment Guidance Manual.
- European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- European Chemicals Bureau (ECB) (2003). Institute for Health and Consumer Protection. Technical Guidance Document on Risk Assessment.
- 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.
- Friebel, E & Nadebaum, P. (2011) Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 2: Application document, CRC CARE Technical Report no 10, CRC for Contamination Assessment and Remediation of the Environment, Adelaide, Australia.
- International Uniform Chemical Information Database (IUCLID) (2011). IUCLID Chemical Data Sheets Information System. Accessed at: <http://ecb.jrc.ec.europa.eu/esis/index.php?PGM=dat>
- Jefferys, E.A. & B.J. Fox (2001). The diet of the Pilliga mouse, *Pseudomys pilligaensis* (Rodentia: Muridae) from the Pilliga Scrub, northern New South Wales. In: Proceedings of the Linnean Society of New South Wales. 123:89-99
- Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. Regulatory Toxicology and Pharmacology 25:1-5.
- Lloyd-Smith, M.M. (2016). Unconventional Gas Exploration and Production: Human Health Impacts and Environmental Legacy. Available online at: <http://www.ntn.org.au/resources>
- Marchant, S. & P.J. Higgins (1990). Handbook of Australian, New Zealand and Antarctic Birds. Volume One – Ratites to Ducks. Melbourne, Victoria: Oxford University Press
- Mayfield, D., M. Johnson, J. Burris, A Fairbrother. 2014. Furthering the Derivation of Predictive Wildlife Toxicity Reference Values for Use in Soil Cleanup Decisions. Integrated Environmental Assessment and Management. 10(3):358-371.
- Menkhorst, Peter; Knight, Frank (2001). A field guide to the mammals of Australia. South Melbourne, Australia: Oxford University Press. pp. 194–195. ISBN 019550870X.
- Ministry of Health. (2008). Drinking-water Standards for New Zealand 2005 (Revised 2008). Wellington: Ministry of Health.
- Ministry of Housing, Spatial Planning and Environment (RIVM). (1994). Intervention Values and Target Values – Soil Quality Standards. Directorate-General for Environmental Protection, The Hague, The Netherlands.
- Morton, S.R., K.G. Brennan & M.D. Armstrong (1989). Distribution and Abundance of Waterbirds in the Alligator Rivers Region, Northern Territory. Volume 1
- National Environment Protection Council (NEPC). (2013). National Environment Protection (Assessment of Site Contamination) Measure.

- Natural Resource Management Ministerial Council (NRMMC). Australian Drinking Water Guidelines 6, Volume 1. National Water Quality Management Strategy. January 2011. Updated January 2016.
- NEPM. (2012). Schedule B(4) Guideline on Health Risk Assessment Methodology, Schedule B(6) Guideline on Risk Based Assessment of Groundwater Contamination, Schedule (7a) Guideline on Health-Based Investigation Levels, Schedule B (7b) Guideline on Exposure Scenarios and Exposure Settings and Schedule (5) Guideline on Ecological Risk Assessment.
- Organisation for Economic Co-operation and Development (OECD). (1992). Test No. 301: Ready Biodegradability. (Biodégradabilité Facile.) Paris: OECD Publishing.
- Organisation for Economic Co-operation and Development (OECD). (2014). The OECD Environmental Risk Assessment Toolkit: Tools for Environmental Risk Assessment and Management
- Sample, B.E. and Arenal, C.A. (1999). Allometric models for interspecies extrapolation for wildlife toxicity data. *Bull. Environ. Contam. Toxicol.*, 62:653–663.
- Sample, B.E., D.M. Opresko, and G.W. Suter II. (1996). Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp. ES/ER/TM-86/R3.
- Schneider, K., Schwarz, M., Burkholder, I., Kopp-Schneider, A., Edler, L., Kinsner-Ovaskainen, A., Hartung, T., and Hoffmann, S. (2009). ToxRTool, a new tool to assess the reliability of toxicological data. *Toxicology Letters* 189:138-144.
- Standards Australia/Standards New Zealand Standard Committee. (2009). AS/NZS ISO 31000:2009, Risk Management-Principles and Guidelines, November 2009.
- Standards Australia/Standards New Zealand Standard Committee. (2012). Managing environment-related risk. AS/NZS Handbook HB 203:2012
- Tokushima, H. & P.J. Jarman (2008). Ecology of the rare but irruptive Pilliga mouse (*Pseudomys pilligaensis*). II. Demography, home range and dispersal. *Australian Journal of Zoology*. 56:375-387.
- Tokushuma, H., S.W. Green & P.J. Jarman (2008). Ecology of the rare but irruptive Pilliga mouse (*Pseudomys pilligaensis*). I. Population fluctuation and breeding season. *Australian Journal of Zoology*. 56:363-373
- U.S. Toxic Substances Control Act Test Submissions 2.0 (TSCATS 2.0) database <https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0>
- USEPA (2011a). EPI Suite™ v4.0 Exposure and Assessment Model. Accessed at: <http://www.epa.gov/opptintr/exposure/pubs/episuite.htm>
- USEPA. (1993). Wildlife exposure factors handbook. Volume I of II. EPA/600/R-93/187a. *Office of Research and Development*, Washington, D.C. 20460
- USEPA. (2007). Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. EPA/540/R/99/005. OSWER 9285.7-02EP. PB99-963312. October 2007.

- USEPA. (2008). T-HERPS Version 1.0 User's Guide for Risk to Amphibians and Reptiles from Pesticides Terrestrial Herpetofaunal Exposure Residue Program Simulation September 4, 2008. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C.
- USEPA. (2009). National Recommended Water Quality Criteria for protection of aquatic life and human health.
- USEPA. (2011b). Ecological Soil Screening Levels. Accessed at: <http://www.epa.gov/ecotox/ecossl/>
- USEPA. (2012). T-REX Version 1.5 User's Guide for Calculating Pesticide Residues on Avian and Mammalian Food Items User's Guide T-REX Version 1.5 (Terrestrial Residue EXposure model), March 22, 2012. Environmental Fate and Effects Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C.
- USEPA. (2015). ProUCL Version 5.1 User Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041. October 2015.
- USEPA. (2016a). EPA-Expo-Box (A Toolbox for Exposure Assessors), available at <http://www.epa.gov/expobox>
- USEPA. (2016b) Regional Screening Levels, May 2016 update. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls>
- WA Department of Environment and Conservation. (2010). Assessment Levels for Soil, Sediment and Water. February 2010. Contaminated Site Management Series.
- World Health Organisation. Guidelines for Drinking-water Quality. (2006). Fourth Edition. WHO Press, Geneva, Switzerland. ISBN 978 92 4 154815 1. pp 189. 2011. Available online at: <http://www.who.int>.

## TABLES

**Table 1a**  
**Oral Reference Doses and Drinking Water Guidelines Derived for Vendor Chemicals in Drilling Fluids**  
**Narrabri Gas Project**

Constituent (CAS No.)	Study	Critical Effect/Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (ppm)
Acrylamide-sodium acrylate copolymer (25085-02-3)	_*	-	-	-	-	-
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (533-74-4)	2-yr rat dietary	Liver and RBC toxicity	1	100	0.01	0.04
Ethylene oxide/propylene oxide copolymer (9003-11-6)	2-yr rat dietary	Reduced bod wt. gain	2,500	100	25	88
Glutaraldehyde (111-30-8)	2-yr rat drinking water	Reduced body wt., body wt. gain, food consumption	4	100	0.04	0.14
Glyoxal (107-22-2)	2-yr rat drinking water	Decreased serum liver enzyme; stomach lesions	25	100	0.25	0.88
Methanol (67-56-1)	Mouse developmental	Increased cervical ribs per litter	43.1 mg/L**	100	2***	7
Polyalkylene (9038-95-3)	2-yr rat dietary	None	500	100	5	18
Polypropylene glycol (25322-69-4)	14-wk rat oral gavage	None	500	1,000	0.5	2
Potassium chloride (7447-40-7)	2-yr rat dietary	None	1,820	100	18	63
Silicic acid, potassium salt (1312-76-1)	6-month rat drinking water	None	214	1,000	0.2	0.7
Sodium carboxymethylcellulose (9004-32-4)	_*	-	-	-	-	-
Sodium polyacrylate (9003-04-7)	28-d rat dietary	None	1,136	1000	1	4
Starch (9005-25-8)	_*	-	-	-	-	-
Xanthan Gum (11138-66-2)	2-yr rat feeding	None	1,000	100	10	35

\*No toxicity studies. Expected to be a low concern to human health.

\*\*The Point of Departure (POD) value is the internal C<sub>max</sub> methanol blood concentration obtained using BMD analysis from an inhalation study.

\*\*\*PBPK modeling used for mouse-to-human extrapolation.

**Table 1b**  
**Australian Drinking Water Screening Values for Vendor Chemicals in Drilling Fluids**  
**Narrabri Gas Project**

Constituent (CAS No.)	Drinking Water Screening Guideline	Drinking Water Screening Value
Sodium carbonate (497-19-8)	Sodium; pH	180 ppm (aesthetic); 6.5 to 8.5
Sodium hydroxide (1310-73-2)	Sodium; pH	180 ppm (aesthetic); 6.5 to 8.5
Sodium chloride (7647-14-5)	Sodium; pH	180 ppm (aesthetic); 6.5 to 8.5



**Table 1c: Oral Reference Doses and Drinking Water Guidelines Derived for Water Management Facility  
Narrabri Gas Project**

Constituent (CAS No.)	Study	Critical Effect/Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (ppm)
Citric acid (77-92-9)	2-yr rat dietary	Body weight gain	1,200	100	12	42
CMI/MI [3:1]* (55965-84-9)	2-yr rat drinking water	No systemic toxicity	17	100	0.2	0.7
Proprietary Mixture D1 (MixtureD1-CasRn)	90-day rat oral gavage	Mortality, weight loss, dyspnea	5	1,000	0.005	0.02
Proprietary Ester A (EsterA-CasRn)	2-yr rat dietary	No systemic toxicity	384	100	4	14
Homopolymer of maleic acid (26099-09-2)	._**	-	-	-	-	-
Proprietary Polymer A (PolymerA-CasRn)	-	-	-	-	-	-
Polyacrylamide (9003-05-8)	2-yr rat dietary	No systemic effects.	5,000	100	50	175
PolyDADMAC (26062-79-3)	6-month rat dietary	No systemic effects.	2,000	1,000	2	7
Proprietary Mixture D2 (MixtureD1-CasRn)	2-yr rat dietary	No systemic effects.	2,000	100	20	79
Sodium Dodecyl Sulfate (151-21-3)	2-yr rat dietary	Liver effects	113	100	1.0	3.5
Sodium metabisulfite (7681-57-4)	2-yr rat dietary	No systemic effects.	955	100	10	35
Proprietary Mixture A2 (MixtureA2-CasRn)	OECD 422 rat oral gavage	No systemic effects.	1,000	1,000	1.0	3.5

\*Includes CMI (CAS No. 26172-55-4) and MI (CAS No. 2682-20-4).

\*\*Study was available or inadequate/unreliable to derive a toxicological reference or drinking water guidance value.

**Table 1d: Australian Drinking Water Guidance Values for Water Management Facility  
Narrabri Gas Project**

Constituent (CAS No.)	Drinking Water Guideline	Drinking Water Guidance Value
Aluminum chlorohydrate (CAS No. 12042-91-0)	Aluminum; chloride	0.2 mg/L (aesthetics); 250 mg/L (aesthetics)
Calcium chloride (10043-52-4)	chloride	250 mg/L (aesthetics)
Hydrochloric acid (7647-01-0)	pH; chloride	6.5 to 8.5; 250 mg/L (aesthetics)
Magnesium nitrate (10377-60-3)	Nitrate	50 mg/L
Na <sub>4</sub> EDTA (64-02-8)	EDTA	0.25 mg/L
Sodium hypochlorite (7681-52-9)	Chlorine	5 mg/L (health) and 0.6 mg/L (aesthetics)
Sodium sulfate (7757-82-6)	Sodium; sulfate	180 mg/L (aesthetics); 250 mg/L (aesthetics)
Sulfuric acid (7664-3-9)	Sulfate	250 mg/L (aesthetics)

**Table 2a**  
**PNEC<sub>water</sub> Values**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituents	Endpoint	E(L)C50 or NOEC (mg/L)	Assessment Factor	PNEC <sub>water</sub> (mg/L)
Acrylamide-sodium acrylate copolymer (25085-02-3)	_b	-	-	-
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (533-74-4)	Acute fish	0.16	1,000	$1.6 \times 10^{-4}$
Methylisothiocyanate (MITC) (533-74-4)	Chronic fish	0.004	50	$8 \times 10^{-5}$
Ethylene oxide/propylene oxide copolymer (9003-11-6)	Acute aquatic organisms	100	1,000	0.1
Glutaraldehyde (111-30-2)	Chronic algae	0.025	10	0.0025
Glyoxal (107-22-2)	Chronic <i>Daphnia</i>	3.19	10	0.319
Methanol (67-56-1)	Acute <i>Daphnia</i>	10,000	1,000	10
Polyalkylene (9038-95-3)	Acute aquatic organisms	100	1,000	0.1
Polypropylene glycol (25322-69-4)	Chronic <i>Daphnia</i> (read-across)	10	50	0.2
Potassium chloride (7447-40-7)	Acute algae	100	1,000	0.1
Silicic acid, potassium salt (1312-76-1)	_b	-	-	-
Sodium carboxymethylcellulose (9004-32-4)	Acute algae	500	1,000	0.5
Sodium carbonate (497-19-8)	_b	-	-	-
Sodium hydroxide (1310-73-2)	_b	-	-	-
Sodium polyacrylate (9003-04-7)	Chronic <i>Daphnia</i>	12	10	1.2
Starch (9005-25-8)	Acute fish	5,000	1,000	5
Xanthan Gum (11138-66-2)	_b	-	-	-

**Table 2b: Leewood Water Management Facility PNEC<sub>water</sub> Values and ANZECC Water Quality Guidelines**

Constituents	Endpoint	E(L)C50 or NOEC (mg/L)	Assessment Factor	PNEC <sub>water</sub> (mg/L)
Calcium chloride (10043-52-4)	Acute Daphnia	1,062	100	11
Citric acid (77-92-9)	Acute Daphnia	440	1,000	0.44
CMI/MI [3:1]* (55965-84-9)	Chronic Daphnia	0.01	10	0.001
Proprietary Mixture D1 (MixtureD1-CasRn)	Chronic Daphnia	0.05	50	0.001
Proprietary Ester A (EsterA-CasRn)	Chronic Algae	6.75	50	0.14
Homopolymer of maleic acid (26099-09-2)	- <sup>a</sup>	-	-	-
Hydrochloric acid (7647-01-0)	- <sup>b</sup>	-	-	-
NaEDTA (64-02-8)	Chronic Daphnia	22	10	2.2
Proprietary Polymer A (PolymerA-CasRn)	Acute Algae	130	1,000	0.13
Polyacrylamide (9003-05-8)	- <sup>a</sup>	-	-	-
PolyDADMAC (26062-79-3)	Acute fish	6.5	50	0.13
Proprietary Mixture D2 (MixtureD2-CasRn)	Chronic Algae	100	10	10
Sodium Dodecyl Sulfate (151-21-3)	Chronic Daphnia	0.88	10	0.09
Sodium metabisulfite (7681-57-4)	Chronic Daphnia	10	10	1.0
Proprietary Mixture A2 (MixtureA2-CasRn)	Acute Algae	6.1	1,000	0.006
Sodium sulfate (7757-82-6)	Chronic Invertebrate	1,109	100	11
Sulfuric acid (7664-93-9)	- <sup>b</sup>	-	-	-

\*Includes CMI (CAS No. 26172-55-4) and MI (CAS No. 2682-20-4).

<sup>a</sup>No data.

<sup>b</sup>Not calculated.

#### ANZECC Water Quality Guideline (2000)

Constituent (CAS No.)	Substance	Freshwater Trigger Value
Aluminum chlorohydrate (CAS No. 12042-91-0)	Aluminum	55 µg/L (>pH 6.5) 0.8 µg/L (<pH 6.5)
Magnesium nitrate (10377-60-3)	Nitrate	700 µg/L
Sodium hypochlorite (7681-52-9)	Chlorine	3 µg/L (as total residual chlorine)

**Table 3a**  
**PNEC<sub>soil</sub> Values**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituents	Endpoint	E(L)C50 or NOEC (mg/kg soil dw)	Assessment Factor	PNEC <sub>soil</sub> (mg/kg soil dw )
Acrylamide-sodium acrylate copolymer (25085-02-3)	- <sup>b</sup>	-	-	-
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (533-74-4)	Acute earthworm	4	1,000	0.004
Methylisothiocyanate (MITC) (533-74-4)	Acute earthworm	2.79	1,000	0.00279
Ethylene oxide/propylene oxide copolymer (9003-11-6)	- <sup>b</sup>	-	-	-
Glutaraldehyde (111-30-2)	Chronic soil organisms	1.12 <sup>c</sup>	50	0.02
Glyoxal (107-22-2)	Chronic <i>Daphnia</i>	203	50	4.06
Methanol (67-56-1)	Chronic terrestrial invertebrate	1,000	10	100
Polyalkylene (9038-95-3)	- <sup>b</sup>	-	-	-
Polypropylene glycol (25322-69-4)	-	-	-	0.05 <sup>d</sup>
Potassium chloride (7447-40-7)	- <sup>b</sup>	-	-	- <sup>c</sup>
Silicic acid, potassium salt (1312-76-1)	- <sup>b</sup>	-	-	-
Sodium carboxymethylcellulose (9004-32-4)	- <sup>b</sup>	-	-	- <sup>c</sup>
Sodium carbonate (497-19-8)	- <sup>b</sup>	-	-	-
Sodium hydroxide (1310-73-2)	- <sup>b</sup>	-	-	-
Sodium polyacrylate (9003-04-7)	Chronic nitrogen/ carbon transformation	>2,500	100	25
Starch (9005-25-8)	- <sup>b</sup>	-	-	- <sup>c</sup>
Xanthan Gum (11138-66-2)	- <sup>b</sup>	-	-	-

**Table 3b: Leewood Water Management Facility PNEC<sub>soil</sub> Values**

Constituents	Endpoint	E(L)C50 or NOEC (mg/kg soil dw)	Assessment Factor	PNEC <sub>soil</sub> (mg/kg soil dw )
Calcium chloride (10043-52-4)	- <sup>a</sup>	-	-	-
Citric acid (77-92-9)	<sup>b</sup>	-	-	0.05
CMI/MI [3:1]* (55965-84-9)	<sup>b</sup>	-	-	0.0004
Proprietary Mixture D1 (MixtureD1-CasRn)	<sup>b</sup>	-	-	0.00077
Proprietary Ester A (EsterA-CasRn)	Long-term Plant	960	100	9.6
Homopolymer of maleic acid (26099-09-2)	- <sup>c</sup>	-	-	-
Hydrochloric acid (7647-01-0)	- <sup>d</sup>	-	-	-
NaEDTA (64-02-8)	- <sup>a</sup>	-	-	-
Proprietary Polymer A (PolymerA-CasRn)	- <sup>a</sup>	-	-	-
Polyacrylamide (9003-05-8)	- <sup>a</sup>	-	-	-
PolyDADMAC (26062-79-3)	- <sup>a</sup>	-	-	-
Proprietary Mixture D2 (MixtureD2-CasRn)	<sup>b</sup>	-	-	1.3
Sodium Dodecyl Sulfate (151-21-3)	<sup>b</sup>	-	-	0.38
Sodium metabisulfite (7681-57-4)	- <sup>a</sup>	-	-	-
Proprietary Mixture A2 (MixtureA2-CasRn)	- <sup>a</sup>	-	-	-
Sodium sulfate (7757-82-6)	- <sup>a</sup>	-	-	-
Sulfuric acid (7664-3-9)	- <sup>a</sup>	-	-	-

<sup>a</sup>Equilibrium partitioning method cannot be used to calculate PNEC value since Koc and Kow values cannot be experimentally derived or estimated.

<sup>b</sup>Calculated using equilibrium partitioning method.

<sup>c</sup>No data.

<sup>d</sup>Not calculated.



**Table 4a**  
**PBT Assessment of Vendor Chemicals in Drilling Fluids**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Substance	P/vP criteria fulfilled?	B/vB criteria fulfilled?	T criteria fulfilled?	Overall conclusion
Acrylamide-sodium acrylate copolymer (25085-02-3)	Yes (polymer, not readily biodegradable)	No (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	Not PBT based on physico-chemical properties)
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (533-74-4)	No (experimental data)	No (screening data available)	No (experimental data)	Not PBT (based on screening and experimental data)
Ethylene oxide/propylene oxide copolymer (9003-11-6)	No (screening data available)	No (polymer, physico-chemical properties)	No (screening data, physico-chemical properties)	Not PBT (polymer, physico-chemical properties and screening data)
Methylisothiocyanate (MITC) (533-74-4)	No (experimental data)	No (screening data available)	Yes (experimental data)	Not PBT (based on screening and experimental data)
Glutaraldehyde (111-30-8)	No (screening data available)	No (screening data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Glyoxal (107-22-2)	No (screening data available)	No (screening data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Methanol (67-56-1)	No (screening data available)	No (experimental data available)	No (screening data available)	Not PBT (based on screening and experimental data)
Polyalkylene (9038-95-3)	No (screening data available)	No (polymer, physico-chemical properties)	No (screening data, physico-chemical properties)	
Polypropylene glycol (25322-69-4)	No (screening data available)	No (polymer, physico-chemical properties)	No (screening data available)	Not PBT (polymer, physico-chemical properties and screening data)
Potassium chloride (7447-40-7)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Silicic acid, potassium salt (1312-76-1)	Not applicable (inorganic substances ubiquitous in the environment)	Not applicable (inorganic substances ubiquitous in the environment)		Not PBT (based on screening data and ubiquitous inorganic substance)
Sodium carboxymethylcellulose (9004-32-4)	Yes (biopolymer, not readily biodegradable)	No (biopolymer, physico-chemical properties)	No (screening data available)	Not PBT (polymer, physico-chemical properties and screening data)
Sodium carbonate (497-19-8)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Sodium hydroxide (1310-73-2)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Sodium polyacrylate (9003-04-7)	Yes (polymer, not readily biodegradable)	No (polymer, physico-chemical properties)	No (experimental data available)	Not PBT based on physico-chemical properties and experimental data)
Starch (9005-25-8)	No (estimated)	No (polymer, physico-chemical properties)	No (screening data available)	Not PBT (polymer, physico-chemical properties and screening data)
Xanthan Gum (11138-66-2)	Yes (screening data available)	No (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	Not PBT (based on physico-chemical properties)

**Table 4b: Leewood Water Treatment Facility PBT Assessment of Water Treatment Chemicals**

Substance	P/vP criteria fulfilled?	B/vB criteria fulfilled?	T criteria fulfilled?	Overall conclusion
Aluminum chlorohydrate (CAS No. 12042-91-0)	Not applicable (ionic species ubiquitous in environment)	No (screening and experimental data available)	Yes (experimental data available)	Not PBT (based on screening/experimental data and ubiquitous inorganic salt)
Calcium chloride (10043-52-4)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Citric acid (77-92-9)	No (screening data available)	No (screening data available)	No (screening data available)	Not PBT (based on screening data)
CMI/MI [3:1]* (55965-84-9)	No (experimental data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on experimental data)
Proprietary Mixture D1 (MixtureD1-CasRn)	No (experimental data available)	No (screening data available)	Yes (experimental data available)	Not PBT (based on screening and experimental data)
Proprietary Ester A (EsterA-CasRn)	Yes (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Homopolymer of maleic acid (26099-09-2)	Not determined.	Not determined.	Not determined.	Not determined.
Hydrochloric acid (7647-01-0)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Magnesium nitrate (10377-60-3)	Not applicable (ionic species)	No (ionic species)	No screening data available)	Not PBT (based on screening data and ionic species)
NaEDTA (64-02-8)	Yes (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Proprietary Polymer A (PolymerA-CasRn)	Yes (screening data available)	No (polymer, physico-chemical properties)	No (screening data available)	Not PBT (based on screening data and physico-chemical properties)

Substance	P/vP criteria fulfilled?	B/vB criteria fulfilled?	T criteria fulfilled?	Overall conclusion
Polyacrylamide (9003-05-8)	Yes (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (based on polymer, physico-chemical properties)
PolyDADMAC (26062-79-3)	Yes (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (screening data available)	No (based on screening data and physico-chemical properties)
Proprietary Mixture D2 (MixtureD2-CasRn)	Yes (screening data available)	No (screening data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Sodium Dodecyl Sulfate (151-21-3)	No (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Sodium hypochlorite (7681-52-9)	Not applicable (ionic species)	No (ionic species)	Yes (experimental data available)	Not PBT (based on screening data and ionic species)
Sodium metabisulfite (7681-57-4)	Not applicable (ionic species)	No (ionic species)	No screening data available	Not PBT (based on screening data and ionic species)
Proprietary Mixture A2 (MixtureA2-CasRn)	Not applicable (ionic species)	No (ionic species)	No screening data available	Not PBT (based on screening data and ionic species)
Sodium sulfate (7757-82-6)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (experimental data available)	Not PBT (based on experimental data and ubiquitous inorganic salt)
Sulfuric acid (7664-93-9)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)

**Table 5a**  
**Environmental Fate Information**  
**Drilling Fluid System**

Constituent	Environmental Fate Information
Acrylamide-sodium acrylate copolymer	Not readily biodegradable
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	Degradation by hydrolysis <sup>a</sup>
Methylisothiocyanate (MITC)	Not readily biodegradable; volatilization <sup>b</sup>
Ethylene oxide/propylene oxide copolymer	Readily biodegradable or inherently biodegradable <sup>d</sup>
Glutaraldehyde	Readily biodegradable (half-life = 15 days) <sup>c</sup>
Glyoxal	Readily biodegradable (half-life = 15 days) <sup>c</sup>
Methanol	Readily biodegradable (half-life = 15 days) <sup>c</sup>
Polyalkylene	Readily biodegradable to slowly biodegradable <sup>d</sup>
Polypropylene glycol	Readily biodegradable (half-life = 15 days) <sup>c</sup>
Potassium chloride	Dissociates completely in aqueous media
Silicic acid, potassium salt	Not applicable; inorganic substance
Sodium carboxymethylcellulose	Inherently biodegradable (half-life = 150 days) <sup>a</sup>
Sodium carbonate	Dissociates completely in aqueous media
Sodium chloride	Dissociates completely in aqueous media
Sodium hydroxide	Dissociates completely in aqueous media
Sodium polyacrylate	Not readily biodegradable
Starch	Readily biodegradable (half-life = 15 days) <sup>c</sup>
Xanthan gum	Inherently biodegradable (half-life = 150 days) <sup>a</sup>

<sup>a</sup>Half-life in water is 5 hours at 25oC (pH 7); half-life in soil is 7-12 hours at 20oC.

<sup>b</sup>MITC is expected to be removed rapidly from water and soil by volatilization (vapor pressure = 2,500 Pa).

<sup>c</sup>EU Guidance Document: Half-life estimates from in vitro biodegradation test results

<sup>d</sup>Dependent on the size and composition of the polymer.

**Table 5b**  
**Biodegradation Information**  
**Leewood Water Management Facility**  
**Narrabri Gas Project**

Constituent	Environmental Fate Information
Aluminum chlorohydrate	Dissociates completely in aqueous media
Calcium chloride	Dissociates completely in aqueous media
Citric acid	Readily biodegradable (half-life = 15 days) <sup>a</sup>
CMI/MI [3:1]	Half-lives in river sediment-water system: 17.3 h (CMI) and 9.1 h (MI)
Proprietary Mixture D1	Not biodegradable. Other degradation pathways exists. The half-life in aerobic metabolism study was <4 hours. Half-lives in soil are 4-25 hours. See dossier.
Proprietary Ester A	Not readily biodegradable
Homopolymer of maleic acid	Not determined.
Hydrochloric acid	Dissociates completely in aqueous media
Manganese nitrate	Dissociates completely in aqueous media
NaEDTA	Not readily biodegradable. Can be degraded under alkaline conditions.
Proprietary Polymer A	Not readily biodegradable
Polyacrylamide	Not readily biodegradable
PolyDADMAC	Not readily biodegradable
Proprietary Mixture D2	Inherently biodegradable (half-life = 150 days) <sup>a</sup>
Sodium dodecyl sulfate	Readily biodegradable (half-life = 15 days) <sup>a</sup>
Sodium hypochlorite	Dissociates completely in aqueous media
Sodium metabisulfite	Dissociates completely in aqueous media
Proprietary Mixture A2	Dissociates completely in aqueous media
Sodium sulfate	Dissociates completely in aqueous media
Sulfuric acid	Dissociates completely in aqueous media

<sup>a</sup>EU Guidance Document: Half-life estimates from in vitro biodegradation test results

**Table 6**  
**Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
Potassium chloride	7447-40-7	69,200	NA	69200	69200	69200
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1170	1170	1170
Glyoxal	107-22-2	51	15	51	44.4	36.9
Methanol	67-56-1	5	15	5	4.4	3.6
Pentanedial / Glutaraldehyde	111-30-8	500	NA	500	500.0	500.0
Sodium carbonate	497-19-8	130	NA	130	130	130
Sodium carboxymethyl cellulose	9004-32-4	5,195	150	5195	5123	5029
Sodium hydroxide	1310-73-2	500	NA	500	500	500
Starch	9005-25-8	5,096	15	5096	4436	3688
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	0.21	50	0.0	0.0
Methylisothiocyanate (MITC)	556-61-6	-	NA	0.00	50.0	50.0
Xanthan gum	11138-66-2	5,100	150	5100	5030	5030
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	NA	40.00	40.0	40.0
Polyalkylene	9038-95-3	37,100	NA	37100	37100	37100
Polypropylene glycol	25322-69-4	80	15	80.0	69.6	69.6
Silicic acid, potassium salt	1312-76-1	37,000	NA	37000	37000	37000
Sodium chloride	7647-14-5	76,000	NA	76000	76000	76000
Sodium polyacrylate	9003-04-7	1,820	NA	1820.00	1820.0	1820.0

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabilizes to 100% MITC after 3-5 days based on degradation.



**Table 7**  
**Comparison of Theoretical Concentrations of COPCs to Drinking Water Guidelines**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)			Drinking Water Screening Level	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)		
				Temporal Scenario (days)				Temporal Scenario (days)		
		Drilling Fluids	Half-Life (days)	0	3	7		0	3	7
Potassium chloride	7447-40-7	69,200	NA	69,200	69,200	69,200	63	1.1E+03	1.1E+03	1.1E+03
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1,170	1,170	1,170	-	NA	NA	NA
Glyoxal	107-22-2	51	15	51	44	37	0.88	5.8E+01	5.0E+01	4.2E+01
Methanol	67-56-1	5	15	5	4	4	7.00	7.1E-01	6.2E-01	5.2E-01
Pentanedial / Glutaraldehyde	111-30-8	500	NA	500	500	500	0.14	3.6E+03	3.6E+03	3.6E+03
Sodium carbonate	497-19-8	130	NA	130	130	130	180.00	7.2E-01	7.2E-01	7.2E-01
Sodium carboxymethyl cellulose	9004-32-4	5,195	150	5,195	5,123	5,029	-	NA	NA	NA
Sodium hydroxide	1310-73-2	500	NA	500	500	500	180.00	2.8E+00	2.8E+00	2.8E+00
Starch	9005-25-8	5,096	15	5,096	4,436	3,688	-	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	0.21	50	0	0	0.04	1.3E+03	5.8E-02	9.6E-08
Methylisothiocyanate (MITC)	556-61-6	-	NA	0	50	50	18.00	NA	2.8E+00	2.8E+00
Xanthan gum	11138-66-2	5,100	150	5,100	5,030	5,030	35.00	1.5E+02	1.4E+02	1.4E+02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	NA	40	40	40	88.00	4.5E-01	4.5E-01	4.5E-01
Polyalkylene	9038-95-3	37,100	NA	37,100	37,100	37,100	18.00	2.1E+03	2.1E+03	2.1E+03
Polypropylene glycol	25322-69-4	80	15	80	70	70	2.00	4.0E+01	3.5E+01	3.5E+01
Silicic acid, potassium salt	1312-76-1	37,000	NA	37,000	37,000	37,000	0.70	5.3E+04	5.3E+04	5.3E+04
Sodium chloride	7647-14-5	76,000	NA	76,000	76,000	76,000	180.00	4.2E+02	4.2E+02	4.2E+02
Sodium polyacrylate	9003-04-7	1,820	NA	1,820	1,820	1,820	4.00	4.6E+02	4.6E+02	4.6E+02
Cumulative Ratio:								6.2E+04	6.1E+04	6.1E+04

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table 8**  
**Comparison of Theoretical Concentrations of COPCs to PNECs (Water)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)			PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)		
				Temporal Scenario (days)				Temporal Scenario (days)		
		Drilling Fluids	Half-Life (days)	0	3	7		0	3	7
Potassium chloride	7447-40-7	69,200	NA	69,200	69,200	69,200	1.00E-01	6.9E+05	6.9E+05	6.9E+05
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1,170	1,170	1,170	-	NA	NA	NA
Glyoxal	107-22-2	51	15	51	44	37	3.19E-01	1.6E+02	1.4E+02	1.2E+02
Methanol	67-56-1	5	15	5	4	4	1.00E+01	5.0E-01	4.4E-01	3.6E-01
Pentanedial / Glutaraldehyde	111-30-8	500	NA	500	500	500	2.50E-03	2.0E+05	2.0E+05	2.0E+05
Sodium carbonate	497-19-8	130	NA	130	130	130	-	NA	NA	NA
Sodium carboxymethyl cellulose	9004-32-4	5,195	150	5,195	5,123	5,029	5.00E-01	1.0E+04	1.0E+04	1.0E+04
Sodium hydroxide	1310-73-2	500	NA	500	500	500	-	NA	NA	NA
Starch	9005-25-8	5,096	15	5,096	4,436	3,688	5.00E+00	1.0E+03	8.9E+02	7.4E+02
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	0.21	50	0	0	1.60E-04	3.1E+05	1.4E+01	2.4E-05
Methylisothiocyanate (MITC)	556-61-6	-	NA	0	50	50	8.00E-05	0.0E+00	6.2E+05	6.2E+05
Xanthan gum	11138-66-2	5,100	150	5,100	5,030	5,030	-	NA	NA	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	NA	40	40	40	1.00E-01	4.0E+02	4.0E+02	4.0E+02
Polyalkylene	9038-95-3	37,100	NA	37,100	37,100	37,100	1.00E-01	3.7E+05	3.7E+05	3.7E+05
Polypropylene glycol	25322-69-4	80	15	80	70	70	2.00E-01	4.0E+02	3.5E+02	3.5E+02
Silicic acid, potassium salt	1312-76-1	37,000	NA	37,000	37,000	37,000	-	NA	NA	NA
Sodium chloride	7647-14-5	76,000	NA	76,000	76,000	76,000	-	NA	NA	NA
Sodium polyacrylate	9003-04-7	1,820	NA	1,820	1,820	1,820	1.20E+00	1.5E+03	1.5E+03	1.5E+03

**Cumulative Ratio:**    1.6E+06    1.9E+06    1.9E+06

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table 9**  
**Summary of Theoretical Concentrations of Vendor Chemicals with Spent Drilling Muds and Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg) (a)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)
Potassium chloride	7447-40-7	41,520	4152	2076
Copolymer of acrylamide and sodium acrylate	25085-02-3	702	70.2	35.1
Glyoxal	107-22-2	31	3.06	1.53
Methanol	67-56-1	3	0.3	0.15
Pentanedial / Glutaraldehyde	111-30-8	300	30	15
Sodium carbonate	497-19-8	78	7.8	3.90
Sodium carboxymethyl cellulose	9004-32-4	3,117	312	156
Sodium hydroxide	1310-73-2	300	30	15.00
Starch	9005-25-8	3,058	306	153
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	0.0	0.00
Methylisothiocyanate (MITC)	556-61-6	30	3.0	1.50
Xanthan gum	11138-66-2	3,060	306	153
Ethylene oxide/propylene oxide copolymer	9003-11-6	24	2.4	1.20
Polyalkylene	9038-95-3	22,260	2226	1113
Polypropylene glycol	25322-69-4	48	4.8	2.40
Silicic acid, potassium salt	1312-76-1	22,200	2220	1110
Sodium chloride	7647-14-5	45,600	4560	2280
Sodium polyacrylate	9003-04-7	1,092	109	54.60

a/ Assume 10 percent of residual vendor chemicals remain on cuttings after shaker.

b/ Assume drill cuttings mixed at 1 to 1 ratio with clean fill; therefore, reduction of COPC concentration of 50%.

c/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.

**Table 10**  
**Comparison of Theoretical Concentrations of COPCs to PNECs (Solid)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)		
						Spent Drilling Muds	Surface Cuttings	Buried Cuttings
Potassium chloride	7447-40-7	41,520	4,152	2,076	-c	NA	NA	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	702	70	35	-	NA	NA	NA
Glyoxal	107-22-2	31	3	2	4.1E+00	7.5E+00	7.5E-01	3.8E-01
Methanol	67-56-1	3	0	0	1.0E+02	3.0E-02	3.0E-03	1.5E-03
Pentanedial / Glutaraldehyde	111-30-8	300	30	15	2.0E-02	1.5E+04	1.5E+03	7.5E+02
Sodium carbonate	497-19-8	78	8	4	-	NA	NA	NA
Sodium carboxymethyl cellulose	9004-32-4	3,117	312	156	-c	NA	NA	NA
Sodium hydroxide	1310-73-2	300	30	15	-	NA	NA	NA
Starch	9005-25-8	3,058	306	153	-c	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	-	-	4.0E-03	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	30	3	1	2.8E-03	1.1E+04	1.1E+03	5.4E+02
Xanthan gum	11138-66-2	3,060	306	153	-	NA	NA	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	24	2	1	-	NA	NA	NA
Polyalkylene	9038-95-3	22,260	2,226	1,113	-	NA	NA	NA
Polypropylene glycol	25322-69-4	48	5	2	5.0E-02	9.6E+02	9.6E+01	4.8E+01
Silicic acid, potassium salt	1312-76-1	22,200	2,220	1,110	-	NA	NA	NA
Sodium chloride	7647-14-5	45,600	4,560	2,280	-	NA	NA	NA
Sodium polyacrylate	9003-04-7	1,092	109	55	2.5E+01	4.4E+01	4.4E+00	2.2E+00
<b>Cumulative Ratio:</b>						2.7E+04	2.7E+03	1.3E+03

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.

**Table 11**  
**Comparison of Theoretical Concentrations of COPCs to PNECs (Water)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Permeate Concentration (mg/l)	Estimated Permeate Vendor Chemical Concentrations Including Biodegradation and Mixing in Bohena Creek (mg/l)			PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)		
			Exposure Scenario				Exposure Scenario		
			Permeate	Degredation	Bohena Creek		Permeate	Degredation	Bohena Creek
Proprietary Polymer A	PolymerA-CasRn	0.49	0.49	0.06	0.0015	1.30E-01	3.8E+00	4.7E-01	1.2E-02
Proprietary Ester A	EsterA-CasRn	0.098	0.098	0	0.0003	1.40E-01	7.0E-01	8.7E-02	2.2E-03
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA	5.50E-02	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	NA	NA	NA	1.00E+00	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA	3.00E-03	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA	-	NA	NA	NA
Citric Acid	77-92-9	NA	NA	NA	NA	4.40E-01	NA	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA	-	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA	1.10E+01	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.29	0.29	0.29	0.0007	2.20E+00	1.3E-01	1.3E-01	3.2E-04
Polydadmac	26062-79-3	NA	NA	NA	NA	1.30E-01	NA	NA	NA
Polyacrylamide	9003-05-8	NA	NA	NA	NA	-	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	0.50	0.50	0.028	0.0007	1.00E-03	5.0E+02	2.8E+01	7.0E-01
2 methyl-isothiazolin-3 one	2682-20-4	0.10	0.10	0.006	0.00014	1.00E-03	1.0E+02	5.6E+00	1.4E-01
Proprietary Mixture D1	MixtureD1-CasRn	0.065	0.065	0.001	0.000019	1.00E-03	6.5E+01	7.8E-01	1.9E-02
Proprietary Mixture D2	MixtureD2-CasRn	0.065	0.07	0.065	0.0016	1.00E+01	6.5E-03	6.5E-03	1.6E-04
Sodium Chloride	7647-14-5	NA	NA	NA	NA	-	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	NA	NA	NA	9.00E-02	NA	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	NA	NA	NA	6.00E-03	NA	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA	-	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA	-	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA	-	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	NA	NA	NA	1.20E+00	NA	NA	NA

**Cumulative Ratio:      6.7E+02                      3.5E+01                      8.8E-01**

**Table 12**  
**Comparison of Theoretical Concentrations of COPCs to PNECs (Solid)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Permeate in Soil From Release (mg/kg)	Estimated Vendor Chemical Concentration in Soil After 20 Years Irrigation (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)	
					Soil	Irrigated Soil
Proprietary Polymer A	PolymerA-CasRn	0.04	0.21	-	NA	NA
Proprietary Ester A	EsterA-CasRn	0.008	0.01	9.6E+00	8.0E-04	5.4E-04
Aluminium Chlorohydrate	1327-41-9	NA	NA	-	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	NA	-	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	-	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	-	NA	NA
Citric Acid	77-92-9	NA	NA	5.0E-02	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	-	NA	NA
Calcium Chloride	10043-52-4	NA	NA	-	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.02	0.12	-	NA	NA
Polydadmac	26062-79-3	NA	NA	-	NA	NA
Polyacrylamide	9003-05-8	NA	NA	-	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	NA	4.0E-04	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	NA	4.0E-04	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	NA	7.7E-04	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.01	0.03	1.3E+00	4.0E-03	2.1E-02
Sodium Chloride	7647-14-5	NA	NA	-	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	NA	3.8E-01	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	NA	-	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	-	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	-	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	-	NA	NA
Sodium Polyacrylate	9003-04-7	NA	NA	2.5E+01	NA	NA
<b>Cumulative Ratio:</b>					4.8E-03	2.2E-02

**Table 13**  
**Trespasser Exposure Assumptions**  
**Narrabri Gas Project**

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Water	Ingestion	IR	Ingestion rate	l/hr	0.025	enHealth, 2012
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		BW	Body weight	kg	51	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
	Dermal	SA	Surface area for contact (total body)	cm <sup>2</sup>	14,900	(d) enHealth, 2012, USEPA, 2016
		Kp	Dermal permeability factor	cm/h	chemical-specific	USEPA, 2016
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		EV	Event Frequency	events/day	1.0	USEPA, 2016
		BW	Body weight	kg	51	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
		CF	Conversion factor	l/cm <sup>3</sup>	1.0E-03	enHealth, 212
Soil	Ingestion	IR	Ingestion rate	mg/day	50	enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
	Dermal	CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
		SA	Surface area for contact (exposed)	cm <sup>2</sup> /day	4,700	(e) enHealth, 2012, USEPA, 2016
		ABS	Absorption Factor	unitless	chemical-specific	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		BW	Body weight	kg	51	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
		AF	Soil Adherence Factor	mg soil/cm <sup>2</sup> skin	0.07	(f) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 212

**a/ Units:**

l/hr = litres per hour	cm/h = centimetre per hour
hr/day = hours per day	l/cm <sup>3</sup> = litre per cubic centimetre
day/yr = days per year	cm <sup>2</sup> /day = square centimetre per day
yr = year	mg soil/cm <sup>2</sup> skin = milligrams soil per square centimetre skin
kg = kilogram	kg/mg = kilogram per milligram
cm <sup>2</sup> = square centimetre	

**b/ References:**

enHealth, 2012:  
enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommittee of the Australian Health Protection Principal Committee, Canberra, Australia.

BPJ:  
Best Professional Judgement

USEPA, 2016  
USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at  
<http://www.epa.gov/expobox>

c/ The body weight is the time weighted average calculated from enHealth exposure factors for a male or female child aged 8 to 18 years old.

d/ Total body surface area is the time weighted average of total surface area of male or female child aged 6 to 11, 11 to 16, and 16 to 18 years old.

e/ Exposed body surface area is the time weighted average of head, forearms, hands, lower legs, and feet.

Forearms are considered 45% of arm surface area; lower leg is considered 40% of leg surface area (USEPA, 2016).

f/ Adherence factor calculated for exposed body part surface area is the time weighted average of head, forearms, hands, lower legs, and feet.



**Table 14**  
**Worker Exposure Assumptions**  
**Narrabri Gas Project**

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Soil	Ingestion	IR	Ingestion rate	mg/day	330	USEPA, 2016
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	1	BPJ
		BW	Body weight	kg	78	enHealth, 2012
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	365	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact (exposed)	cm <sup>2</sup> /day	2,936	(c) enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	1	BPJ
		BW	Body weight	kg	78	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	365	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		ABS	Absorption factor	unitless	chemical-specific	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm <sup>2</sup> skin	0.21	(d) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012

**a/ Units:**

mg/day = milligrams per day

day/yr = days per year

yr = year

kg = kilogram

mg soil/cm<sup>2</sup> skin = milligrams soil per square centimetre skin

kg/mg = kilogram per milligram

cm<sup>2</sup> = square centimetre

cm<sup>2</sup>/day = square centimetre per day

**b/ References:**

USEPA, 2016

USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at <http://www.epa.gov/expobox>

enHealth, 2012:

enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommittee of the Australian Health Protection Principal Committee, Canberra, Australia.

BPJ: Best Professional Judgement

**c/ Exposed body surface area is the time weighted average of head, forearms, hands, lower legs, and feet.**

Forearms are considered 45% of arm surface area; lower leg is considered 40% of leg surface area (USEPA, 2016).

**d/ Adherence factor calculated for exposed body part surface area is the time weighted average of head, forearms, hands, lower legs, and feet.**

**Table 15**  
**Agricultural Worker Exposure Assumptions**  
**Narrabri Gas Project**

Media	Exposure Route	Parameter Code	Parameter Definition	Units	Parameter Value	Source
Soil	Ingestion	IR	Ingestion rate	mg/day	100	enHealth, 2012
		EF	Exposure frequency	day/yr	4	BPJ
		ED	Exposure duration	yr	35	BPJ
		BW	Body weight	kg	78	enHealth, 2012
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact	cm <sup>2</sup> /day	5,664	(c) enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	4	BPJ
		ED	Exposure duration	yr	35	BPJ
		BW	Body weight	kg	78	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		ABS	Absorption factor	unitless	chemical-specific	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm <sup>2</sup> skin	0.08	(d) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012

**a/ Units:**

mg/day = milligrams per day

day/yr = days per year

yr = year

kg = kilogram

mg soil/cm<sup>2</sup> skin = milligrams soil per square centimetre skin

kg/mg = kilogram per milligram

cm<sup>2</sup> = square centimetre

cm<sup>2</sup>/day = square centimetre per day

**b/ References:**

USEPA, 2016

USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at <http://www.epa.gov/expobox>

enHealth, 2012:

enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommittee of the Australian Health Protection Principal Committee, Canberra, Australia.

BPJ: Best Professional Judgement

**c/ Exposed body surface area is the time weighted average of head, forearms, hands, lower legs, and feet.**

Forearms are considered 45% of arm surface area; lower leg is considered 40% of leg surface area (USEPA, 2016).

**d/ Adherence factor calculated for exposed body part surface area is the time weighted average of head, forearms, hands, lower legs, and feet.**

**Table 16**  
**Chemical-Specific Parameters**  
**Narrabri Gas Project**

Chemical Name	CAS Number	RBA (unitless)	Source	FA (unitless)	Source (a)	Kp (cm/hour)	Source (a)	Dermal Absorption Factor (unitless)	Source (a)	t* (hours)	Source (a)	tau <sub>event</sub> (hours/event)	Source (a)	B (unitless)	Source (a)
<b>Drilling Chemicals</b>															
Potassium chloride	7447-40-7	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	2.75E-01	calculated (b)	NA	calculated (b)
Copolymer of acrylamide and sodium acrylate	25085-02-3	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Glyoxal	107-22-2	1.0	enHealth, 2012	1.0	USEPA, 2016	8.79E-03	Risk Dossier, calculated (b)	1.0	enHealth, 2012	5.33E-01	calculated (b)	2.22E-01	calculated (b)	2.58E-02	calculated (b)
Methanol	67-56-1	1.0	enHealth, 2012	1.0	USEPA, 2016	3.25E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	3.81E-01	calculated (b)	1.59E-01	calculated (b)	7.08E-04	calculated (b)
Pentanedial / Glutaraldehyde	111-30-8	1.0	enHealth, 2012	1.0	USEPA, 2016	2.52E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	9.16E-01	calculated (b)	3.82E-01	calculated (b)	9.71E-04	calculated (b)
Sodium carbonate	497-19-8	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	4.12E-01	calculated (b)	NA	calculated (b)
Sodium carboxymethyl cellulose	9004-32-4	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Sodium hydroxide	1310-73-2	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	1.76E-01	calculated (b)	NA	calculated (b)
Starch	9005-25-8	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1.0	enHealth, 2012	1.0	USEPA, 2016	3.08E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	2.04E+00	calculated (b)	8.51E-01	calculated (b)	1.51E-03	calculated (b)
Methylisothiocyanate (MITC)	556-61-6	1.0	enHealth, 2012	1.0	USEPA, 2016	9.74E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	6.47E-01	calculated (b)	2.70E-01	calculated (b)	3.20E-03	calculated (b)
Xanthan gum	11138-66-2	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Polyalkylene	9038-95-3	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Polypropylene glycol	25322-69-4	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Silicic acid, potassium salt	1312-76-1	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Sodium Chloride	7647-14-5	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Sodium polyacrylate	9003-04-7	1.0	enHealth, 2012	1.0	USEPA, 2016	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
<b>Water Treatment Chemicals</b>															
Proprietary Polymer A	PolymerA-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Proprietary Ester A	EsterA-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Aluminium Chlorohydrate	1327-41-9	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Sodium Meta Bisulphite	7681-57-4	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Sodium Hypochlorite	7681-52-9	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Citric Acid	77-92-9	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Hydrochloric Acid	7647-01-0	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Calcium Chloride	10043-52-4	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Ethylene diamine tetraacetic acid, EDTA	64-02-8	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Polydadmac	26062-79-3	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Polyacrylamide	9003-05-8	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
2 methyl-isothiazolin-3 one	2682-20-4	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Proprietary Mixture D1	MixtureD1-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Proprietary Mixture D2	MixtureD2-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Sodium dodecyl sulfate	151-21-3	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Proprietary Mixture A2	MixtureA2-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Homopolymer of maleic acid	26009-09-2	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-
Proprietary Mixture A3	MixtureA3-CasRn	1.0	enHealth, 2012	1.0	USEPA, 2016	-	-	1.0	enHealth, 2012	-	-	-	-	-	-

NA = not applicable

- indicates not necessary for complete exposure pathways

a/ References:

USEPA, 2016

USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at

<http://www.epa.gov/expobox>

enHealth, 2012:

enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommittee of the Australian

**Table 17**  
**Kangaroo Exposure Assumptions**  
**Narrabri Gas Project**

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	Fleming, 2001

**a/ Units:**

l/day = litres per day

day/yr = days per year

yr = year

kg = kilogram

**b/ References:**

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.

BPJ - Best Professional Judgement

**Table 18**  
**Dingo Exposure Assumptions**  
**Narrabri Gas Project**

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	Dawson, 1995

a/ Units:

l/day = litres per day

day/yr = days per year

yr = year

kg = kilogram

b/ References:

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.

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**Table 19**  
**Mouse Exposure Assumptions**  
**Narrabri Gas Project**

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR-S	Ingestion rate soil	kg/day	0.0000038	Calculated with average ingestion rate (3.8 mg/day); white-footed mouse data from USEPA 1993.
	HR	Home Range ratio	unitless	0.5	Tokushima and Jarman (2008) measured average movement distances of 40 m (range 0–181 m) for recaptured individuals; however, larger movement patterns cannot be disregarded.
	BW	Body weight	kg	0.012	Average body weight from Australian Government DOE (2015) and Menkhorst and Knight (2001). The weight of the animal is 10-14 grams.

a/ Units:

mg/day = milligrams per day

kg/day = kilograms per day

kg = kilogram

b/ References:

USEPA, 1993

USEPA. (1993) Wildlife Exposure Factors Handbook United States Environmental Protection Agency

Office of Research and Development. EPA/600/R-93/187. December 1993.

Australian Government Department of the Environment. "Pseudomys pilligaensis".

Available online at: [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=99](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=99) . Retrieved 2 June 2015.

Menkhorst, Peter; Knight, Frank (2001). A field guide to the mammals of Australia.

South Melbourne, Australia: Oxford University Press. pp. 194–195. ISBN 019550870X.

**Table 20**  
**Avian Receptor Exposure Assumptions**  
**Narrabri Gas Project**

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
<i><b>Rainbow Bee-Eater</b></i>					
Ingestion	IR-S	Ingestion rate soil	kg/day	0.006	Nagy, 1987
	IR-F	Ingestion rate food	kg/day	0.032	Cleland et al, 1918
	HR	Home Range ratio	unitless	0.5	BPJ
	BW	Body weight	kg	0.034	What-when-how, 2016
	PR	Prey Ratio	unitless	0.5	The rainbow bee-eater mainly consumes insects; a prey ratio of 0.5 is conservatively assumed and likely overestimates potential consumption of worms.
<i><b>Cattle Egret</b></i>					
Ingestion	IR-S	Ingestion rate soil	kg/day	0.031	BPJ
	IR-F	Ingestion rate food	kg/day	0.157	The Cattle Egret feeds mostly on grasshoppers, other insects, and small mammals (Marchant & Higgins, 1990). For this evaluation, diet is assumed to consist entirely of earthworms (BPJ) to link the potential COPCs in soil and feed habits of egret. The ingestion rate is calculated using USEPA T-REX model equations.
	HR	Home Range ratio	unitless	0.5	BPJ
	BW	Body weight	kg	0.390	Siegfried, 1969
	PR	Prey Ratio	unitless	0.5	The cattle egret mainly consumes insects; a prey ratio of 0.5 is conservatively assumed and likely overestimates potential consumption of worms.

a/ Units:

kg/day = milligrams per day

kg = kilogram

b/ References:

BPJ - Best Professional Judgement

Nagy KA. 1987. Field metabolic rate and food requirement scaling in mammals and birds. Ecol Monogr 57(2):111-128.

Cleland, J.B., J.H. Maiden, W.W. Frogatt, E.W. Ferguson & C.T. Musson (1918). The food of Australian birds. Scientific Bulletin of Department of Agriculture, NSW. 15:1--112.

What-when-how. 2016 Rainbow Bee-eater (Birds). Retrieved from <http://what-when-how.com/birds/rainbow-bee-eater-birds/>. November 2016.

W.R. Siegfried (1969) Energy Metabolism of the Cattle Egret, Zoologica Africana, 4:2, 265-273, DOI: 10.1080/00445096.1969.11447375

Marchant, S. & P.J. Higgins (1990). Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks. Melbourne, Victoria: Oxford University Press



**Table 21**  
**Cattle Exposure Assumptions**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

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	365	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	454	API, 2004
	AT-NC	Averaging time - noncancer	days	365	API, 2004

a/ Units:

l/day = litres per day

day/yr = days per year

yr = year

kg = kilogram

b/ References:

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.

BPJ - Best Professional Judgement

**Table 22**  
**Risk Estimates for Trespasser from Vendor Chemicals in Lined Pits (Day 0)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	69,200	Yes	NA	1.8E+01	9.3E-01	NA	5.2E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	51	Yes	4.1E-04	2.5E-01	6.8E-04	6.6E-03	2.7E-03	2.6E-02
Methanol	67-56-1	5	No	1.3E-06	2.0E+00	6.7E-05	2.1E-05	3.4E-05	1.1E-05
Pentanedial / Glutaraldehyde	111-30-8	500	Yes	1.5E-04	4.0E-02	6.7E-03	2.4E-03	1.7E-01	6.1E-02
Sodium carbonate	497-19-8	130	Yes	NA	5.1E+01	1.7E-03	NA	3.4E-05	NA
Sodium carboxymethyl cellulose	9004-32-4	5,195	Yes	NA	-	7.0E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	500	Yes	NA	5.1E+01	6.7E-03	NA	1.3E-04	NA
Starch	9005-25-8	5,096	Yes	NA	-	6.8E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	Yes	2.8E-05	1.0E-02	6.7E-04	4.5E-04	6.7E-02	4.5E-02
Xanthan gum	11138-66-2	5,100	Yes	NA	1.0E+01	6.8E-02	NA	6.8E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	80	Yes	NA	5.0E-01	1.1E-03	NA	2.1E-03	NA
Silicic acid, potassium salt	1312-76-1	37,000	Yes	NA	2.0E-01	5.0E-01	NA	2.5E+00	NA
Sodium chloride	7647-14-5	76,000	Yes	NA	5.1E+01	1.0E+00	NA	2.0E-02	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	NA	Yes	NA	5.0E-03	NA	NA	NA	NA

Exposure Pathway HI:                      **2.9E+00**                      **1.3E-01**

CADD = chronic absorbed daily dose

Cumulative HI:                      **3.1E+00**

**Table 23**  
**Risk Estimates for Trespasser from Vendor Chemicals in Lined Pits (Day 3)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	69,200	Yes	NA	1.8E+01	9.3E-01	NA	5.2E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	44.40	Yes	3.6E-04	2.5E-01	6.0E-04	5.8E-03	2.4E-03	2.3E-02
Methanol	67-56-1	4.35	No	1.2E-06	2.0E+00	5.8E-05	1.9E-05	2.9E-05	9.3E-06
Pentanedial / Glutaraldehyde	111-30-8	500	Yes	1.5E-04	4.0E-02	6.7E-03	2.4E-03	1.7E-01	6.1E-02
Sodium carbonate	497-19-8	130	Yes	NA	5.1E+01	1.7E-03	NA	3.4E-05	NA
Sodium carboxymethyl cellulose	9004-32-4	5,123	Yes	NA	-	6.9E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	500	Yes	NA	5.1E+01	6.7E-03	NA	1.3E-04	NA
Starch	9005-25-8	4,436	Yes	NA	-	6.0E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	1.3E-09	1.0E-02	3.1E-08	2.1E-08	3.1E-06	2.1E-06
Xanthan gum	11138-66-2	5,030	Yes	NA	1.0E+01	6.8E-02	NA	6.8E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	37,000	Yes	NA	2.0E-01	5.0E-01	NA	2.5E+00	NA
Sodium chloride	7647-14-5	76,000	Yes	NA	5.1E+01	1.0E+00	NA	2.0E-02	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	50	Yes	4.9E-05	5.0E-03	6.7E-04	7.9E-04	1.3E-01	1.6E-01

Exposure Pathway HI: **3.0E+00** **2.4E-01**

Cumulative HI: **3.2E+00**

CADD = chronic absorbed daily dose

**Table 24**  
**Risk Estimates for Trespasser from Vendor Chemicals in Lined Pits (Day 7)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	69,200	Yes	NA	1.8E+01	9.3E-01	NA	5.2E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	36.91	Yes	3.0E-04	2.5E-01	5.0E-04	4.8E-03	2.0E-03	1.9E-02
Methanol	67-56-1	3.62	No	9.6E-07	2.0E+00	4.9E-05	1.5E-05	2.4E-05	7.7E-06
Pentanedial / Glutaraldehyde	111-30-8	500	Yes	1.5E-04	4.0E-02	6.7E-03	2.4E-03	1.7E-01	6.1E-02
Sodium carbonate	497-19-8	130	Yes	NA	5.1E+01	1.7E-03	NA	3.4E-05	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	Yes	NA	-	6.8E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	500	Yes	NA	5.1E+01	6.7E-03	NA	1.3E-04	NA
Starch	9005-25-8	3,688	Yes	NA	-	5.0E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	2.1E-15	1.0E-02	5.2E-14	3.4E-14	5.2E-12	3.4E-12
Xanthan gum	11138-66-2	5,030	Yes	NA	1.0E+01	6.8E-02	NA	6.8E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	37,000	Yes	NA	2.0E-01	5.0E-01	NA	2.5E+00	NA
Sodium chloride	7647-14-5	76,000	Yes	NA	5.1E+01	1.0E+00	NA	2.0E-02	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	50	Yes	4.9E-05	5.0E-03	6.7E-04	7.9E-04	1.3E-01	1.6E-01

Exposure Pathway HI:                      **3.0E+00**                      **2.4E-01**

CADD = chronic absorbed daily dose

Cumulative HI:                      **3.2E+00**

**Table 25**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	4,152	1.8E+01	2.2E-04	1.5E-03	1.2E-05	8.2E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	3.8E-06	2.5E-05	NA	NA
Glyoxal	107-22-2	3	2.5E-01	1.6E-07	1.1E-06	6.6E-07	4.3E-06
Methanol	67-56-1	0.3	2.0E+00	1.6E-08	1.1E-07	8.1E-09	5.3E-08
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	1.6E-06	1.1E-05	4.0E-05	2.7E-04
Sodium carbonate	497-19-8	8	5.1E+01	4.2E-07	2.8E-06	8.1E-09	5.4E-08
Sodium carboxymethyl cellulose	9004-32-4	312	-	1.7E-05	1.1E-04	NA	NA
Sodium hydroxide	1310-73-2	30	5.1E+01	1.6E-06	1.1E-05	3.1E-08	2.1E-07
Starch	9005-25-8	306	-	1.6E-05	1.1E-04	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.0E+01	1.6E-05	1.1E-04	1.6E-06	1.1E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	2	2.5E+01	1.3E-07	8.5E-07	5.2E-09	3.4E-08
Polyalkylene	9038-95-3	2,226	5.0E+00	1.2E-04	7.9E-04	2.4E-05	1.6E-04
Polypropylene glycol	25322-69-4	5	5.0E-01	2.6E-07	1.7E-06	5.2E-07	3.4E-06
Silicic acid, potassium salt	1312-76-1	2,220	2.0E-01	1.2E-04	7.8E-04	6.0E-04	3.9E-03
Sodium Chloride	7647-14-5	4,560	5.1E+01	2.4E-04	1.6E-03	4.8E-06	3.1E-05
Sodium polyacrylate	9003-04-7	109	1.0E+00	5.9E-06	3.9E-05	5.9E-06	3.9E-05
Methylisothiocyanate (MITC)	556-61-6	3	5.0E-03	1.6E-07	1.1E-06	3.2E-05	2.1E-04

**Exposure Pathway HI: 7.2E-04 4.7E-03**

CADD = chronic absorbed daily dose

**Cumulative HI: 5.4E-03**

**Table 26**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	2,076	1.8E+01	1.1E-04	7.3E-04	6.2E-06	4.1E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	1.9E-06	1.2E-05	NA	NA
Glyoxal	107-22-2	2	2.5E-01	8.2E-08	5.4E-07	3.3E-07	2.2E-06
Methanol	67-56-1	0.15	2.0E+00	8.1E-09	5.3E-08	4.0E-09	2.7E-08
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	8.1E-07	5.3E-06	2.0E-05	1.3E-04
Sodium carbonate	497-19-8	4	5.1E+01	2.1E-07	1.4E-06	4.1E-09	2.7E-08
Sodium carboxymethyl cellulose	9004-32-4	156	-	8.4E-06	5.5E-05	NA	NA
Sodium hydroxide	1310-73-2	15	5.1E+01	8.1E-07	5.3E-06	1.6E-08	1.0E-07
Starch	9005-25-8	153	-	8.2E-06	5.4E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.0E+01	8.2E-06	5.4E-05	8.2E-07	5.4E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	6.4E-08	4.2E-07	2.6E-09	1.7E-08
Polyalkylene	9038-95-3	1,113	5.0E+00	6.0E-05	3.9E-04	1.2E-05	7.9E-05
Polypropylene glycol	25322-69-4	2	5.0E-01	1.3E-07	8.5E-07	2.6E-07	1.7E-06
Silicic acid, potassium salt	1312-76-1	1,110	2.0E-01	6.0E-05	3.9E-04	3.0E-04	2.0E-03
Sodium Chloride	7647-14-5	2,280	5.1E+01	1.2E-04	8.1E-04	2.4E-06	1.6E-05
Sodium polyacrylate	9003-04-7	55	1.0E+00	2.9E-06	1.9E-05	2.9E-06	1.9E-05
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	8.1E-08	5.3E-07	1.6E-05	1.1E-04

Exposure Pathway HI:

3.6E-04

2.4E-03

CADD = chronic absorbed daily dose

Cumulative HI:

2.7E-03

**Table 27**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Soils From Irrigation/Dust Suppression**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Proprietary Polymer A	PolymerA-CasRn	0.21	-	1.1E-08	7.3E-08	NA	NA
Proprietary Ester A	EsterA-CasRn	0.005	4.0E+00	2.8E-10	1.8E-09	6.9E-11	4.6E-10
Aluminium Chlorohydrate	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.0E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.4E+00	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+01	NA	NA	NA	NA
Hydrochloric Acid	7647-01-0	NA	7.1E+01	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	7.1E+01	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	7.1E-02	6.6E-09	4.4E-08	9.3E-08	6.1E-07
Polydadmac	26062-79-3	NA	2.0E+00	NA	NA	NA	NA
Polyacrylamide	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	2.0E-01	NA	NA	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	2.0E-01	NA	NA	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	5.0E-03	NA	NA	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.027	2.0E+01	1.5E-09	9.7E-09	7.4E-11	4.9E-10
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.0E+00	NA	NA	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.0E+00	NA	NA	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	-	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	1.4E+01	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	-	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA

Exposure Pathway HI: 9.3E-08 6.1E-07

CADD = chronic absorbed daily dose

Cumulative HI: 7.1E-07



**Table 28**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	4,152	1.8E+01	9.6E-05	1.8E-04	5.3E-06	1.0E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	1.6E-06	3.0E-06	NA	NA
Glyoxal	107-22-2	3.1	2.5E-01	7.1E-08	1.3E-07	2.8E-07	5.3E-07
Methanol	67-56-1	0.3	2.0E+00	7.0E-09	1.3E-08	3.5E-09	6.5E-09
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	7.0E-07	1.3E-06	1.7E-05	3.2E-05
Sodium carbonate	497-19-8	8	5.1E+01	1.8E-07	3.4E-07	3.5E-09	6.6E-09
Sodium carboxymethyl cellulose	9004-32-4	312	-	7.2E-06	1.4E-05	NA	NA
Sodium hydroxide	1310-73-2	30	5.1E+01	7.0E-07	1.3E-06	1.4E-08	2.5E-08
Starch	9005-25-8	306	-	7.1E-06	1.3E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.0E+01	7.1E-06	1.3E-05	7.1E-07	1.3E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	2.5E+01	5.6E-08	1.0E-07	2.2E-09	4.2E-09
Polyalkylene	9038-95-3	2,226	5.0E+00	5.2E-05	9.6E-05	1.0E-05	1.9E-05
Polypropylene glycol	25322-69-4	5	5.0E-01	1.1E-07	2.1E-07	2.2E-07	4.2E-07
Silicic acid, potassium salt	1312-76-1	2,220	2.0E-01	5.1E-05	9.6E-05	2.6E-04	4.8E-04
Sodium Chloride	7647-14-5	4,560	5.1E+01	1.1E-04	2.0E-04	2.1E-06	3.8E-06
Sodium polyacrylate	9003-04-7	109	1.0E+00	2.5E-06	4.7E-06	2.5E-06	4.7E-06
Methylisothiocyanate (MITC)	556-61-6	3	5.0E-03	7.0E-08	1.3E-07	1.4E-05	2.6E-05

**Exposure Pathway HI: 3.1E-04 5.8E-04**

CADD = chronic absorbed daily dose

**Cumulative HI: 8.9E-04**

**Table 29**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	2,076	1.8E+01	4.8E-05	9.0E-05	2.7E-06	5.0E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	8.1E-07	1.5E-06	NA	NA
Glyoxal	107-22-2	2	2.5E-01	3.5E-08	6.6E-08	1.4E-07	2.7E-07
Methanol	67-56-1	0.15	2.0E+00	3.5E-09	6.5E-09	1.7E-09	3.2E-09
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	3.5E-07	6.5E-07	8.7E-06	1.6E-05
Sodium carbonate	497-19-8	4	5.1E+01	9.0E-08	1.7E-07	1.8E-09	3.3E-09
Sodium carboxymethyl cellulose	9004-32-4	156	-	3.6E-06	6.8E-06	NA	NA
Sodium hydroxide	1310-73-2	15	5.1E+01	3.5E-07	6.5E-07	6.8E-09	1.3E-08
Starch	9005-25-8	153	-	3.5E-06	6.6E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.0E+01	3.5E-06	6.6E-06	3.5E-07	6.6E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	2.8E-08	5.2E-08	1.1E-09	2.1E-09
Polyalkylene	9038-95-3	1,113	5.0E+00	2.6E-05	4.8E-05	5.2E-06	9.6E-06
Polypropylene glycol	25322-69-4	2	5.0E-01	5.6E-08	1.0E-07	1.1E-07	2.1E-07
Silicic acid, potassium salt	1312-76-1	1,110	2.0E-01	2.6E-05	4.8E-05	1.3E-04	2.4E-04
Sodium Chloride	7647-14-5	2,280	5.1E+01	5.3E-05	9.9E-05	1.0E-06	1.9E-06
Sodium polyacrylate	9003-04-7	55	1.0E+00	1.3E-06	2.4E-06	1.3E-06	2.4E-06
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	3.5E-08	6.5E-08	7.0E-06	1.3E-05

**Exposure Pathway HI: 1.6E-04 2.9E-04**

CADD = chronic absorbed daily dose

**Cumulative HI: 4.4E-04**

**Table 30**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Soils From Irrigation/Dust Supression**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Proprietary Polymer A	PolymerA-CasRn	0.21	-	4.8E-09	8.9E-09	NA	NA
Proprietary Ester A	EsterA-CasRn	0.005	4.0E+00	1.2E-10	2.2E-10	3.0E-11	5.6E-11
Aluminium Chlorohydrate	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.0E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.4E+00	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+01	NA	NA	NA	NA
Hydrochloric Acid	7647-01-0	NA	7.1E+01	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	7.1E+01	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	7.1E-02	2.9E-09	5.4E-09	4.0E-08	7.5E-08
Polydadmac	26062-79-3	NA	2.0E+00	NA	NA	NA	NA
Polyacrylamide	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	2.0E-01	NA	NA	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	2.0E-01	NA	NA	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	5.0E-03	NA	NA	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.027	2.0E+01	6.4E-10	1.2E-09	3.2E-11	6.0E-11
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.0E+00	NA	NA	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.0E+00	NA	NA	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	-	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	1.4E+01	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	-	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA

Exposure Pathway HI: 4.0E-08 7.5E-08

CADD = chronic absorbed daily dose

Cumulative HI: 1.2E-07

**Table 31**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	4,152	1.8E+01	5.8E-05	2.6E-04	3.2E-06	1.5E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	9.9E-07	4.5E-06	NA	NA
Glyoxal	107-22-2	3.1	2.5E-01	4.3E-08	1.9E-07	1.7E-07	7.8E-07
Methanol	67-56-1	0.3	2.0E+00	4.2E-09	1.9E-08	2.1E-09	9.5E-09
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	4.2E-07	1.9E-06	1.1E-05	4.8E-05
Sodium carbonate	497-19-8	7.8	5.1E+01	1.1E-07	5.0E-07	2.1E-09	9.7E-09
Sodium carboxymethyl cellulose	9004-32-4	312	-	4.4E-06	2.0E-05	NA	NA
Sodium hydroxide	1310-73-2	30	5.1E+01	4.2E-07	1.9E-06	8.2E-09	3.7E-08
Starch	9005-25-8	306	-	4.3E-06	1.9E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.0E+01	4.3E-06	1.9E-05	4.3E-07	1.9E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	2.5E+01	3.4E-08	1.5E-07	1.3E-09	6.1E-09
Polyalkylene	9038-95-3	2,226	5.0E+00	3.1E-05	1.4E-04	6.3E-06	2.8E-05
Polypropylene glycol	25322-69-4	4.8	5.0E-01	6.7E-08	3.1E-07	1.3E-07	6.1E-07
Silicic acid, potassium salt	1312-76-1	2,220	2.0E-01	3.1E-05	1.4E-04	1.6E-04	7.1E-04
Sodium Chloride	7647-14-5	4,560	5.1E+01	6.4E-05	2.9E-04	1.2E-06	5.6E-06
Sodium polyacrylate	9003-04-7	109	1.0E+00	1.5E-06	7.0E-06	1.5E-06	7.0E-06
Methylisothiocyanate (MITC)	556-61-6	3.0	5.0E-03	4.2E-08	1.9E-07	8.4E-06	3.8E-05

Exposure Pathway HI: **1.9E-04** **8.5E-04**

CADD = chronic absorbed daily dose

Cumulative HI: **1.0E-03**

**Table 32**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	2,076	1.8E+01	2.9E-05	1.3E-04	1.6E-06	7.3E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	4.9E-07	2.2E-06	NA	NA
Glyoxal	107-22-2	1.5	2.5E-01	2.1E-08	9.7E-08	8.6E-08	3.9E-07
Methanol	67-56-1	0.15	2.0E+00	2.1E-09	9.5E-09	1.1E-09	4.8E-09
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	2.1E-07	9.5E-07	5.3E-06	2.4E-05
Sodium carbonate	497-19-8	3.9	5.1E+01	5.5E-08	2.5E-07	1.1E-09	4.8E-09
Sodium carboxymethyl cellulose	9004-32-4	156	-	2.2E-06	9.9E-06	NA	NA
Sodium hydroxide	1310-73-2	15	5.1E+01	2.1E-07	9.5E-07	4.1E-09	1.9E-08
Starch	9005-25-8	153	-	2.1E-06	9.7E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.0E+01	2.1E-06	9.7E-06	2.1E-07	9.7E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	1.7E-08	7.6E-08	6.7E-10	3.1E-09
Polyalkylene	9038-95-3	1,113	5.0E+00	1.6E-05	7.1E-05	3.1E-06	1.4E-05
Polypropylene glycol	25322-69-4	2.4	5.0E-01	3.4E-08	1.5E-07	6.7E-08	3.1E-07
Silicic acid, potassium salt	1312-76-1	1,110	2.0E-01	1.6E-05	7.1E-05	7.8E-05	3.5E-04
Sodium Chloride	7647-14-5	2,280	5.1E+01	3.2E-05	1.5E-04	6.2E-07	2.8E-06
Sodium polyacrylate	9003-04-7	55	1.0E+00	7.7E-07	3.5E-06	7.7E-07	3.5E-06
Methylisothiocyanate (MITC)	556-61-6	1.5	5.0E-03	2.1E-08	9.5E-08	4.2E-06	1.9E-05

Exposure Pathway HI:

9.4E-05

4.3E-04

Cumulative HI:

5.2E-04

CADD = chronic absorbed daily dose

**Table 33**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Soils From Irrigation/Dust Suppression**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Proprietary Polymer A	PolymerA-CasRn	0.21	-	2.9E-09	1.3E-08	NA	NA
Proprietary Ester A	EsterA-CasRn	0.005	4.0E+00	7.2E-11	3.3E-10	1.8E-11	8.2E-11
Aluminium Chlorohydrate	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.0E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.4E+00	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+01	NA	NA	NA	NA
Hydrochloric Acid	7647-01-0	NA	7.1E+01	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	7.1E+01	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	7.1E-02	1.7E-09	7.9E-09	2.4E-08	1.1E-07
Polydadmac	26062-79-3	NA	2.0E+00	NA	NA	NA	NA
Polyacrylamide	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	2.0E-01	NA	NA	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	2.0E-01	NA	NA	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	5.0E-03	NA	NA	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.027	2.0E+01	3.9E-10	1.7E-09	1.9E-11	8.7E-11
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.0E+00	NA	NA	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.0E+00	NA	NA	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	-	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	1.4E+01	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	-	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA

Exposure Pathway HI: 2.4E-08 1.1E-07

CADD = chronic absorbed daily dose

Cumulative HI: 1.3E-07

**Table 34**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Lined Pits (Day 0)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	6.3E+02	1.6E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	51	8.6E+00	1.2E-01	1.4E-02
Methanol	67-56-1	5	6.4E+00	1.2E-02	1.8E-03
Pentanedial / Glutaraldehyde	111-30-8	500	1.4E+00	1.2E+00	8.4E-01
Sodium carbonate	497-19-8	130	NA	3.0E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,195	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	500	NA	1.2E+00	NA
Starch	9005-25-8	5,096	NA	1.2E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	3.4E-01	1.2E-01	3.3E-01
Xanthan gum	11138-66-2	5,100	3.4E+02	1.2E+01	3.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	80	1.7E+02	1.8E-01	1.1E-03
Silicic acid, potassium salt	1312-76-1	37,000	7.4E+01	8.5E+01	1.2E+00
Sodium Chloride	7647-14-5	76,000	NA	1.7E+02	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00
				<b>Cumulative:</b>	<b>3.1E+00</b>



**Table 35**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Lined Pits (Day 3)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	6.3E+02	1.6E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	44	8.6E+00	1.0E-01	1.2E-02
Methanol	67-56-1	4	6.4E+00	1.0E-02	1.6E-03
Pentanedial / Glutaraldehyde	111-30-8	500	1.4E+00	1.2E+00	8.4E-01
Sodium carbonate	497-19-8	130	NA	3.0E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,123	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	500	NA	1.2E+00	NA
Starch	9005-25-8	4,436	NA	1.0E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	5.3E-06	1.5E-05
Xanthan gum	11138-66-2	5,030	3.4E+02	1.2E+01	3.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	37,000	7.4E+01	8.5E+01	1.2E+00
Sodium Chloride	7647-14-5	76,000	NA	1.7E+02	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	50	1.7E-01	1.2E-01	6.7E-01

**Cumulative: 3.5E+00**

**Table 36**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Lined Pits (Day 7)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	6.3E+02	1.6E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	37	8.6E+00	8.5E-02	9.9E-03
Methanol	67-56-1	4	6.4E+00	8.3E-03	1.3E-03
Pentanedial / Glutaraldehyde	111-30-8	500	1.4E+00	1.2E+00	8.4E-01
Sodium carbonate	497-19-8	130	NA	3.0E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	500	NA	1.2E+00	NA
Starch	9005-25-8	3,688	NA	8.5E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	8.8E-12	2.6E-11
Xanthan gum	11138-66-2	5,030	3.4E+02	1.2E+01	3.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	37,000	7.4E+01	8.5E+01	1.2E+00
Sodium Chloride	7647-14-5	76,000	NA	1.7E+02	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	50	1.7E-01	1.2E-01	6.7E-01

**Cumulative: 3.5E+00**

**Table 37**  
**Risk Estimates for Dingo from Vendor Chemicals in Lined Pits (Day 0)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	7.4E+02	7.7E+01	1.0E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	51	1.0E+01	5.6E-02	5.6E-03
Methanol	67-56-1	5	7.5E+00	5.5E-03	7.4E-04
Pentanedial / Glutaraldehyde	111-30-8	500	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	130	NA	1.4E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,195	NA	5.7E+00	NA
Sodium hydroxide	1310-73-2	500	NA	5.5E-01	NA
Starch	9005-25-8	5,096	NA	5.6E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	50	4.1E-01	5.5E-02	1.4E-01
Xanthan gum	11138-66-2	5,100	4.1E+02	5.6E+00	1.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	80	2.0E+02	8.9E-02	4.4E-04
Silicic acid, potassium salt	1312-76-1	37,000	8.7E+01	4.1E+01	4.7E-01
Sodium Chloride	7647-14-5	76,000	NA	8.4E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00
				<b>Cumulative:</b>	<b>1.3E+00</b>

**Table 38**  
**Risk Estimates for Dingo from Vendor Chemicals in Lined Pits (Day 3)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	7.4E+02	7.7E+01	1.0E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	44	1.0E+01	4.9E-02	4.9E-03
Methanol	67-56-1	4	7.5E+00	4.8E-03	6.4E-04
Pentanedial / Glutaraldehyde	111-30-8	500	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	130	NA	1.4E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,123	NA	5.7E+00	NA
Sodium hydroxide	1310-73-2	500	NA	5.5E-01	NA
Starch	9005-25-8	4,436	NA	4.9E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	2.6E-06	6.3E-06
Xanthan gum	11138-66-2	5,030	4.1E+02	5.6E+00	1.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	37,000	8.7E+01	4.1E+01	4.7E-01
Sodium Chloride	7647-14-5	76,000	NA	8.4E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	50	2.0E-01	5.5E-02	2.7E-01

**Cumulative: 1.4E+00**

**Table 39**  
**Risk Estimates for Dingo from Vendor Chemicals in Lined Pits (Day 7)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	69,200	7.4E+02	7.7E+01	1.0E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	37	1.0E+01	4.1E-02	4.0E-03
Methanol	67-56-1	4	7.5E+00	4.0E-03	5.3E-04
Pentanedial / Glutaraldehyde	111-30-8	500	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	130	NA	1.4E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	NA	5.6E+00	NA
Sodium hydroxide	1310-73-2	500	NA	5.5E-01	NA
Starch	9005-25-8	3,688	NA	4.1E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	4.2E-12	1.0E-11
Xanthan gum	11138-66-2	5,030	4.1E+02	5.6E+00	1.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	37,000	8.7E+01	4.1E+01	4.7E-01
Sodium Chloride	7647-14-5	76,000	NA	8.4E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	50	2.0E-01	5.5E-02	2.7E-01

**Cumulative: 1.4E+00**

**Table 40**  
**Risk Estimates for Pilliga Mouse from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	4,152	4.2E+03	6.6E-01	1.6E-04
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	1.1E-02	NA
Glyoxal	107-22-2	3.1	5.8E+01	4.8E-04	8.3E-06
Methanol	67-56-1	0.3	4.3E+01	4.8E-05	1.1E-06
Pentanedial / Glutaraldehyde	111-30-8	30	9.3E+00	4.8E-03	5.1E-04
Sodium carbonate	497-19-8	7.8	NA	1.2E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	4.9E-02	NA
Sodium hydroxide	1310-73-2	30	NA	4.8E-03	NA
Starch	9005-25-8	306	NA	4.8E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	2.3E+03	4.8E-02	2.1E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	5.8E+03	3.8E-04	6.5E-08
Polyalkylene	9038-95-3	2,226	1.2E+03	3.5E-01	3.0E-04
Polypropylene glycol	25322-69-4	4.8	1.2E+03	7.6E-04	6.5E-07
Silicic acid, potassium salt	1312-76-1	2,220	5.0E+02	3.5E-01	7.1E-04
Sodium Chloride	7647-14-5	4,560	NA	7.2E-01	NA
Sodium polyacrylate	9003-04-7	109	2.6E+03	1.7E-02	6.5E-06
Methylisothiocyanate (MITC)	556-61-6	3.0	1.2E+00	4.7E-04	4.1E-04

Exposure Pathway HI:

**2.1E-03**

**Table 41**  
**Risk Estimates for Pilliga Mouse from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	2,076	4.2E+03	3.3E-01	7.8E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	5.6E-03	NA
Glyoxal	107-22-2	1.5	5.8E+01	2.4E-04	4.2E-06
Methanol	67-56-1	0.2	4.3E+01	2.4E-05	5.5E-07
Pentanedial / Glutaraldehyde	111-30-8	15	9.3E+00	2.4E-03	2.6E-04
Sodium carbonate	497-19-8	3.9	NA	6.2E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	2.5E-02	NA
Sodium hydroxide	1310-73-2	15	NA	2.4E-03	NA
Starch	9005-25-8	153	NA	2.4E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	2.3E+03	2.4E-02	1.0E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	5.8E+03	1.9E-04	3.3E-08
Polyalkylene	9038-95-3	1,113	1.2E+03	1.8E-01	1.5E-04
Polypropylene glycol	25322-69-4	2.4	1.2E+03	3.8E-04	3.3E-07
Silicic acid, potassium salt	1312-76-1	1,110	5.0E+02	1.8E-01	3.5E-04
Sodium Chloride	7647-14-5	2,280	NA	3.6E-01	NA
Sodium polyacrylate	9003-04-7	55	2.6E+03	8.6E-03	3.3E-06
Methylisothiocyanate (MITC)	556-61-6	1.5	1.2E+00	2.4E-04	2.0E-04

**Exposure Pathway HI: 1.1E-03**



**Table 42**  
**Risk Estimates for Pilliga Mouse from Residual Vendor Chemicals with Soils Irrigated with Permeate**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	3.3E-05	NA
Proprietary Ester A	EsterA-CasRn	0.0052	8.9E+02	8.2E-07	9.1E-10
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	2.2E+03	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.8E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	2.0E-05	NA
Polydamac	26062-79-3	NA	4.6E+03	NA	NA
Polyacrylamide	9003-05-8	NA	1.2E+04	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	4.0E+01	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	5.8E+00	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	1.2E+01	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.027	4.6E+03	4.4E-06	9.4E-10
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	2.6E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	2.3E+03	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	2.6E+03	NA	NA

**Exposure Pathway HI: 1.8E-09**

**Table 43**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater and Cattle Egret					
Potassium chloride	7447-40-7	4,152	3.3E+03	1.8E+03	5.4E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	3.0E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	1.3E+00	2.9E-02
Methanol	67-56-1	0.3	3.3E+01	1.3E-01	3.8E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	1.3E+01	2.4E-02
Sodium carbonate	497-19-8	7.8	NA	3.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	1.3E+02	NA
Sodium hydroxide	1310-73-2	30	NA	1.3E+01	NA
Starch	9005-25-8	306	NA	1.3E+02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	1.3E+02	7.2E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	1.0E+00	2.3E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	9.4E+02	1.1E+00
Polypropylene glycol	25322-69-4	4.8	9.0E+02	2.0E+00	2.3E-03
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	9.4E+02	2.5E+00
Sodium Chloride	7647-14-5	4,560	NA	1.9E+03	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	4.6E+01	2.3E-02
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	1.3E+00	1.4E+00

**Exposure Pathway HI: 5.6E+00**

**Table 44**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	2,076	3.3E+03	8.8E+02	2.7E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	1.5E+01	NA
Glyoxal	107-22-2	1.5	4.5E+01	6.5E-01	1.4E-02
Methanol	67-56-1	0.15	3.3E+01	6.4E-02	1.9E-03
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	6.4E+00	1.2E-02
Sodium carbonate	497-19-8	3.9	NA	1.7E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	6.6E+01	NA
Sodium hydroxide	1310-73-2	15	NA	6.4E+00	NA
Starch	9005-25-8	153	NA	6.5E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	6.5E+01	3.6E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	5.1E-01	1.1E-04
Polyalkylene	9038-95-3	1,113	9.0E+02	4.7E+02	5.3E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.0E+00	1.1E-03
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	4.7E+02	1.2E+00
Sodium Chloride	7647-14-5	2,280	NA	9.7E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	2.3E+01	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	6.4E-01	7.1E-01

**Exposure Pathway HI: 2.8E+00**

**Table 45**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater and Cattle Egret					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	8.7E-02	NA
Proprietary Ester A	EsterA-CasRn	0.0052	6.9E+02	2.2E-03	3.2E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.7E+03	NA	NA
Sodium Hypochlorite	7681-52-9	NA	3.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.1E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	5.2E-02	NA
Polydadmac	26062-79-3	NA	3.6E+03	NA	NA
Polyacrylamide	9003-05-8	NA	9.0E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	1.3E+02	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	1.3E+02	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	2.3E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	3.6E+03	1.2E-02	3.2E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	2.0E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.8E+03	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	2.0E+03	NA	NA

**Exposure Pathway HI: 6.4E-06**

**Table 46**  
**Risk Estimates for Cattle from Residual Vendor Chemicals in Permeate Used for Stock Watering**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Stock Water	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Proprietary Polymer A	PolymerA-CasRn	0.49	NA	9.3E-02	NA
Proprietary Ester A	EsterA-CasRn	0.10	6.4E+01	1.9E-02	2.9E-04
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.6E+02	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.0E+02	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.29	NA	5.6E-02	NA
Polydadmac	26062-79-3	NA	3.3E+02	NA	NA
Polyacrylamide	9003-05-8	NA	8.3E+02	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	0.50	2.8E+00	9.5E-02	3.4E-02
2 methyl-isothiazolin-3 one	2682-20-4	0.10	2.8E+00	1.9E-02	6.7E-03
Proprietary Mixture D1	MixtureD1-CasRn	0.07	8.3E-01	1.2E-02	1.5E-02
Proprietary Mixture D2	MixtureD2-CasRn	0.07	3.3E+02	1.2E-02	3.7E-05
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.9E+01	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.7E+02	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.9E+02	NA	NA

Exposure Pathway HI:

5.6E-02

## **APPENDIX A THIRD PARTY REVIEW**

## PEER REVIEWER STATEMENT

Peer Reviewer: Cybele Heddle, EHS Support Pty Ltd – Ecological risk assessment and regulatory compliance

EPBC Additional Peer Review Requirement:

*The chemical risk assessment must be peer reviewed by a suitably qualified chemical risk assessment expert/s. The peer review must include a statement from the suitably qualified chemical risk assessment expert/s stating that they carried out the peer review of the findings of the chemical risk assessment and evaluated the adequacy of the proposed monitoring, mitigation and management measures.*

In accordance with the EPBC Additional Requirements, I have reviewed the findings of the Chemical Risk Assessment Report for the Narrabri Gas Project and the proposed monitoring, mitigation and management measures.



Reviewer Signature: \_\_\_\_\_ Date: 4 December 2016




## PEER REVIEWER STATEMENT

Peer Reviewer: Jackie Wright, Environmental Risk Sciences Pty Ltd – Human health risk assessment and regulatory compliance

EPBC Additional Peer Review Requirement:

*The chemical risk assessment risk assessment must be peer reviewed by a suitably qualified chemical risk assessment expert/s. The peer review must include a statement from the suitably qualified chemical risk assessment expert/s stating that they carried out the peer review of the findings of the chemical risk assessment and evaluated the adequacy of the proposed monitoring, mitigation and management measures.*

In accordance with the EPBC Additional Requirements, I have reviewed the findings of the Chemical Risk Assessment Report for the Narrabri Gas Project and the proposed monitoring, mitigation and management measures.

Reviewer Signature: \_\_\_\_\_  \_\_\_\_\_ Date: \_\_ 5 December 2016 \_\_\_\_\_

## **APPENDIX B SAFETY DATA SHEETS**

## SAFETY DATA SHEET

## ALDACIDE® G ANTIMICROBIAL

Revision Date: 09-May-2016

Revision Number: 35

## 1. Product Identifier &amp; Identity for the Chemical

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** ALDACIDE® G ANTIMICROBIAL

**Other means of Identification**

**Synonyms** None  
**Hazardous Material Number:** HM003462

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Biocide  
**Uses advised against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
 15 Marriott Road  
 Jandakot  
 WA 6164  
 Australia  
  
 ACN Number: 009 000 775  
 Telephone Number: + 61 1 800 686 951  
 Fax Number: 61 (08) 9455 5300  
 fdunexchem@halliburton.com

**E-mail Address****Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
 Police or Fire Brigade: - 000 (exchange): - 1100

## 2. Hazard Identification

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Acute Oral Toxicity	Category 4 - H302
Acute inhalation toxicity - vapor	Category 3 - H331
Skin Corrosion/Irritation	Category 1 - H314
Serious Eye Damage/Irritation	Category 1 - H318
Respiratory Sensitization	Category 1 - H334
Skin Sensitization	Category 1 - H317
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335

Acute Aquatic Toxicity	Category 1 - H400
Chronic Aquatic Toxicity	Category 3 - H412

**Label elements, including precautionary statements****Hazard pictograms****Signal Word**

Danger

**Hazard Statements:**

H302 - Harmful if swallowed  
 H314 - Causes severe skin burns and eye damage  
 H317 - May cause an allergic skin reaction  
 H318 - Causes serious eye damage  
 H331 - Toxic if inhaled  
 H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled  
 H335 - May cause respiratory irritation  
 H360 - May damage fertility or the unborn child  
 H400 - Very toxic to aquatic life  
 H412 - Harmful to aquatic life with long lasting effects

**Precautionary Statements****Prevention**

P201 - Obtain special instructions before use  
 P202 - Do not handle until all safety precautions have been read and understood  
 P260 - Do not breathe dust/fume/gas/mist/vapors/spray  
 P264 - Wash face, hands and any exposed skin thoroughly after handling  
 P270 - Do not eat, drink or smoke when using this product  
 P271 - Use only outdoors or in a well-ventilated area  
 P272 - Contaminated work clothing should not be allowed out of the workplace  
 P273 - Avoid release to the environment  
 P280 - Wear protective gloves/protective clothing/eye protection/face protection  
 P281 - Use personal protective equipment as required  
 P285 - In case of inadequate ventilation wear respiratory protection  
 P301+ P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell  
 P330 - Rinse mouth  
 P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower  
 P363 - Wash contaminated clothing before reuse  
 P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing  
 P310 - Immediately call a POISON CENTER or doctor/physician  
 P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing  
 P391 - Collect spillage  
 P403 + P233 - Store in a well-ventilated place. Keep container tightly closed  
 P405 - Store locked up  
 P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Response****Storage****Disposal****Contains****Substances**

Glutaraldehyde  
 Methanol

**CAS Number**

111-30-8  
 67-56-1

**Other hazards which do not result in classification**

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

For the full text of the H-phrases mentioned in this Section, see Section 16

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Glutaraldehyde	111-30-8	10 - 30%	Acute Tox. 3 (H301) Acute Tox. 2 (H330) Skin Corr. 1B (H314) Eye Corr. 1 (H318) Resp. Sens. 1 (H334) Skin Sens. 1 (H317) STOT SE 3 (H335) Aquatic Acute 1 (H400) Aquatic Chronic 2 (H411)
Methanol	67-56-1	0.1 - 1%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)

### 4. First aid measures

**Description of necessary first aid measures**

<b>Inhalation</b>	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
<b>Eyes</b>	Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.
<b>Skin</b>	In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.
<b>Ingestion</b>	Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. May cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if swallowed. Toxic if inhaled. Potential reproductive hazard. May cause birth defects.

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

### 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

Water fog, carbon dioxide, foam, dry chemical.

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special exposure hazards in a fire**

Decomposition in fire may produce harmful gases.

**Special protective equipment and precautions for fire fighters****Special protective equipment for firefighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Ensure adequate ventilation. Avoid breathing vapors. Avoid contact with skin, eyes and clothing. Evacuate all persons from the area. Use only competent persons for cleanup.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

## 7. Handling and storage

**7.1. Precautions for safe handling****Handling Precautions**

Use appropriate protective equipment. Ensure adequate ventilation. Avoid breathing vapors. Avoid breathing mist. Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from acids. Store away from alkalis. Store in a well ventilated area. Keep container closed when not in use. Store locked up. Product has a shelf life of 36 months.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Glutaraldehyde	111-30-8	0.1 ppm	0.05 ppm
Methanol	67-56-1	TWA: 200 ppm TWA: 262 mg/m <sup>3</sup> STEL: 250 ppm STEL: 328 mg/m <sup>3</sup>	TWA: 200 ppm STEL: 250 ppm

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation. If vapors are strong enough to be irritating to the nose or eyes, the TLV is probably being exceeded and special ventilation or respiratory protection maybe required.

**Personal protective equipment (PPE)****Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

**Respiratory Protection**

If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

<b>Hand Protection</b>	Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.
<b>Skin Protection</b>	Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.
<b>Eye Protection</b>	Chemical goggles; also wear a face shield if splashing hazard exists.
<b>Other Precautions</b>	Eyewash fountains and safety showers must be easily accessible.
<b>Environmental Exposure Controls</b>	Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

<b>Physical State:</b>	Liquid	<b>Color</b>	Clear light yellow
<b>Odor:</b>	Sharp	<b>Odor Threshold:</b>	No information available
<u>Property</u>	<u>Values</u>		
<u>Remarks/ - Method</u>			
<b>pH:</b>	3.1-4.5		
<b>Freezing Point / Range</b>	(-5) - (-10) °C		
<b>Melting Point / Range</b>	No data available		
<b>Boiling Point / Range</b>	100.5 °C / 213 °F		
<b>Flash Point</b>	No data available		
<b>Evaporation rate</b>	0.9		
<b>Vapor Pressure</b>	0.2 mmHg		
<b>Vapor Density</b>	0.8		
<b>Specific Gravity</b>	1.064		
<b>Water Solubility</b>	Soluble in water		
<b>Solubility in other solvents</b>	No data available		
<b>Partition coefficient: n-octanol/water</b>	-0.333		
<b>Autoignition Temperature</b>	> 275 °C / > 527 °F		
<b>Decomposition Temperature</b>	No data available		
<b>Viscosity</b>	No data available		
<b>Explosive Properties</b>	No information available		
<b>Oxidizing Properties</b>	No information available		

### 9.2. Other information

<b>VOC Content (%)</b>	No data available
------------------------	-------------------

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical stability

Stable

### 10.3. Possibility of hazardous reactions

Will Not Occur

### 10.4. Conditions to avoid

Keep away from heat, sparks and flame.

### 10.5. Incompatible materials

Strong acids. Strong alkalis.

### 10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

## 11. Toxicological Information

### Information on routes of exposure

**Principle Route of Exposure** Eye or skin contact, inhalation; Ingestion.

### Symptoms related to exposure

### Most Important Symptoms/Effects

Causes severe eye irritation which may damage tissue. Causes severe skin irritation with tissue destruction. May



cause allergic skin reaction. May cause allergic respiratory reaction. May cause respiratory irritation. Harmful if swallowed. Toxic if inhaled. Potential reproductive hazard. May cause birth defects.

### Numerical measures of toxicity

#### Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Glutaraldehyde	111-30-8	50 mg/kg (Guinea Pig)	560 µL/kg (Rabbit)	0.28-0.5 mg/L (Rat) 4h
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, vapor, 4h)

#### Immediate, delayed and chronic health effects from exposure

<b>Inhalation</b>	Toxic if inhaled. May cause allergic respiratory reaction. Causes severe respiratory irritation. Inhalation of vapors may result in skin sensitization.
<b>Eye Contact</b>	Causes serious eye damage.
<b>Skin Contact</b>	Causes severe burns. May cause an allergic skin reaction.
<b>Ingestion</b>	Causes burns of the mouth, throat and stomach. Harmful if swallowed.

#### Exposure Levels

No data available

#### Interactive effects

Skin disorders. Lung disorders. Liver disorders.

#### Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Glutaraldehyde	111-30-8	Causes severe skin irritation with tissue destruction. (Rabbit)
Methanol	67-56-1	Non-irritating to the skin (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Glutaraldehyde	111-30-8	Causes severe eye irritation which may damage tissue. (Rabbit)
Methanol	67-56-1	Non-irritating to the eye (Rabbit)

Substances	CAS Number	Skin Sensitization
Glutaraldehyde	111-30-8	Skin sensitizer in guinea pig.
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Glutaraldehyde	111-30-8	May cause sensitization by inhalation
Methanol	67-56-1	No information available

Substances	CAS Number	Mutagenic Effects
Glutaraldehyde	111-30-8	In vivo tests did not show mutagenic effects.
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.

Substances	CAS Number	Carcinogenic Effects
Glutaraldehyde	111-30-8	Did not show carcinogenic effects in animal experiments
Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Glutaraldehyde	111-30-8	Not a confirmed teratogen or embryotoxin.
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals

Substances	CAS Number	STOT - single exposure
Glutaraldehyde	111-30-8	No information available
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)

Substances	CAS Number	STOT - repeated exposure
------------	------------	--------------------------

Glutaraldehyde	111-30-8	May cause disorder and damage to the (Kidney)
Methanol	67-56-1	No data of sufficient quality are available.

Substances	CAS Number	Aspiration hazard
Glutaraldehyde	111-30-8	Not applicable
Methanol	67-56-1	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Glutaraldehyde	111-30-8	EC50 (72h) 0.61 mg/L (Desmodesmus subspicatus)	LC50 (96h) 10 mg/L (Lepomis macrochirus) NOEC (97d) 1.6 mg/L (Oncorhynchus mykiss) LC50 (96h) 3.5 mg/L (Oncorhynchus mykiss)	EC50 (17h) 6.65 mg/L (Pseudomonas putida)	EC50 (48h) 0.35 mg/L (Daphnia magna) EC50 (48h) 0.7 mg/L (Acartia tonsa) NOEC (21d) 0.13 mg/L (Daphnia magna)
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Daphnia magna) NOEC (21 d) =208 mg/L (Daphnia magna)

### 12.2. Persistence and degradability

Readily biodegradable

Substances	CAS Number	Persistence and Degradability
Glutaraldehyde	111-30-8	Readily biodegradable (75% @ 28d)
Methanol	67-56-1	(95-97% @ 20d)

### 12.3. Bioaccumulative potential

Does not bioaccumulate.

Substances	CAS Number	Log Pow
Glutaraldehyde	111-30-8	-0.36
Methanol	67-56-1	-0.77 BCF = 1.0 – 4.5 (Cyprinus carpio) BCF < 10 (Leuciscus idus melanotus)

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Glutaraldehyde	111-30-8	Potential for mobility in soil is high (Koc between 50 and 150). Given its very low Henry's constant (3.3E-08 atm*m3/mole; 25 °C Measured), volatilization from natural bodies of water or moist soil is not expected to be an important fate process.
Methanol	67-56-1	No information available

### 12.6. Other adverse effects

#### Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

## 13. Disposal Considerations

### Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

### Disposal of any contaminated packaging

Follow all applicable national or local regulations.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

**UN Number** UN3265  
**UN proper shipping name:** Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)  
**Transport Hazard Class(es):** 8  
**Packing Group:** III  
**Environmental Hazards:** Marine Pollutant

**Special precautions during transport**

None

**HazChem Code**

None Allocated

**15. Regulatory Information****Safety, health and environmental regulations specific for the product****International Inventories**

**Australian AICS Inventory** All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.  
**New Zealand Inventory of Chemicals** All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.  
**EINECS (European Inventory of Existing Chemical Substances)** This product, and all its components, complies with EINECS  
**US TSCA Inventory** All components listed on inventory or are exempt.  
**Canadian Domestic Substances List (DSL)** All components listed on inventory or are exempt.

**Poisons Schedule number**

S6

**International Agreements**

<b>Montreal Protocol - Ozone Depleting Substances:</b>	Does not apply
<b>Stolkhom Convention - Persistent Organic Pollutants:</b>	Does not apply
<b>Rotterdam Convention - Prior Informed Consent:</b>	Does not apply
<b>Basel Convention - Hazardous Waste:</b>	Does not apply

**16. Other information****Date of preparation or review**

**Revision Date:** 09-May-2016

**Revision Note****Full text of H-Statements referred to under sections 2 and 3**

H301 - Toxic if swallowed  
H302 - Harmful if swallowed  
H314 - Causes severe skin burns and eye damage  
H317 - May cause an allergic skin reaction  
H318 - Causes serious eye damage  
H330 - Fatal if inhaled  
H331 - Toxic if inhaled

H334 - May cause allergy or asthma symptoms or breathing difficulties if inhaled

H335 - May cause respiratory irritation

H400 - Very toxic to aquatic life

H411 - Toxic to aquatic life with long lasting effects

H412 - Harmful to aquatic life with long lasting effects

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

EC50 – Effective Concentration 50%

LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%

LL50 – Lethal Loading 50%

mg/kg – milligram/kilogram

mg/L – milligram/liter

NOEC – No Observed Effect Concentration

OEL – Occupational Exposure Limit

PBT – Persistent Bioaccumulative and Toxic

ppm – parts per million

STEL – Short Term Exposure Limit

TWA – Time-Weighted Average

vPvB – very Persistent and very Bioaccumulative

h - hour

mg/m<sup>3</sup> - milligram/cubic meter

mm - millimeter

mmHg - millimeter mercury

w/w - weight/weight

d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

NZ CCID

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

**SAFETY DATA SHEET****BARACARB**

Revision Date: 27-Jun-2016

Revision Number: 34

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** BARACARB

**Other means of Identification**

**Synonyms** None  
**Hazardous Material Number:** HM004943

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Bridging Agent  
**Uses advised against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-mail Address** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Carcinogenicity

Category 2 - H351

**Label elements, including precautionary statements****Hazard pictograms****Signal Word**

Warning

**Hazard Statements:**

H351 - Suspected of causing cancer if inhaled

**Precautionary Statements****Prevention**

P201 - Obtain special instructions before use  
 P202 - Do not handle until all safety precautions have been read and understood  
 P281 - Use personal protective equipment as required  
 P308 + P313 - IF exposed or concerned: Get medical advice/attention  
 P405 - Store locked up  
 P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Response****Storage****Disposal****Contains****Substances**

Crystalline silica, quartz

**CAS Number**

14808-60-7

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

*For the full text of the H-phrases mentioned in this Section, see Section 16*

<b>3. Composition/information on Ingredients</b>
--

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Crystalline silica, quartz	14808-60-7	0.1 - 1%	Carc. 2 (H351) STOT RE 1 (H372)

<b>4. First aid measures</b>
------------------------------

**Description of necessary first aid measures****Inhalation**

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes**

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Skin**

Wash with soap and water. Get medical attention if irritation persists.

**Ingestion**

Under normal conditions, first aid procedures are not required.

**Symptoms caused by exposure**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also

been associated with scleroderma and kidney disease.

**Medical Attention and Special Treatment****Notes to Physician**

Treat symptomatically

## 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special exposure hazards in a fire**

Not applicable

**Special protective equipment and precautions for fire fighters****Special protective equipment for firefighters**

Not applicable

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation. Evacuate all persons from the area.

**6.2. Environmental precautions**

None known.

**6.3. Methods and material for containment and cleaning up**

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

## 7. Handling and storage

**7.1. Precautions for safe handling****Handling Precautions**

Avoid contact with eyes, skin, or clothing. This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from acids. Store in a cool, dry location. Store locked up. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 60 months.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Crystalline silica, quartz	14808-60-7	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.025 mg/m <sup>3</sup>

**Appropriate engineering controls****Engineering Controls**

Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

**Personal protective equipment (PPE)****Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

**Respiratory Protection**

Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product.

**Hand Protection**

Normal work gloves.

**Skin Protection**

Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

**Eye Protection**

Wear safety glasses or goggles to protect against exposure.

**Other Precautions**

None known.

**Environmental Exposure Controls**

No information available

## 9. Physical and Chemical Properties

**9.1. Information on basic physical and chemical properties**

**Physical State:** Solid Powder

**Color:** White

**Odor:** Odorless

**Odor Threshold:** No information available

**Property****Values****Remarks/ - Method****pH:**

8-9

**Freezing Point / Range**

No data available

**Melting Point / Range**

No data available

**Boiling Point / Range**

No data available

**Flash Point**

No data available

**Evaporation rate**

No data available

**Vapor Pressure**

No data available

**Vapor Density**

No data available

**Specific Gravity**

2.7

**Water Solubility**

Insoluble in water

**Solubility in other solvents**

No data available

**Partition coefficient: n-octanol/water**

No data available

**Autoignition Temperature**

No data available

**Decomposition Temperature**

No data available

**Viscosity**

No data available

**Explosive Properties**

No information available

**Oxidizing Properties**

No information available

**9.2. Other information****VOC Content (%)**

No data available

## 10. Stability and Reactivity

**10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical stability**

Stable

**10.3. Possibility of hazardous reactions**

Will Not Occur

**10.4. Conditions to avoid**

None anticipated

**10.5. Incompatible materials**



Strong acids.

#### **10.6. Hazardous decomposition products**

Carbon monoxide and carbon dioxide. Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

## **11. Toxicological Information**

### **Information on routes of exposure**

**Principle Route of Exposure** Eye or skin contact, inhalation.

### **Symptoms related to exposure**

#### **Most Important Symptoms/Effects**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

### **Numerical measures of toxicity**

### **Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica, quartz	14808-60-7	> 15000 mg/kg (human)	No information available	No data available

### **Immediate, delayed and chronic health effects from exposure**

#### **Inhalation**

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

#### **Eye Contact**

May cause mechanical irritation to eye.

#### **Skin Contact**

None known.

#### **Ingestion**

None known.

### **Chronic Effects/Carcinogenicity**

**Silicosis:** Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

**Cancer Status:** The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

**Exposure Levels**

No data available

**Interactive effects**

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible. No information available

Substances	CAS Number	Skin Sensitization
Crystalline silica, quartz	14808-60-7	No information available.

Substances	CAS Number	Respiratory Sensitization
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	Mutagenic Effects
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.

Substances	CAS Number	Reproductive toxicity
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	STOT - single exposure
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Crystalline silica, quartz	14808-60-7	Not applicable

## 12. Ecological Information

**Ecotoxicity****Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Crystalline silica, quartz	14808-60-7	EC50 (72 h) =440 mg/L (Selenastrum capricornutum)	LL0 (96 h) =10000 mg/L (Danio rerio)	No information available	LL50 (24 h) >10000 mg/L (Daphnia magna)

**12.2. Persistence and degradability**

The methods for determining biodegradability are not applicable to inorganic substances.

Substances	CAS Number	Persistence and Degradability
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.

**12.3. Bioaccumulative potential**

Does not bioaccumulate.

Substances	CAS Number	Log Pow
Crystalline silica, quartz	14808-60-7	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Crystalline silica, quartz	14808-60-7	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

<b>13. Disposal Considerations</b>
------------------------------------

**Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

**Environmental regulations**

Not applicable

<b>14. Transport Information</b>
----------------------------------

**Transportation Information**

<b>UN Number</b>	Not restricted
<b>UN proper shipping name:</b>	Not restricted
<b>Transport Hazard Class(es):</b>	Not applicable
<b>Packing Group:</b>	Not applicable
<b>Environmental Hazards:</b>	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

<b>15. Regulatory Information</b>
-----------------------------------

**Safety, health and environmental regulations specific for the product****International Inventories**

<b>Australian AICS Inventory</b>	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
<b>New Zealand Inventory of Chemicals</b>	All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.
<b>EINECS (European Inventory of Existing Chemical Substances)</b>	This product, and all its components, complies with EINECS
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.
<b>Canadian Domestic Substances List (DSL)</b>	All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

**International Agreements**

Montreal Protocol - Ozone Depleting Substances:  
Stolkhom Convention - Persistent Organic Pollutants:  
Rotterdam Convention - Prior Informed Consent:  
Basel Convention - Hazardous Waste:

Does not apply  
Does not apply  
Does not apply  
Does not apply

**16. Other information****Date of preparation or review**

Revision Date: 27-Jun-2016

**Revision Note**

SDS sections updated: 2

**Full text of H-Statements referred to under sections 2 and 3**

H351 - Suspected of causing cancer if inhaled

H372 - Causes damage to organs through prolonged or repeated exposure if inhaled

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight  
CAS – Chemical Abstracts Service  
EC50 – Effective Concentration 50%  
LC50 – Lethal Concentration 50%  
LD50 – Lethal Dose 50%  
LL50 – Lethal Loading 50%  
mg/kg – milligram/kilogram  
mg/L – milligram/liter  
NOEC – No Observed Effect Concentration  
OEL – Occupational Exposure Limit  
PBT – Persistent Bioaccumulative and Toxic  
ppm – parts per million  
STEL – Short Term Exposure Limit  
TWA – Time-Weighted Average  
vPvB – very Persistent and very Bioaccumulative  
h - hour  
mg/m<sup>3</sup> - milligram/cubic meter  
mm - millimeter  
mmHg - millimeter mercury  
w/w - weight/weight  
d - day

**Key literature references and sources for data**

www.ChemADVISOR.com/  
NZ CCID

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

# MATERIAL SAFETY DATA SHEET

**Product Trade Name:** **BARA-DEFOAM® HP**

**Revision Date:** 03-Jan-2012

## 1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
NewZealand: 06-7559274

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

### Identification of Substances or Preparation

**Product Trade Name:** BARA-DEFOAM® HP  
**Synonyms:** None  
**Chemical Family:** Polyether polyol  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** None Allocated  
**Poisons Schedule:** None Allocated  
**Application:** Defoamer

**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Polyether polyol	Proprietary	60 - 100%	Not applicable	Not applicable	Not applicable

Non-Hazardous Substance to Total of 100%

### 3. HAZARDS IDENTIFICATION

<b>Hazard Overview</b>	May cause eye and skin irritation.
<b>Risk Phrases</b>	None
<b>HSNO Classification</b>	Not Determined

### 4. FIRST AID MEASURES

<b>Inhalation</b>	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
<b>Skin</b>	Wash with soap and water. Get medical attention if irritation persists. Remove contaminated clothing and launder before reuse.
<b>Eyes</b>	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
<b>Ingestion</b>	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.
<b>Notes to Physician</b>	Not Applicable

### 5. FIRE FIGHTING MEASURES

<b>Suitable Extinguishing Media</b>	Water fog, carbon dioxide, foam, dry chemical.
<b>Extinguishing media which must not be used for safety reasons</b>	None known.
<b>Special Exposure Hazards</b>	Avoid spraying water directly into storage containers due to danger of boilover. Decomposition in fire may produce toxic gases.
<b>Special Protective Equipment for Fire-Fighters</b>	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

<b>Personal Precautionary Measures</b>	Use appropriate protective equipment.
<b>Environmental Precautionary Measures</b>	Prevent from entering sewers, waterways, or low areas.
<b>Procedure for Cleaning / Absorption</b>	Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

### 7. HANDLING AND STORAGE

<b>Handling Precautions</b>	Avoid contact with eyes, skin, or clothing. Keep floors clean of spills.
<b>Storage Information</b>	Store away from oxidizers. Keep container closed when not in use. Product has a shelf life of 36 months.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	Use in a well ventilated area.
Respiratory Protection	Not normally necessary.
Hand Protection	Impervious rubber gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Liquid
Color:	Clear colorless to pale yellow
Odor:	Mild sweet
pH:	Not Determined
Specific Gravity @ 20 C (Water=1):	1
Density @ 20 C (kg/l):	Not Determined
Bulk Density @ 20 C (kg/m <sup>3</sup> ):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (C):	-15
Pour Point/Range (C):	Not Determined
Flash Point/Range (C):	> 182
Flash Point Method:	PMCC
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (g/m <sup>3</sup> ):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (g/m <sup>3</sup> ):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined
Vapor Pressure @ 20 C (mmHg):	< 0.01
Vapor Density (Air=1):	> 1
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (g/l):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined
Decomposition Temperature (C):	Not Determined

## 10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	Keep away from heat, sparks and flame.
Incompatibility (Materials to Avoid)	Strong oxidizers. Isocyanates. Strong acids.
Hazardous Decomposition Products	Aldehydes. Ketones. Organic acid vapors. Hydrocarbons. Carbon monoxide and carbon dioxide.

**11. TOXICOLOGICAL INFORMATION**

**Principle Route of Exposure** Eye or skin contact, inhalation.

Symptoms related to exposure

**Inhalation** Heated vapors may cause respiratory irritation.

**Skin Contact** Prolonged or repeated contact may cause skin irritation.

**Eye Contact** May cause mild eye irritation.

**Ingestion** None known

**Aggravated Medical Conditions** None known.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 1% are chronic health hazards.

**Other Information** None known.

**Toxicity Tests**

**Oral Toxicity:** LD50: > 2000 mg/kg (Rat)

**Dermal Toxicity:** LD50: > 2000 mg/kg (Rabbit)

**Inhalation Toxicity:** Not determined

**Primary Irritation Effect:** Not determined

**Carcinogenicity** Not determined

**Genotoxicity:** Not determined

**Reproductive /** Not determined

**Developmental Toxicity:**

**12. ECOLOGICAL INFORMATION**

**Mobility (Water/Soil/Air)** Not determined

**Persistence/Degradability** COD: 2.14 p/p

**Bio-accumulation** Not determined

**Ecotoxicological Information**

**Acute Fish Toxicity:** Not determined

**Acute Crustaceans Toxicity:** Not determined

**Acute Algae Toxicity:** Not determined

**Chemical Fate Information** Not determined

**Other Information** Not applicable



### 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Disposal should be made in accordance with federal, state, and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

### 14. TRANSPORT INFORMATION

#### Land Transportation

**ADR**  
Not restricted

#### Air Transportation

**ICAO/IATA**  
Not restricted

#### Sea Transportation

**IMDG**  
Not restricted

#### Other Transportation Information

**Labels:** None

### 15. REGULATORY INFORMATION

#### Chemical Inventories

<b>Australian AICS Inventory</b>	All components listed on inventory or are exempt.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.
<b>EINECS Inventory</b>	This product, and all its components, complies with EINECS

**Classification** Not Classified

**Risk Phrases** None

**Safety Phrases** None

### 16. OTHER INFORMATION

**The following sections have been revised since the last issue of this SDS**  
Not applicable

#### Contact

**Australian Poisons Information Centre**  
24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**New Zealand National Poisons Centre**  
0800 764 766

**Additional Information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**\*\*\*END OF MSDS\*\*\***

**SAFETY DATA SHEET****BAROFIBRE®**

Revision Date: 15-Sep-2015

Revision Number: 26

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** BAROFIBRE®

**Other means of Identification**

**Synonyms:** None

**Product Code:** HM003539

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Loss Circulation Material

**Uses Advised Against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-Mail address:** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Not classified

**Label elements, including precautionary statements****Hazard Pictograms****Signal Word** Not Hazardous**Hazard Statements** Not Classified**Precautionary Statements****Prevention** None**Response** None**Storage** None**Disposal** None**Contains****Substances**

Contains no hazardous substances in concentrations above cut-off values according to the competent authority

**CAS Number**

NA

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification***For the full text of the H-phrases mentioned in this Section, see Section 16***Classification** Not Classified**Risk Phrases** None**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

**4. First aid measures****Description of necessary first aid measures****Inhalation** Under normal conditions, first aid procedures are not required. Move person to fresh air.**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.**Skin** Under normal conditions, first aid procedures are not required.**Ingestion** Under normal conditions, first aid procedures are not required.**Symptoms caused by exposure**

No significant hazards expected.

**Medical Attention and Special Treatment****Notes to Physician** Treat symptomatically

## 5. Fire Fighting Measures

### Suitable extinguishing equipment

#### **Suitable Extinguishing Media**

Water fog, carbon dioxide, foam, dry chemical.

#### **Extinguishing media which must not be used for safety reasons**

None known.

### Specific hazards arising from the chemical

#### **Special Exposure Hazards**

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

### Special protective equipment and precautions for fire fighters

#### **Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

### 6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid creating and breathing dust. Ensure adequate ventilation.

### 6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

### 6.3. Methods and material for containment and cleaning up

Scoop up and remove.

## 7. Handling and storage

### 7.1. Precautions for Safe Handling

#### **Handling Precautions**

Avoid creating or inhaling dust. Avoid contact with eyes, skin, or clothing. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

#### **Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

### 7.2. Conditions for safe storage, including any incompatibilities

#### **Storage Information**

Store away from oxidizers. Store in a dry location. Product has a shelf life of 36 months.

#### **Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

### Control parameters - exposure standards, biological monitoring

#### **Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

### Appropriate engineering controls

#### **Engineering Controls**

Use in a well ventilated area.

### Personal protective equipment (PPE)

<b>Respiratory Protection</b>	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Dust/mist respirator. (N95, P2/P3)
<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Safety glasses.
<b>Other Precautions</b>	None known.
<b>Environmental Exposure Controls</b>	Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

<b>Physical State:</b>	Solid Powder	<b>Color:</b>	Tan
<b>Odor:</b>	Odorless	<b>Odor Threshold:</b>	No information available

<u>Property</u>	<u>Values</u>
<u>Remarks/ - Method</u>	
<b>pH:</b>	4.9 (1%)
<b>Freezing Point/Range</b>	190 °C
<b>Melting Point/Range</b>	No data available
<b>Boiling Point/Range</b>	No data available
<b>Flash Point</b>	193 °C / 380 °F PMCC
<b>lower flammability limit</b>	0.29
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	No data available
<b>Vapor Density</b>	No data available
<b>Specific Gravity</b>	1.3
<b>Water Solubility</b>	Insoluble in water
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

### 9.2. Other information

<b>VOC Content (%)</b>	No data available
<b>Bulk Density</b>	24-31 lbs/ft3

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical Stability

Stable

### 10.3. Possibility of Hazardous Reactions

Will Not Occur

### 10.4. Conditions to Avoid

None anticipated

### 10.5. Incompatible Materials

Strong oxidizers.

### 10.6. Hazardous Decomposition Products

None known.

## 11. Toxicological Information

### Information on routes of exposure

**Principle Route of Exposure** Eye or skin contact, inhalation.

**Symptoms related to exposure**

**Most Important Symptoms/Effects**

No significant hazards expected.

**Numerical measures of toxicity**

**Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

**Immediate, delayed and chronic health effects from exposure**

**Inhalation** May cause mild respiratory irritation.

**Eye Contact** May cause mild eye irritation.

**Skin Contact** None known.

**Ingestion** None known.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

None known.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Eye damage/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Skin Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Respiratory Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Mutagenic Effects
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Carcinogenic Effects
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Reproductive toxicity
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - single exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - repeated exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Aspiration hazard
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available



**12.3. Bioaccumulative potential**

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

**13. Disposal Considerations****Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

<b>UN Number:</b>	Not restricted
<b>UN Proper Shipping Name:</b>	Not restricted
<b>Transport Hazard Class(es):</b>	Not applicable
<b>Packing Group:</b>	Not applicable
<b>Environmental Hazards:</b>	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

**15. Regulatory Information****Safety, health and environmental regulations specific for the product****International Inventories**

<b>Australian AICS Inventory</b>	All components listed on inventory or are exempt.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>EINECS Inventory</b>	This product, and all its components, complies with EINECS
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.
<b>Canadian DSL Inventory</b>	All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

## 16. Other information

### Date of preparation or review

**Revision Date:** 15-Sep-2015

### **Revision Note**

SDS sections updated: 2

### **Full text of R-phrases referred to under Sections 2 and 3**

None

### **Full text of H-Statements referred to under sections 2 and 3**

None

### **Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

### **Key abbreviations or acronyms used**

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m<sup>3</sup> - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

### **Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

NZ CCID

### **Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

**SAFETY DATA SHEET****BENTONITE**

Revision Date: 15-Mar-2016

Revision Number: 38

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** BENTONITE

**Other means of Identification**

**Synonyms** None  
**Product Code:** HM000126

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Weight Additive  
**Uses advised against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-mail Address** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Carcinogenicity	Category 2 - H351
Specific Target Organ Toxicity - (Repeated Exposure)	Category 2 - H373

**Label elements, including precautionary statements****Hazard pictograms**

**Signal Word**

Warning

**Hazard Statements**

H351 - Suspected of causing cancer

H373 - May cause damage to organs through prolonged or repeated exposure

**Precautionary Statements****Prevention**

P201 - Obtain special instructions before use

P202 - Do not handle until all safety precautions have been read and understood

P260 - Do not breathe dust/fume/gas/mist/vapors/spray

P281 - Use personal protective equipment as required

**Response**

P308 + P313 - IF exposed or concerned: Get medical advice/attention

P314 - Get medical attention/advice if you feel unwell

**Storage**

P405 - Store locked up

**Disposal**

P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Contains****Substances**

Crystalline silica, quartz

Crystalline silica, cristobalite

Crystalline silica, tridymite

**CAS Number**

14808-60-7

14464-46-1

15468-32-3

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

*For the full text of the H-phrases mentioned in this Section, see Section 16*

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Crystalline silica, quartz	14808-60-7	1 - 5%	Carc. 2 (H351) STOT RE 1 (H372)
Crystalline silica, cristobalite	14464-46-1	0.1 - 1%	Carc. 2 (H351) STOT RE 1 (H372)
Crystalline silica, tridymite	15468-32-3	0.1 - 1%	Carc. 2 (H351) STOT RE 1 (H372)

### 4. First aid measures

**Description of necessary first aid measures****Inhalation**

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes**

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Skin**

Wash with soap and water. Get medical attention if irritation persists.

**Ingestion**

Under normal conditions, first aid procedures are not required.

**Symptoms caused by exposure**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease. Potential carcinogen. Prolonged or repeated exposure may cause damage to organs.

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

## 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special exposure hazards in a fire**

None anticipated

**Special protective equipment and precautions for fire fighters****Special protective equipment for firefighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust.

**6.2. Environmental precautions**

None known.

**6.3. Methods and material for containment and cleaning up**

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

## 7. Handling and storage

**7.1. Precautions for safe handling****Handling Precautions**

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Crystalline silica, quartz	14808-60-7	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.025 mg/m <sup>3</sup>
Crystalline silica, cristobalite	14464-46-1	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.025 mg/m <sup>3</sup>
Crystalline silica, tridymite	15468-32-3	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.05 mg/m <sup>3</sup>

**Appropriate engineering controls****Engineering Controls**

Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

**Personal protective equipment (PPE)****Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

**Respiratory Protection**

Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product.

**Hand Protection**

Normal work gloves.

**Skin Protection**

Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

**Eye Protection**

Wear safety glasses or goggles to protect against exposure.

**Other Precautions**

None known.

**Environmental Exposure Controls**

No information available

## 9. Physical and Chemical Properties

**9.1. Information on basic physical and chemical properties**

**Physical State:** Solid

**Color:** Various

**Odor:** Odorless

**Odor Threshold:** No information available

PropertyValues

Remarks/ - Method

**pH:**

9.9

**Freezing Point / Range**

No data available

**Melting Point / Range**

No data available

**Boiling Point / Range**

No data available

**Flash Point**

No data available

**Evaporation rate**

No data available

**Vapor Pressure**

No data available

**Vapor Density**

No data available

**Specific Gravity**

2.65

**Water Solubility**

Insoluble in water

**Solubility in other solvents**

No data available

**Partition coefficient: n-octanol/water**

No data available

**Autoignition Temperature**

No data available

**Decomposition Temperature**

No data available

**Viscosity**

No data available

**Explosive Properties**

No information available

**Oxidizing Properties**

No information available

**9.2. Other information**

**VOC Content (%)**

No data available

## 10. Stability and Reactivity

**10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical stability**

Stable

**10.3. Possibility of hazardous reactions**

Will Not Occur

**10.4. Conditions to avoid**

None anticipated

**10.5. Incompatible materials**

Hydrofluoric acid.

**10.6. Hazardous decomposition products**

Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).

**11. Toxicological Information****Information on routes of exposure****Principle Route of Exposure** Eye or skin contact, inhalation.**Symptoms related to exposure****Most Important Symptoms/Effects**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease. Potential carcinogen. Prolonged or repeated exposure may cause damage to organs.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica, quartz	14808-60-7	> 15000 mg/kg (human)	No information available	No data available
Crystalline silica, cristobalite	14464-46-1	>15,000 mg/kg (Human)	No data available	No data available
Crystalline silica, tridymite	15468-32-3	>15,000 mg/kg (Human)	No data available	No data available

**Immediate, delayed and chronic health effects from exposure****Inhalation**

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

**Eye Contact**

May cause mechanical irritation to eye.

**Skin Contact**

None known.

**Ingestion**

None known.

**Chronic Effects/Carcinogenicity**

**Silicosis:** Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

**Cancer Status:** The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American

Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

#### Exposure Levels

No data available

#### Interactive effects

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

#### Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin
Crystalline silica, cristobalite	14464-46-1	Non-irritating to the skin
Crystalline silica, tridymite	15468-32-3	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible. No information available
Crystalline silica, cristobalite	14464-46-1	Mechanical irritation of the eyes is possible.
Crystalline silica, tridymite	15468-32-3	Mechanical irritation of the eyes is possible.

Substances	CAS Number	Skin Sensitization
Crystalline silica, quartz	14808-60-7	No information available.
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

Substances	CAS Number	Respiratory Sensitization
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

Substances	CAS Number	Mutagenic Effects
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.
Crystalline silica, cristobalite	14464-46-1	Not regarded as mutagenic.
Crystalline silica, tridymite	15468-32-3	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.
Crystalline silica, cristobalite	14464-46-1	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.
Crystalline silica, tridymite	15468-32-3	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.

Substances	CAS Number	Reproductive toxicity
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available



Crystalline silica, tridymite	15468-32-3	No information available
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Substances	CAS Number	STOT - single exposure
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.
Crystalline silica, cristobalite	14464-46-1	No significant toxicity observed in animal studies at concentration requiring classification.
Crystalline silica, tridymite	15468-32-3	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)
Crystalline silica, cristobalite	14464-46-1	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)
Crystalline silica, tridymite	15468-32-3	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Crystalline silica, quartz	14808-60-7	Not applicable
Crystalline silica, cristobalite	14464-46-1	Not applicable
Crystalline silica, tridymite	15468-32-3	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Crystalline silica, quartz	14808-60-7	EC50 (72 h) =440 mg/L (Selenastrum capricornutum)	LL0 (96 h) =10000 mg/L (Danio rerio)	No information available	LL50 (24 h) >10000 mg/L (Daphnia magna)
Crystalline silica, cristobalite	14464-46-1	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)
Crystalline silica, tridymite	15468-32-3	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, cristobalite	14464-46-1	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, tridymite	15468-32-3	The methods for determining biodegradability are not applicable to inorganic substances.

### 12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

### 12.6. Other adverse effects

#### Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

### 13. Disposal Considerations

**Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations. Substance should NOT be deposited into a sewage facility.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

**Environmental regulations**

Not applicable

### 14. Transport Information

**Transportation Information**

UN Number	Not restricted
UN proper shipping name	Not restricted
Transport Hazard Class(es)	Not applicable
Packing Group:	Not applicable
Environmental Hazards	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

### 15. Regulatory Information

**Safety, health and environmental regulations specific for the product****International Inventories**

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
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New Zealand Inventory of Chemicals	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
------------------------------------	--

EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
---	--

US TSCA Inventory	All components listed on inventory or are exempt.
-------------------	---

Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.
---	---

**Poisons Schedule number**

None Allocated

**International Agreements**

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

### 16. Other information

**Date of preparation or review**

Revision Date: 15-Mar-2016

**Revision Note**

SDS sections updated: 2

**Full text of H-Statements referred to under sections 2 and 3**

H351 - Suspected of causing cancer if inhaled

H372 - Causes damage to organs through prolonged or repeated exposure if inhaled

H373 - May cause damage to organs through prolonged or repeated exposure if inhaled

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

EC50 – Effective Concentration 50%

LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%

LL50 – Lethal Loading 50%

mg/kg – milligram/kilogram

mg/L – milligram/liter

NOEC – No Observed Effect Concentration

OEL – Occupational Exposure Limit

PBT – Persistent Bioaccumulative and Toxic

ppm – parts per million

STEL – Short Term Exposure Limit

TWA – Time-Weighted Average

vPvB – very Persistent and very Bioaccumulative

h - hour

mg/m<sup>3</sup> - milligram/cubic meter

mm - millimeter

mmHg - millimeter mercury

w/w - weight/weight

d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

NZ CCID

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

## SAFETY DATA SHEET

### BORE-HIB®

Revision Date: 17-Sep-2015

Revision Number: 21

#### 1. Product Identifier & Identity for the Chemical

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### 1.1. Product Identifier

**Product Name** BORE-HIB®

##### Other means of Identification

**Synonyms** None  
**Product Code:** HM005877

##### Recommended use of the chemical and restrictions on use

**Recommended Use** Shale stabilizer  
**Uses advised against** No information available

##### Supplier's name, address and phone number

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-mail Address** fdunexchem@halliburton.com

##### Emergency phone number

+ 61 1 800 686 951

##### **Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

#### 2. Hazard Identification

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### Classification of the hazardous chemical

Skin Corrosion/Irritation	Category 2 - H315
Serious Eye Damage/Irritation	Category 1 - H318

##### Label elements, including precautionary statements

**Hazard pictograms**

**Signal Word**

Danger

**Hazard Statements**

H315 - Causes skin irritation  
 H318 - Causes serious eye damage

**Precautionary Statements****Prevention**

P264 - Wash face, hands and any exposed skin thoroughly after handling  
 P280 - Wear protective gloves/eye protection/face protection

**Response**

P302 + P352 - IF ON SKIN: Wash with plenty of soap and water  
 P332 + P313 - If skin irritation occurs: Get medical advice/attention  
 P362 - Take off contaminated clothing and wash before reuse  
 P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes.  
 Remove contact lenses, if present and easy to do. Continue rinsing  
 P310 - Immediately call a POISON CENTER or doctor/physician

**Storage**

None

**Disposal**

None

**Contains****Substances**

Silicic acid, potassium salt

**CAS Number**

1312-76-1

**Other hazards which do not result in classification**

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).

This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

*For the full text of the H-phrases mentioned in this Section, see Section 16*

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Silicic acid, potassium salt	1312-76-1	30 - 60%	Skin Irrit. 2 (H315) Eye Corr. 1 (H318)

### 4. First aid measures

**Description of necessary first aid measures****Inhalation**

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes**

Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

**Skin**

In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

**Ingestion**

Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

Causes severe eye irritation which may damage tissue. Causes skin irritation.

**Medical Attention and Special Treatment****Notes to Physician**

Treat symptomatically

## 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special exposure hazards in a fire**

Not applicable

**Special protective equipment and precautions for fire fighters****Special protective equipment for firefighters**

Not applicable

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Spills of this product are very slippery. Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Ensure adequate ventilation. Evacuate all persons from the area.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

## 7. Handling and storage

**7.1. Precautions for safe handling****Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid breathing mist. Material is slippery underfoot. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store in a cool well ventilated area. Keep container closed when not in use. Store at temperatures between 40 and 90 F (5 and 35 C). Product has a shelf life of 36 months.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Silicic acid, potassium salt	1312-76-1	Not applicable	Not applicable

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area.

**Personal protective equipment (PPE)**

<b>Personal Protective Equipment</b>	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
<b>Respiratory Protection</b>	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
<b>Hand Protection</b>	Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Nitrile gloves. (>= 0.4 mm thickness) This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.
<b>Skin Protection</b>	Full protective chemical resistant clothing. Rubber apron.
<b>Eye Protection</b>	Chemical goggles; also wear a face shield if splashing hazard exists.
<b>Other Precautions</b>	Eyewash fountains and safety showers must be easily accessible.
<b>Environmental Exposure Controls</b>	Do not allow material to contaminate ground water system

<b>9. Physical and Chemical Properties</b>
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**9.1. Information on basic physical and chemical properties**

<b>Physical State:</b>	Liquid	<b>Color</b>	Clear colorless to pale yellow
<b>Odor:</b>	Mild	<b>Odor Threshold:</b>	No information available

PropertyRemarks/ - MethodValues

<b>pH:</b>	11.9
<b>Freezing Point / Range</b>	No data available
<b>Melting Point / Range</b>	No data available
<b>Boiling Point / Range</b>	100 °C / 212 °F
<b>Flash Point</b>	> 177 °C / 350.6 °F PMCC
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	No data available
<b>Vapor Density</b>	No data available
<b>Specific Gravity</b>	1.36
<b>Water Solubility</b>	Miscible with water
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

**9.2. Other information**

<b>VOC Content (%)</b>	No data available
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<b>10. Stability and Reactivity</b>
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**10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical stability**

Stable

**10.3. Possibility of hazardous reactions**

Will Not Occur

**10.4. Conditions to avoid**

Contact with certain metals produces hydrogen gas.

**10.5. Incompatible materials**

Amphoteric metals such as aluminum, magnesium, lead, tin, or zinc.

**10.6. Hazardous decomposition products**

Flammable hydrogen gas.

## 11. Toxicological Information

**Information on routes of exposure**

**Principle Route of Exposure** Eye or skin contact, inhalation.

**Symptoms related to exposure****Most Important Symptoms/Effects**

Causes severe eye irritation which may damage tissue. Causes skin irritation.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Silicic acid, potassium salt	1312-76-1	1300 mg/kg (Rat)	> 5000 mg/kg (Rat)	> 2.06 mg/L (Rat)

**Immediate, delayed and chronic health effects from exposure**

<b>Inhalation</b>	May cause respiratory irritation.
<b>Eye Contact</b>	Causes severe eye irritation which may damage tissue.
<b>Skin Contact</b>	Causes moderate skin irritation.
<b>Ingestion</b>	Irritation of the mouth, throat, and stomach.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

Skin disorders.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Silicic acid, potassium salt	1312-76-1	Causes moderate skin irritation. (Rabbit)

Substances	CAS Number	Serious eye damage/irritation
Silicic acid, potassium salt	1312-76-1	Corrosive to eyes (Rabbit)

Substances	CAS Number	Skin Sensitization
Silicic acid, potassium salt	1312-76-1	Did not cause sensitization on laboratory animals (guinea pig) (mouse)

Substances	CAS Number	Respiratory Sensitization
Silicic acid, potassium salt	1312-76-1	No information available

Substances	CAS Number	Mutagenic Effects
Silicic acid, potassium salt	1312-76-1	In vitro tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Silicic acid, potassium salt	1312-76-1	Did not show carcinogenic or teratogenic effects in animal experiments (similar substances)

Substances	CAS Number	Reproductive toxicity
Silicic acid, potassium salt	1312-76-1	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal



		experiments. (similar substances)
<b>Substances</b>	<b>CAS Number</b>	<b>STOT - single exposure</b>
Silicic acid, potassium salt	1312-76-1	No significant toxicity observed in animal studies at concentration requiring classification.
<b>Substances</b>	<b>CAS Number</b>	<b>STOT - repeated exposure</b>
Silicic acid, potassium salt	1312-76-1	No significant toxicity observed in animal studies at concentration requiring classification. (similar substances)
<b>Substances</b>	<b>CAS Number</b>	<b>Aspiration hazard</b>
Silicic acid, potassium salt	1312-76-1	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Silicic acid, potassium salt	1312-76-1	EC50 (72h) 201mg/L (Skeletonema costatum) EC50 (72h) 207 mg/L (Desmodesmus subspicatus)	LC50 (96h) 301-478 mg/L (Lepomis macrochirus) LC50 (96h) 3185 mg/L (Brachydanio rerio) (similar substance) LC50 (96h) > 1800 mg/L (Scophthalmus maximus)	No information available	EC50 (96) 216 mg/L (Daphnia magna) EC50 (48h) 1528.57 mg/L (Acartia tonsa)

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Silicic acid, potassium salt	1312-76-1	The methods for determining biodegradability are not applicable to inorganic substances.

### 12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Silicic acid, potassium salt	1312-76-1	No information available

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Silicic acid, potassium salt	1312-76-1	No information available

### 12.6. Other adverse effects

#### Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

## 13. Disposal Considerations

### Safe handling and disposal methods

Disposal should be made in accordance with federal, state, and local regulations.

### Disposal of any contaminated packaging

Follow all applicable national or local regulations.

### Environmental regulations

Not applicable

## 14. Transport Information

### Transportation Information

UN Number	Not restricted
UN proper shipping name	Not restricted
Transport Hazard Class(es)	Not applicable
Packing Group:	Not applicable
Environmental Hazards	Not applicable

### Special precautions during transport

None

### HazChem Code

None Allocated

## 15. Regulatory Information

### Safety, health and environmental regulations specific for the product

#### International Inventories

Australian AICS Inventory	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
New Zealand Inventory of Chemicals	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
EINECS (European Inventory of Existing Chemical Substances)	This product, and all its components, complies with EINECS
US TSCA Inventory	All components listed on inventory or are exempt.
Canadian Domestic Substances List (DSL)	All components listed on inventory or are exempt.

### Poisons Schedule number

None Allocated

### International Agreements

Montreal Protocol - Ozone Depleting Substances:	Does not apply
Stolkhom Convention - Persistent Organic Pollutants:	Does not apply
Rotterdam Convention - Prior Informed Consent:	Does not apply
Basel Convention - Hazardous Waste:	Does not apply

## 16. Other information

### Date of preparation or review

Revision Date: 17-Sep-2015

### Revision Note

SDS sections updated: 2

### Full text of H-Statements referred to under sections 2 and 3

H315 - Causes skin irritation

H318 - Causes serious eye damage

### Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

### Key abbreviations or acronyms used

bw – body weight

CAS – Chemical Abstracts Service  
EC50 – Effective Concentration 50%  
LC50 – Lethal Concentration 50%  
LD50 – Lethal Dose 50%  
LL50 – Lethal Loading 50%  
mg/kg – milligram/kilogram  
mg/L – milligram/liter  
NOEC – No Observed Effect Concentration  
OEL – Occupational Exposure Limit  
PBT – Persistent Bioaccumulative and Toxic  
ppm – parts per million  
STEL – Short Term Exposure Limit  
TWA – Time-Weighted Average  
vPvB – very Persistent and very Bioaccumulative  
h - hour  
mg/m<sup>3</sup> - milligram/cubic meter  
mm - millimeter  
mmHg - millimeter mercury  
w/w - weight/weight  
d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

**Disclaimer Statement**

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**End of Safety Data Sheet**

## MATERIAL SAFETY DATA SHEET

**Product Trade Name:**            **CALCIUM CARBONATE**

**Revision Date:**                    29-Apr-2013

### 1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

**Statement of Hazardous Nature**    Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

**Manufacturer/Supplier**            Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
New Zealand: 06-7559274

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

#### Identification of Substances or Preparation

**Product Trade Name:**            CALCIUM CARBONATE  
**Synonyms:**                        None  
**Chemical Family:**               Mineral  
**UN Number:**                      None  
**Dangerous Goods Class:**       None  
**Subsidiary Risk:**                None  
**Hazchem Code:**                None Allocated  
**Poisons Schedule:**            None Allocated  
**Application:**                    pH Control

**Prepared By**                        Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com

### 2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Calcium carbonate	471-34-1	60 - 100%	TWA: 10 mg/m <sup>3</sup>	TWA: 10 mg/m <sup>3</sup>	10 mg/m <sup>3</sup>
Crystalline silica, quartz	14808-60-7	1 - 5%	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.2 mg/m <sup>3</sup>	TWA: 0.025 mg/m <sup>3</sup>

### 3. HAZARDS IDENTIFICATION

#### Hazard Overview

#### **CAUTION! - ACUTE HEALTH HAZARD**

May cause eye and respiratory irritation.

#### **DANGER! - CHRONIC HEALTH HAZARD**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, or equivalent respirator when using this product. Review the Material Safety Data Sheet (MSDS) for this product, which has been provided to your employer.

#### Risk Phrases

R49 May cause cancer by inhalation.

R48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation.

#### HSNO Classification

6.4A Irritating to the eye 6.7A Known or presumed human carcinogens 6.9A Toxic to human target organs or systems

### 4. FIRST AID MEASURES

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Skin

Wash with soap and water. Get medical attention if irritation persists.

#### Eyes

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

#### Ingestion

Under normal conditions, first aid procedures are not required.

#### Notes to Physician

Treat symptomatically.

### 5. FIRE FIGHTING MEASURES

#### Suitable Extinguishing Media

All standard fire fighting media

#### Extinguishing media which must not be used for safety reasons

None known.

#### Special Exposure Hazards

Not applicable.

#### Special Protective Equipment for Fire-Fighters

Not applicable.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautionary Measures** Use appropriate protective equipment. Avoid creating and breathing dust.

<b>Environmental Precautionary Measures</b>	None known.
<b>Procedure for Cleaning / Absorption</b>	Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

## 7. HANDLING AND STORAGE

<b>Handling Precautions</b>	This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.
<b>Storage Information</b>	Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

<b>Engineering Controls</b>	Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.
<b>Respiratory Protection</b>	Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), or equivalent respirator when using this product.
<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.
<b>Eye Protection</b>	Wear safety glasses or goggles to protect against exposure.
<b>Other Precautions</b>	None known.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State:</b>	Solid
<b>Color:</b>	Light tan
<b>Odor:</b>	Odorless
<b>pH:</b>	8
<b>Specific Gravity @ 20 C (Water=1):</b>	2.7
<b>Density @ 20 C (kg/l):</b>	Not Determined
<b>Bulk Density @ 20 C (kg/m<sup>3</sup>):</b>	Not Determined
<b>Boiling Point/Range (C):</b>	Not Determined
<b>Freezing Point/Range (C):</b>	Not Determined
<b>Pour Point/Range (C):</b>	Not Determined
<b>Flash Point/Range (C):</b>	Not Determined
<b>Flash Point Method:</b>	Not Determined
<b>Autoignition Temperature (C):</b>	Not Determined
<b>Flammability Limits in Air - Lower (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Lower (%):</b>	Not Determined
<b>Flammability Limits in Air - Upper (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Upper (%):</b>	Not Determined
<b>Vapor Pressure @ 20 C (mmHg):</b>	Not Determined
<b>Vapor Density (Air=1):</b>	Not Determined
<b>Percent Volatiles:</b>	Not Determined

## 9. PHYSICAL AND CHEMICAL PROPERTIES

Evaporation Rate (Butyl Acetate=1):	Not Determined
Solubility in Water (g/100ml):	Soluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (g/l):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined
Decomposition Temperature (C):	Not Determined

## 10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Strong acids. Prolonged contact with aluminum. Ammonium salts.
Hazardous Decomposition Products	Carbon monoxide and carbon dioxide. Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

## 11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure	Eye or skin contact, inhalation.
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### Symptoms related to exposure

Inhalation	<p>Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).</p> <p>Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).</p>
Skin Contact	May cause mechanical skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	None known
Aggravated Medical Conditions	Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

**Chronic Effects/Carcinogenicity** Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

**Other Information** For further information consult "Adverse Effects of Crystalline Silica Exposure" published by the American Thoracic Society Medical Section of the American Lung Association, American Journal of Respiratory and Critical Care Medicine, Volume 155, pages 761-768 (1997).

#### Toxicity Tests

<b>Oral Toxicity:</b>	Not determined
<b>Dermal Toxicity:</b>	Not determined
<b>Inhalation Toxicity:</b>	Not determined
<b>Primary Irritation Effect:</b>	Not determined
<b>Carcinogenicity</b>	Refer to <u>IARC Monograph 68, Silica, Some Silicates and Organic Fibres</u> (June 1997).
<b>Genotoxicity:</b>	Not determined
<b>Reproductive / Developmental Toxicity:</b>	Not determined

## 12. ECOLOGICAL INFORMATION

<b>Mobility (Water/Soil/Air)</b>	Not determined
<b>Persistence/Degradability</b>	Not determined
<b>Bio-accumulation</b>	Not determined

#### Ecotoxicological Information

<b>Acute Fish Toxicity:</b>	Not determined
<b>Acute Crustaceans Toxicity:</b>	Not determined



<b>Acute Algae Toxicity:</b>	Not determined
<b>Chemical Fate Information</b>	Not determined
<b>Other Information</b>	Not applicable

### 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Bury in a licensed landfill according to federal, state, and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

### 14. TRANSPORT INFORMATION

#### Land Transportation

**ADR**  
Not restricted

#### Air Transportation

**ICAO/IATA**  
Not restricted

#### Sea Transportation

**IMDG**  
Not restricted

#### Other Transportation Information

**Labels:** None

### 15. REGULATORY INFORMATION

#### Chemical Inventories

<b>Australian AICS Inventory</b>	All components listed on inventory or are exempt.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.
<b>EINECS Inventory</b>	This product, and all its components, complies with EINECS

**Classification** T - Toxic.  
Crystalline silica is not classified as a carcinogen in EU Council Directives 67/548/EEC and 88/379/EEC.

**Risk Phrases** R49 May cause cancer by inhalation.  
R48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation.

**Safety Phrases** None

### 16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS  
Not applicable

## Contact

### Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

### New Zealand National Poisons Centre

0800 764 766

### Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

### Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**\*\*\*END OF MSDS\*\*\***

**SAFETY DATA SHEET****CAUSTIC SODA**

Revision Date: 22-Jan-2016

Revision Number: 32

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** CAUSTIC SODA

**Other means of Identification**

**Synonyms:** None  
**Product Code:** HM003599

**Recommended use of the chemical and restrictions on use**

**Recommended Use** pH Control  
**Uses Advised Against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-Mail address:** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Skin Corrosion / irritation	Category 1 - H314
Serious Eye Damage / Eye Irritation	Category 1 - H318
Specific Target Organ Toxicity - (Single Exposure)	Category 3 - H335
Substances/mixtures corrosive to metal.	Category 1 - H290

**Label elements, including precautionary statements****Hazard Pictograms****Signal Word**

Danger

**Hazard Statements**

H290 - May be corrosive to metals  
 H314 - Causes severe skin burns and eye damage  
 H318 - Causes serious eye damage  
 H335 - May cause respiratory irritation

**Precautionary Statements****Prevention**

P234 - Keep only in original container  
 P260 - Do not breathe dust/fume/gas/mist/vapors/spray  
 P264 - Wash face, hands and any exposed skin thoroughly after handling  
 P271 - Use only outdoors or in a well-ventilated area  
 P280 - Wear protective gloves/eye protection/face protection

**Response**

P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting  
 P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower  
 P363 - Wash contaminated clothing before reuse  
 P304 + P340 - IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing  
 P310 - Immediately call a POISON CENTER or doctor/physician  
 P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing  
 P390 - Absorb spillage to prevent material damage

**Storage**

P403 + P233 - Store in a well-ventilated place. Keep container tightly closed  
 P405 - Store locked up  
 P406 - Store in corrosive resistant container with a resistant inner liner.

**Disposal**

P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Contains****Substances**

Sodium hydroxide

**CAS Number**

1310-73-2

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).  
 This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification**

For the full text of the H-phrases mentioned in this Section, see Section 16

**Classification**

C - Corrosive.

**Risk Phrases**

R35 Causes severe burns.  
R37 Irritating to respiratory system.

**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Sodium hydroxide	1310-73-2	60 - 100%	Skin Corr. 1A (H314) Eye Corr. 1 (H318) STOT SE 3 (H335) Met. Corr. 1 (H290)

**4. First aid measures****Description of necessary first aid measures****Inhalation**

If inhaled, move victim to fresh air and seek medical attention.

**Eyes**

Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

**Skin**

In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

**Ingestion**

Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

Causes severe skin irritation with tissue destruction. Causes severe eye irritation which may damage tissue. May cause respiratory irritation.

**Medical Attention and Special Treatment****Notes to Physician**

Treat symptomatically

**5. Fire Fighting Measures****Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special Exposure Hazards**

May form explosive mixtures with strong acids. Reaction with steel and certain other metals generates flammable hydrogen gas.

**Special protective equipment and precautions for fire fighters****Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

**6. Accidental release measures****6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid creating and breathing dust. Ensure adequate ventilation.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas. Consult local authorities.

**6.3. Methods and material for containment and cleaning up**

Neutralize to pH of 6-8. Scoop up and remove.

## 7. Handling and storage

**7.1. Precautions for Safe Handling****Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Launder contaminated clothing before reuse. Use appropriate protective equipment.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from acids. Store in a cool, dry location. Store locked up.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Sodium hydroxide	1310-73-2	2 mg/m <sup>3</sup>	2 mg/M3

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area. Localized ventilation should be used to control dust levels.

**Personal protective equipment (PPE)****Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

**Respiratory Protection**

Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product.

**Hand Protection**

Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480 minutes permeation time as per EN 374): Nitrile gloves. Butyl rubber gloves. (>= 0.7 mm thickness)

This information is based on literature references and on information provided by glove manufacturers, or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed then the gloves should be replaced. Manufacturer's directions for use should be observed because of great diversity of types.

**Skin Protection**

Full protective chemical resistant clothing. Rubber boots

**Eye Protection**

Chemical goggles; also wear a face shield if splashing hazard exists.

**Other Precautions**

Eyewash fountains and safety showers must be easily accessible.

**Environmental Exposure Controls**

Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

**9.1. Information on basic physical and chemical properties**

**Physical State:** Solid

**Color:** White to off white

**Odor:** Odorless

**Odor Threshold:** No information available

Property

Values

Remarks/ - Method

<b>pH:</b>	14
<b>Freezing Point/Range</b>	No data available
<b>Melting Point/Range</b>	No data available
<b>Boiling Point/Range</b>	1390 °C / 2535 °F
<b>Flash Point</b>	No data available
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	No data available
<b>Vapor Density</b>	No data available
<b>Specific Gravity</b>	2.13
<b>Water Solubility</b>	Soluble in water
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

**9.2. Other information**

<b>Molecular Weight</b>	40
<b>VOC Content (%)</b>	No data available

## 10. Stability and Reactivity

**10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical Stability**

Stable

**10.3. Possibility of Hazardous Reactions**

Will Not Occur

**10.4. Conditions to Avoid**

None anticipated

**10.5. Incompatible Materials**

Contact with acids. Peroxides. Halogenated compounds. Prolonged contact with aluminum, lead, or zinc may liberate flammable hydrogen.

**10.6. Hazardous Decomposition Products**

None known.

## 11. Toxicological Information

**Information on routes of exposure**

**Principle Route of Exposure** Eye or skin contact, inhalation.

**Symptoms related to exposure****Most Important Symptoms/Effects**

Causes severe skin irritation with tissue destruction. Causes severe eye irritation which may damage tissue. May cause respiratory irritation.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium hydroxide	1310-73-2	No data available	1350 mg/kg (Rabbit)	No data available

**Immediate, delayed and chronic health effects from exposure**

<b>Inhalation</b>	Causes severe respiratory irritation.
<b>Eye Contact</b>	Causes severe eye irritation which may damage tissue.
<b>Skin Contact</b>	Causes severe burns.
<b>Ingestion</b>	Causes burns of the mouth, throat and stomach.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1%

are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

Skin disorders.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Sodium hydroxide	1310-73-2	Causes severe burns

Substances	CAS Number	Eye damage/irritation
Sodium hydroxide	1310-73-2	Causes severe eye burns (Rabbit)

Substances	CAS Number	Skin Sensitization
Sodium hydroxide	1310-73-2	Did not cause sensitization on laboratory animals (guinea pig)

Substances	CAS Number	Respiratory Sensitization
Sodium hydroxide	1310-73-2	No information available

Substances	CAS Number	Mutagenic Effects
Sodium hydroxide	1310-73-2	Did not show mutagenic effects in animal experiments In vitro tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Sodium hydroxide	1310-73-2	No data of sufficient quality are available.

Substances	CAS Number	Reproductive toxicity
Sodium hydroxide	1310-73-2	No information available

Substances	CAS Number	STOT - single exposure
Sodium hydroxide	1310-73-2	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure
Sodium hydroxide	1310-73-2	No significant toxicity observed in animal studies at concentration requiring classification. Not applicable due to corrosivity of the substance.

Substances	CAS Number	Aspiration hazard
Sodium hydroxide	1310-73-2	Not applicable

## 12. Ecological Information

**Ecotoxicity****Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium hydroxide	1310-73-2	No information available	LC50 (96h) 125 mg/L (Gambusia affinis) LC50 (48h) 189 mg/L (Leuciscus melanotus) LC50 (24h) 145 mg/L (Poecilia reticulata)	No information available	EC50 (48h) 40.4 mg/L (Ceriodaphnia sp.)

**12.2. Persistence and degradability**

Substances	CAS Number	Persistence and Degradability
Sodium hydroxide	1310-73-2	The methods for determining biodegradability are



		not applicable to inorganic substances.
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**12.3. Bioaccumulative potential**

Substances	CAS Number	Log Pow
Sodium hydroxide	1310-73-2	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Sodium hydroxide	1310-73-2	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

**13. Disposal Considerations****Safe handling and disposal methods**

Disposal should be made in accordance with federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

**UN Number:** UN1823  
**UN Proper Shipping Name:** Sodium Hydroxide, Solid  
**Transport Hazard Class(es):** 8  
**Packing Group:** II  
**Environmental Hazards:** Not applicable

**Special precautions during transport**

None

**HazChem Code**

2R

**15. Regulatory Information****Safety, health and environmental regulations specific for the product****International Inventories****Australian AICS Inventory**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

**New Zealand Inventory of Chemicals**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

**EINECS Inventory**

This product, and all its components, complies with EINECS

**US TSCA Inventory**

All components listed on inventory or are exempt.

**Canadian DSL Inventory**

All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

**International Agreements**

Montreal Protocol - Ozone Depleting Substances:  
Stolkhom Convention - Persistent Organic Pollutants:  
Rotterdam Convention - Prior Informed Consent:  
Basel Convention - Hazardous Waste:

Does not apply  
Does not apply  
Does not apply  
Does not apply

**16. Other information****Date of preparation or review**

**Revision Date:** 22-Jan-2016

**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

R35 Causes severe burns.

R37 Irritating to respiratory system.

**Full text of H-Statements referred to under sections 2 and 3**

H290 - May be corrosive to metals

H314 - Causes severe skin burns and eye damage

H318 - Causes serious eye damage

H335 - May cause respiratory irritation

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

EC50 – Effective Concentration 50%

LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%

LL50 – Lethal Loading 50%

mg/kg – milligram/kilogram

mg/L – milligram/liter

NOEC – No Observed Effect Concentration

OEL – Occupational Exposure Limit

PBT – Persistent Bioaccumulative and Toxic

ppm – parts per million

STEL – Short Term Exposure Limit

TWA – Time-Weighted Average

vPvB – very Persistent and very Bioaccumulative

h - hour

mg/m<sup>3</sup> - milligram/cubic meter

mm - millimeter

mmHg - millimeter mercury

w/w - weight/weight

d - day

**Key literature references and sources for data**

www.ChemADVISOR.com/

NZ CCID

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained

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from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

**SAFETY DATA SHEET****DEXTRID® LTE**

Revision Date: 24-Nov-2015

Revision Number: 24

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** DEXTRID® LTE

**Other means of Identification**

**Synonyms:** None  
**Product Code:** HM003615

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Fluid Loss Additive

**Uses Advised Against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-Mail address:** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Acute Aquatic Toxicity	Acute 3 - H402
Chronic Aquatic Toxicity	Chronic 3 - H412

**Label elements, including precautionary statements****Hazard Pictograms**

<b>Signal Word</b>	None
<b>Hazard Statements</b>	H402 - Harmful to aquatic life H412 - Harmful to aquatic life with long lasting effects
<b>Precautionary Statements</b>	
<b>Prevention</b>	P273 - Avoid release to the environment
<b>Response</b>	None
<b>Storage</b>	None
<b>Disposal</b>	P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Contains Substances**

Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione

**CAS Number**

533-74-4

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification***For the full text of the H-phrases mentioned in this Section, see Section 16***Classification**

None

**Risk Phrases**

R52/53 Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0.1 - 1%	Acute Tox. 4 (H302) Eye Irrit. 2 (H319) STOT SE 3 (H336) STOT RE 2 (H373) Aquatic Acute 1 (H400) Aquatic Chronic 1 (H410)

**4. First aid measures****Description of necessary first aid measures****Inhalation**

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes**

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Skin**

Wash with soap and water. Get medical attention if irritation persists.

**Ingestion**

Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

May cause mild eye, skin, and respiratory irritation.

**Medical Attention and Special Treatment**

## Notes to Physician

Treat symptomatically

**5. Fire Fighting Measures****Suitable extinguishing equipment****Suitable Extinguishing Media**

Water fog, carbon dioxide, foam, dry chemical.

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special Exposure Hazards**

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential. Decomposition in fire may produce harmful gases.

**Special protective equipment and precautions for fire fighters****Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

**6. Accidental release measures****6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid creating and breathing dust. Ensure adequate ventilation.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Scoop up and remove.

**7. Handling and storage****7.1. Precautions for Safe Handling****Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid dust accumulations. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 12 months.

**Other Guidelines**

No information available

**8. Exposure Controls/Personal Protection****Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Not applicable	Not applicable

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area.

**Personal protective equipment (PPE)****Respiratory Protection**

If engineering controls and work practices cannot keep exposure below occupational

exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

**Hand Protection**

Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.

**Skin Protection**

Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.

**Eye Protection**

Wear safety glasses or goggles to protect against exposure.

**Other Precautions**

None known.

**Environmental Exposure Controls**

Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

**9.1. Information on basic physical and chemical properties**

**Physical State:** Powder

**Color:** White to off white

**Odor:** Musty

**Odor Threshold:** No information available

Property

Values

Remarks/ - Method

**pH:**

10

**Freezing Point/Range**

No data available

**Melting Point/Range**

No data available

**Boiling Point/Range**

No data available

**Flash Point**

No data available

**Evaporation rate**

No data available

**Vapor Pressure**

No data available

**Vapor Density**

No data available

**Specific Gravity**

1.5

**Water Solubility**

Soluble in water

**Solubility in other solvents**

No data available

**Partition coefficient: n-octanol/water**

No data available

**Autoignition Temperature**

No data available

**Decomposition Temperature**

No data available

**Viscosity**

No data available

**Explosive Properties**

No information available

**Oxidizing Properties**

No information available

**9.2. Other information**

**VOC Content (%)**

No data available

## 10. Stability and Reactivity

**10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical Stability**

Stable

**10.3. Possibility of Hazardous Reactions**

Will Not Occur

**10.4. Conditions to Avoid**

Keep away from heat, sparks and flame.

**10.5. Incompatible Materials**

Strong oxidizers.

**10.6. Hazardous Decomposition Products**

Oxides of sulfur. Carbon monoxide and carbon dioxide.

## 11. Toxicological Information

**Information on routes of exposure**

**Principle Route of Exposure**

Eye or skin contact, inhalation.

**Symptoms related to exposure****Most Important Symptoms/Effects**

May cause mild eye, skin, and respiratory irritation.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	320 mg/kg (Rat)	2260 mg/kg (Rat) 7 g/kg (Rabbit)	1.7 mg/L (Rat) 1h 8.4 mg/L (Rat) 4h 7.29 mg/L (Rat) 4h

**Immediate, delayed and chronic health effects from exposure**

<b>Inhalation</b>	May cause mild respiratory irritation.
<b>Eye Contact</b>	May cause mild eye irritation.
<b>Skin Contact</b>	May cause mild skin irritation.
<b>Ingestion</b>	May cause abdominal pain, vomiting, nausea, and diarrhea.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

None known.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	No data of sufficient quality are available.

Substances	CAS Number	Eye damage/irritation
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Eye, rabbit: Causes mild eye irritation.

Substances	CAS Number	Skin Sensitization
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	No data of sufficient quality are available.

Substances	CAS Number	Respiratory Sensitization
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	No information available

Substances	CAS Number	Mutagenic Effects
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects

Substances	CAS Number	Carcinogenic Effects
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	When tested at maternally toxic doses, no adverse effects on fertility, teratogenicity, or development were observed.

Substances	CAS Number	STOT - single exposure
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	May cause disorder and damage to the Central Nervous System (CNS)



Substances	CAS Number	STOT - repeated exposure
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Causes damage to organs through prolonged or repeated exposure: (Liver) (Kidney)

Substances	CAS Number	Aspiration hazard
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	EC50 (72h) 1.08 mg/L (Ankistrodermus braunii) EC50 (5d) 0.038 mg/L (Marine diatom)	LC50 (96h) 0.16 mg/L (Oncorhynchus mykiss) NOEC (28d) 0.005 (Salmo gairdneri)	No information available	EC50 (48h) 0.3 mg/L (Daphnia magna) NOEC (21d) 15,600 mg/L (Daphnia magna)

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	Readily biodegradable BOD: 4% @ 28d

### 12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0.163

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	No information available

### 12.6. Other adverse effects

#### Endocrine Disruptor Information

This product does not contain any known or suspected endocrine disruptors

## 13. Disposal Considerations

### Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

### Disposal of any contaminated packaging

Follow all applicable national or local regulations.

### Environmental regulations

Not applicable

## 14. Transport Information

### Transportation Information

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable

**Environmental Hazards:** Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

## 15. Regulatory Information

**Safety, health and environmental regulations specific for the product**

**International Inventories**

**Australian AICS Inventory**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

**New Zealand Inventory of Chemicals**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

**EINECS Inventory**

This product, and all its components, complies with EINECS

**US TSCA Inventory**

All components listed on inventory or are exempt.

**Canadian DSL Inventory**

All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

**International Agreements**

**Montreal Protocol - Ozone Depleting Substances:**

Does not apply

**Stolkhom Convention - Persistent Organic Pollutants:**

Does not apply

**Rotterdam Convention - Prior Informed Consent:**

Does not apply

**Basel Convention - Hazardous Waste:**

Does not apply

## 16. Other information

**Date of preparation or review**

**Revision Date:** 24-Nov-2015

**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

None

**Full text of H-Statements referred to under sections 2 and 3**

H302 - Harmful if swallowed

H319 - Causes serious eye irritation

H336 - May cause drowsiness or dizziness

H373 - May cause damage to organs through prolonged or repeated exposure

H400 - Very toxic to aquatic life

H410 - Very toxic to aquatic life with long lasting effects

H412 - Harmful to aquatic life with long lasting effects

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

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EC50 – Effective Concentration 50%  
LC50 – Lethal Concentration 50%  
LD50 – Lethal Dose 50%  
LL50 – Lethal Loading 50%  
mg/kg – milligram/kilogram  
mg/L – milligram/liter  
NOEC – No Observed Effect Concentration  
OEL – Occupational Exposure Limit  
PBT – Persistent Bioaccumulative and Toxic  
ppm – parts per million  
STEL – Short Term Exposure Limit  
TWA – Time-Weighted Average  
vPvB – very Persistent and very Bioaccumulative  
h - hour  
mg/m<sup>3</sup> - milligram/cubic meter  
mm - millimeter  
mmHg - millimeter mercury  
w/w - weight/weight  
d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

## MATERIAL SAFETY DATA SHEET

**Product Trade Name:** **DIAMOND SEAL**

**Revision Date:** 03-Aug-2012

<b>1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING</b>
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**Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
New Zealand: 06-7559274

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**Identification of Substances or Preparation**

**Product Trade Name:** DIAMOND SEAL  
**Synonyms:** None  
**Chemical Family:** Polymer  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** None Allocated  
**Poisons Schedule:** None Allocated  
**Application:** Loss Circulation Material

**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com

<b>2. COMPOSITION/INFORMATION ON INGREDIENTS</b>
--

Substances	CAS Number	PERCENT	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Contains no hazardous substances	Mixture	60 - 100%	Not applicable	Not applicable	Not applicable

Non-Hazardous Substance to Total of 100%

### 3. HAZARDS IDENTIFICATION

**Hazard Overview** May cause eye irritation.

**Risk Phrases** None

**HSNO Classification** Non-hazardous

### 4. FIRST AID MEASURES

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Ingestion** Under normal conditions, first aid procedures are not required.

**Notes to Physician** Not Applicable

### 5. FIRE FIGHTING MEASURES

**Suitable Extinguishing Media** Carbon dioxide, dry chemical, foam.

**Extinguishing media which must not be used for safety reasons** None known.

**Special Exposure Hazards** Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

**Special Protective Equipment for Fire-Fighters** Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautionary Measures** Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

**Environmental Precautionary Measures** None known.

**Procedure for Cleaning / Absorption** Scoop up and remove.

### 7. HANDLING AND STORAGE

**Handling Precautions** Avoid creating or inhaling dust. Wash hands after use. Slippery when wet.

**Storage Information** Store away from oxidizers. Store in a dry location.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

<b>Engineering Controls</b>	A well ventilated area to control dust levels.
<b>Personal Protective Equipment</b>	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
<b>Respiratory Protection</b>	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Wear safety glasses or goggles to protect against exposure.
<b>Other Precautions</b>	None known.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State:</b>	Solid
<b>Color:</b>	White
<b>Odor:</b>	Odorless
<b>pH:</b>	4-11
<b>Specific Gravity @ 20 C (Water=1):</b>	0.65- 0.85
<b>Density @ 20 C (kg/l):</b>	Not Determined
<b>Bulk Density @ 20 C (kg/m<sup>3</sup>):</b>	Not Determined
<b>Boiling Point/Range (C):</b>	Not Determined
<b>Freezing Point/Range (C):</b>	Not Determined
<b>Pour Point/Range (C):</b>	Not Determined
<b>Flash Point/Range (C):</b>	Not Determined
<b>Flash Point Method:</b>	Not Determined
<b>Autoignition Temperature (C):</b>	Not Determined
<b>Flammability Limits in Air - Lower (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Lower (%):</b>	Not Determined
<b>Flammability Limits in Air - Upper (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Upper (%):</b>	Not Determined
<b>Vapor Pressure @ 20 C (mmHg):</b>	Not Determined
<b>Vapor Density (Air=1):</b>	Not Determined
<b>Percent Volatiles:</b>	Not Determined
<b>Evaporation Rate (Butyl Acetate=1):</b>	Not Determined
<b>Solubility in Water (g/100ml):</b>	Insoluble
<b>Solubility in Solvents (g/100ml):</b>	Not Determined
<b>VOCs (g/l):</b>	Not Determined
<b>Viscosity, Dynamic @ 20 C (centipoise):</b>	Not Determined
<b>Viscosity, Kinematic @ 20 C (centistokes):</b>	Not Determined
<b>Partition Coefficient/n-Octanol/Water:</b>	Not Determined
<b>Molecular Weight (g/mole):</b>	Not Determined
<b>Decomposition Temperature (C):</b>	Not Determined

## 10. STABILITY AND REACTIVITY

<b>Stability Data:</b>	Stable
<b>Hazardous Polymerization:</b>	Will Not Occur
<b>Conditions to Avoid</b>	None known.

<b>Incompatibility (Materials to Avoid)</b>	Strong oxidizers.
<b>Hazardous Decomposition Products</b>	Oxides of nitrogen. Ammonia. Hydrocarbons. Carbon monoxide and carbon dioxide. In the event of oxygen depletion, hydrocyanic acid can be formed.
<b>Additional Guidelines</b>	Not Applicable

## 11. TOXICOLOGICAL INFORMATION

<b>Principle Route of Exposure</b>	Eye or skin contact, inhalation.
<b>Symptoms related to exposure</b>	
<b>Inhalation</b>	May cause mild respiratory irritation.
<b>Skin Contact</b>	None known.
<b>Eye Contact</b>	May cause eye irritation.
<b>Ingestion</b>	None known
<b>Aggravated Medical Conditions</b>	None known.
<b>Chronic Effects/Carcinogenicity</b>	No data available to indicate product or components present at greater than 1% are chronic health hazards.
<b>Other Information</b>	None known.
<b>Toxicity Tests</b>	
<b>Oral Toxicity:</b>	LD50: > 5000 mg/kg (Rat)
<b>Dermal Toxicity:</b>	LD50: > 2000 mg/kg (Rabbit)
<b>Inhalation Toxicity:</b>	Not determined
<b>Primary Irritation Effect:</b>	Not determined
<b>Carcinogenicity</b>	Not determined
<b>Genotoxicity:</b>	Not determined
<b>Reproductive / Developmental Toxicity:</b>	Not determined

## 12. ECOLOGICAL INFORMATION

<b>Mobility (Water/Soil/Air)</b>	Not determined
<b>Persistence/Degradability</b>	Not readily biodegradable.
<b>Bio-accumulation</b>	Not determined

### Ecotoxicological Information

<b>Acute Fish Toxicity:</b>	Not determined
<b>Acute Crustaceans Toxicity:</b>	Not determined
<b>Acute Algae Toxicity:</b>	Not determined
<b>Chemical Fate Information</b>	Not determined

Other Information Not applicable

### 13. DISPOSAL CONSIDERATIONS

**Disposal Method** Bury in a licensed landfill according to federal, state, and local regulations.

**Contaminated Packaging** Follow all applicable national or local regulations.

### 14. TRANSPORT INFORMATION

#### Land Transportation

**ADR**  
Not restricted

#### Air Transportation

**ICAO/IATA**  
Not restricted

#### Sea Transportation

**IMDG**  
Not restricted

#### Other Transportation Information

**Labels:** None

### 15. REGULATORY INFORMATION

#### Chemical Inventories

**Australian AICS Inventory** All components listed on inventory or are exempt.  
**New Zealand Inventory of Chemicals** All components listed on inventory or are exempt.

**US TSCA Inventory** All components listed on inventory or are exempt.  
**EINECS Inventory** This product does not comply with EINECS

**Classification** Not Classified

**Risk Phrases** None

**Safety Phrases** None

### 16. OTHER INFORMATION

**The following sections have been revised since the last issue of this SDS**  
Not applicable



## Contact

### Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

### New Zealand National Poisons Centre

0800 764 766

### Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

### Disclaimer Statement

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**\*\*\*END OF MSDS\*\*\***

## SAFETY DATA SHEET

### EZ-MUD® DP

Revision Date: 03-Mar-2016

Revision Number: 20

#### 1. Product Identifier & Identity for the Chemical

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### 1.1. Product Identifier

**Product Name** EZ-MUD® DP

##### Other means of Identification

**Synonyms** None  
**Product Code:** HM003644

##### Recommended use of the chemical and restrictions on use

**Recommended Use** Shale Inhibitor  
**Uses advised against** No information available

##### Supplier's name, address and phone number

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

##### **Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

##### **Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-mail Address** fdunexchem@halliburton.com

##### Emergency phone number

+ 61 1 800 686 951

##### **Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

#### 2. Hazard Identification

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Not classified

**Label elements, including precautionary statements****Hazard pictograms****Signal Word** Not Hazardous**Hazard Statements** Not Classified**Precautionary Statements****Prevention** None**Response** None**Storage** None**Disposal** None**Contains****Substances**

Contains no hazardous substances in concentrations above cut-off values according to the competent authority

**CAS Number**

NA

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification***For the full text of the H-phrases mentioned in this Section, see Section 16***Classification** Not Classified  
**Risk Phrases** None**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

**4. First aid measures****Description of necessary first aid measures****Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.**Skin** Wash with soap and water. Get medical attention if irritation persists.**Ingestion** Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.**Symptoms caused by exposure**

No significant hazards expected.

**Medical Attention and Special Treatment****Notes to Physician** Treat symptomatically

## 5. Fire Fighting Measures

### Suitable extinguishing equipment

#### **Suitable Extinguishing Media**

Water fog, carbon dioxide, foam, dry chemical.

#### **Extinguishing media which must not be used for safety reasons**

None known.

### Specific hazards arising from the chemical

#### **Special exposure hazards in a fire**

Decomposition in fire may produce harmful gases.

### Special protective equipment and precautions for fire fighters

#### **Special protective equipment for firefighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

### 6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation. Slippery when wet.

### 6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

### 6.3. Methods and material for containment and cleaning up

Scoop up and remove.

## 7. Handling and storage

### 7.1. Precautions for safe handling

#### **Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment. Slippery when wet.

#### **Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

### 7.2. Conditions for safe storage, including any incompatibilities

#### **Storage Information**

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 24 months.

#### **Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

### Control parameters - exposure standards, biological monitoring

#### **Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

### Appropriate engineering controls

#### **Engineering Controls**

Use in a well ventilated area.

### Personal protective equipment (PPE)

#### **Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this

<b>Respiratory Protection</b>	product. Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Wear safety glasses or goggles to protect against exposure.
<b>Other Precautions</b>	None known.
<b>Environmental Exposure Controls</b>	No information available

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

**Physical State:** Solid  
**Odor:** Mild

**Color** White  
**Odor Threshold:** No information available

<u>Property</u>	<u>Values</u>
<u>Remarks/ - Method</u>	
<b>pH:</b>	6-8
<b>Freezing Point / Range</b>	No data available
<b>Melting Point / Range</b>	No data available
<b>Boiling Point / Range</b>	No data available
<b>Flash Point</b>	No data available
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	No data available
<b>Vapor Density</b>	No data available
<b>Specific Gravity</b>	0.8
<b>Water Solubility</b>	Soluble in water
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

### 9.2. Other information

**VOC Content (%)** No data available  
**Bulk Density** 40 lbs/ft<sup>3</sup>

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical stability

Stable

### 10.3. Possibility of hazardous reactions

Will Not Occur

### 10.4. Conditions to avoid

None anticipated

### 10.5. Incompatible materials

Strong oxidizers.

### 10.6. Hazardous decomposition products

Ammonia. Oxides of nitrogen. Carbon monoxide and carbon dioxide.

## 11. Toxicological Information

### Information on routes of exposure

**Principle Route of Exposure** Eye or skin contact, inhalation.

### Symptoms related to exposure

**Most Important Symptoms/Effects**

No significant hazards expected.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

**Immediate, delayed and chronic health effects from exposure**

Inhalation	None known.
Eye Contact	May cause mild eye irritation.
Skin Contact	May cause mild skin irritation.
Ingestion	None known.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

None known.

**Data limitations**

No data available

## 12. Ecological Information

**Ecotoxicity****Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

**12.2. Persistence and degradability**

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.3. Bioaccumulative potential**

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

<b>13. Disposal Considerations</b>
------------------------------------

**Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations.

**Environmental regulations**

Not applicable

<b>14. Transport Information</b>
----------------------------------

**Transportation Information**

UN Number	Not restricted
UN proper shipping name	Not restricted
Transport Hazard Class(es)	Not applicable
Packing Group:	Not applicable
Environmental Hazards	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

<b>15. Regulatory Information</b>
-----------------------------------

**Safety, health and environmental regulations specific for the product****International Inventories**

<b>Australian AICS Inventory</b>	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
<b>New Zealand Inventory of Chemicals</b>	All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.
<b>EINECS (European Inventory of Existing Chemical Substances)</b>	This product, and all its components, complies with EINECS
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.

**Canadian Domestic Substances List** All components listed on inventory or are exempt.  
(DSL)

**Poisons Schedule number**

None Allocated

**International Agreements**

Montreal Protocol - Ozone Depleting Substances:

Does not apply

Stolkhom Convention - Persistent Organic Pollutants:

Does not apply

Rotterdam Convention - Prior Informed Consent:

Does not apply

Basel Convention - Hazardous Waste:

Does not apply

## 16. Other information

**Date of preparation or review**

Revision Date: 03-Mar-2016

**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

None

**Full text of H-Statements referred to under sections 2 and 3**

None

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

EC50 – Effective Concentration 50%

LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%

LL50 – Lethal Loading 50%

mg/kg – milligram/kilogram

mg/L – milligram/liter

NOEC – No Observed Effect Concentration

OEL – Occupational Exposure Limit

PBT – Persistent Bioaccumulative and Toxic

ppm – parts per million

STEL – Short Term Exposure Limit

TWA – Time-Weighted Average

vPvB – very Persistent and very Bioaccumulative

h - hour

mg/m<sup>3</sup> - milligram/cubic meter

mm - millimeter

mmHg - millimeter mercury

w/w - weight/weight

d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained



from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

**MATERIAL SAFETY DATA SHEET****Product Trade Name:** GEM™ CP**Revision Date:** 07-Feb-2013**1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING****Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
AustraliaACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300**Product Emergency Telephone**Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
New Zealand: 06-7559274**Fire, Police & Ambulance - Emergency Telephone**Australia: 000  
Papua New Guinea: 000  
New Zealand: 111**Identification of Substance or Preparation****Product Trade Name:** GEM™ CP  
**Synonyms:** None  
**Chemical Family:** Polyalkylene glycol  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** None  
**Poisons Schedule:** None  
**Application:** Shale stabilizer**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com**2. COMPOSITION/INFORMATION ON INGREDIENTS**

Substance	CAS Number	Percent	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Polyalkylene glycol	Proprietary	60 - 100%	Not determined	Not determined	Not applicable

### 3. HAZARDS IDENTIFICATION

**Hazard Overview** May cause eye, skin and respiratory irritation.

**Risk Phrases** R20 Harmful by inhalation.

**HSNO Classification** Not Determined

### 4. FIRST AID MEASURES

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Eyes** In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

**Ingestion** Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

**Notes to Physician** Not Applicable

### 5. FIRE FIGHTING MEASURES

**Suitable Extinguishing Media** Water fog, carbon dioxide, foam, dry chemical.

**Unsuitable Extinguishing Media** None known

**Special Exposure Hazards** Decomposition in fire may produce toxic gases.

**Special Protective Equipment for Fire-Fighters** Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautionary Measures** Use Appropriate protective equipment.

**Environmental Precautionary Measures** Prevent from entering sewers, waterways or low areas.

**Procedure for Cleaning/Absorption** Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

### 7. HANDLING AND STORAGE

**Handling Precautions** Avoid contact with eyes, skin, or clothing. Avoid breathing mist. Avoid breathing vapours.

**Storage Information** Store away from oxidisers. Store away from acids. Store away from alkalis. Keep container closed when not in use. Product has a shelf life of 60 months

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

<b>Engineering Controls</b>	Use in a well ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.
<b>Respiratory Protection</b>	Not normally needed. But if significant exposures are possible then the following respirator is recommended. Organic vapour respirator with a dust/mist filter.
<b>Hand Protection</b>	Impervious rubber gloves. Polyvinylchloride gloves. Neoprene gloves.
<b>Skin Protection</b>	Rubber apron.
<b>Eye Protection</b>	Chemical goggles; also wear a face shield if splashing hazard exists.
<b>Other Precautions</b>	Eyewash fountains and safety showers must be easily accessible.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State:</b>	Liquid
<b>Colour:</b>	Clear light yellow
<b>Odour:</b>	Mild
<b>pH:</b>	5-7.5 (10%)
<b>Specific Gravity @ 20 C (Water=1):</b>	1.02
<b>Density @ 20 C (kg/l):</b>	0.97
<b>Bulk Density @ 20 C (kg/l):</b>	Not Determined
<b>Boiling Point/Range (C):</b>	Not Determined
<b>Freezing Point/Range (C):</b>	Not Determined
<b>Pour Point/Range (C):</b>	Not Determined
<b>Flash Point/Range (C):</b>	> 93
<b>Flash Point Method:</b>	PMCC
<b>Autoignition Temperature (C):</b>	Not Determined <b>Minimum: 370</b>
<b>Flammability Limits in Air - Lower (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Lower (%):</b>	Not Determined
<b>Flammability Limits in Air - Upper (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Upper (%):</b>	Not Determined
<b>Vapour Pressure @ 20 C (mmHg):</b>	< 0.01
<b>Vapour Density (Air=1):</b>	> 1
<b>Percent Volatiles:</b>	Not Determined
<b>Evaporation Rate (Butyl Acetate = 1):</b>	< 0.1
<b>Solubility in Water (g/100ml):</b>	Soluble
<b>Solubility in Solvents (g/100ml):</b>	Not Determined
<b>VOCs (g/l):</b>	Not Determined
<b>Viscosity, Dynamic @ 20 C (centipoise):</b>	Not Determined
<b>Viscosity, Kinematic @ 20 C (centistokes):</b>	19
<b>Partition Coefficient/n-Octanol/Water:</b>	0.353
<b>Molecular Weight (g/mole):</b>	405
<b>Decomposition Temperature (C):</b>	Not Determined

## 10. STABILITY AND REACTIVITY

<b>Stability Data:</b>	Stable
<b>Hazardous Polymerisation:</b>	Will Not Occur
<b>Conditions to Avoid</b>	None known.
<b>Incompatibility (Materials to Avoid)</b>	Strong oxidisers. Strong acids. Strong alkalis

**Hazardous Decomposition Products** Carbon monoxide and carbon dioxide.

**Additional Guidelines** Not Applicable

## 11. TOXICOLOGICAL INFORMATION

**Principle Route of Exposure** None known

### Symptoms related to exposure

**Inhalation** May cause respiratory irritation.

**Skin Contact** May cause moderate skin irritation.

**Eye Contact** Causes moderate eye irritation.

**Ingestion** Irritation of the mouth, throat, and stomach.

**Aggravated Medical Conditions** Skin disorders. Eye ailments.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 1% are chronic health hazards.

**Other Information** None known.

### **Toxicity Tests**

**Oral Toxicity:** LD50: > 2000 mg/kg (Rat)

**Dermal Toxicity:** Not determined.

**Inhalation Toxicity:** Not determined

**Primary Irritation Effect:** Not determined

**Carcinogenicity:** Not determined

**Genotoxicity:** Not determined

**Reproductive/Developmental Toxicity:** Not determined

## 12. ECOLOGICAL INFORMATION

**Mobility (Water/Soil/Air)** Not determined

**Persistence/Degradability** BOD(28 Day): 76% of COD

**Bio-accumulation** Not Determined

### **Ecotoxicological Information**

**Acute Fish Toxicity:** EC50: 86 ppm (Abra alba)

**Acute Crustaceans Toxicity:** TLM48: 356 mg/l (Acartia tonsa)

**Acute Algae Toxicity:** EC50: 465 mg/l (Skeletonema costatum)

**Chemical Fate Information** Not determined

**Other Information** Not applicable

### 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Disposal should be made in accordance with federal, state and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

### 14. TRANSPORT INFORMATION

#### Land Transportation

ADR Not restricted

#### Air Transportation

ICAO/IATA Not restricted

#### Sea Transportation

IMDG Not restricted

#### Other Shipping Information

**Labels:** None

### 15. REGULATORY INFORMATION

#### Chemical Inventories

<b>Australian AICS Inventory</b>	All components listed.
<b>New Zealand Inventory of Chemicals</b>	This product does not comply with NZIOC
<b>US TSCA Inventory</b>	All components listed.
<b>EINECS Inventory</b>	All components are listed on the inventory.

**Classification** Xn - Harmful.

**Risk Phrases** R20 Harmful by inhalation.

**Safety Phrases** S2 Keep out of reach of children.

### 16. OTHER INFORMATION

**The following sections have been revised since the last issue of this MSDS:**  
Not applicable

#### Contact

##### Australian Poisons Information Centre

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

##### New Zealand National Poisons Centre

0800 764 766

**Additional Information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Product Stewardship at 1-580-251-4335.

**Disclaimer Statement**

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**\*\*\*END OF MSDS\*\*\***

**SAFETY DATA SHEET****KCL POTASSIUM CHLORIDE**

Revision Date: 21-Sep-2015

Revision Number: 21

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** KCL POTASSIUM CHLORIDE

**Other means of Identification**

**Synonyms:** None  
**Product Code:** HM000965

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Brine  
**Uses Advised Against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-Mail address:** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Not classified

**Label elements, including precautionary statements****Hazard Pictograms**

**Signal Word** Not Hazardous



**Hazard Statements** Not Classified

**Precautionary Statements**

**Prevention** None

**Response** None

**Storage** None

**Disposal** None

**Contains**

**Substances**

Contains no hazardous substances in concentrations above cut-off values according to the competent authority

**CAS Number**

NA

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification**

*For the full text of the H-phrases mentioned in this Section, see Section 16*

**Classification** Not Classified

**Risk Phrases** None

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

### 4. First aid measures

**Description of necessary first aid measures**

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes** In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Ingestion** Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

No significant hazards expected.

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

### 5. Fire Fighting Measures

**Suitable extinguishing equipment**

**Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

#### **Specific hazards arising from the chemical**

##### **Special Exposure Hazards**

Not applicable.

#### **Special protective equipment and precautions for fire fighters**

##### **Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## **6. Accidental release measures**

### **6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

### **6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

### **6.3. Methods and material for containment and cleaning up**

Scoop up and remove.

## **7. Handling and storage**

### **7.1. Precautions for Safe Handling**

#### **Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

#### **Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

### **7.2. Conditions for safe storage, including any incompatibilities**

#### **Storage Information**

Store in a cool, dry location. Product has a shelf life of 60 months.

#### **Other Guidelines**

No information available

## **8. Exposure Controls/Personal Protection**

### **Control parameters - exposure standards, biological monitoring**

#### **Exposure Limits**

<b>Substances</b>	<b>CAS Number</b>	<b>Australia NOHSC</b>	<b>ACGIH TLV-TWA</b>
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

### **Appropriate engineering controls**

#### **Engineering Controls**

Use in a well ventilated area.

### **Personal protective equipment (PPE)**

#### **Respiratory Protection**

If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Dust/mist respirator. (N95, P2/P3)

#### **Hand Protection**

Normal work gloves.

#### **Skin Protection**

Normal work coveralls.

#### **Eye Protection**

Dust proof goggles.

#### **Other Precautions**

None known.

Environmental Exposure Controls Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

Physical State: Solid  
Odor: Odorless

Color: White to gray  
Odor Threshold: No information available

Property	Values
Remarks/ - Method	
pH:	9.2
Freezing Point/Range	No data available
Melting Point/Range	771 °C
Boiling Point/Range	1413 °C
Flash Point	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.99
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

### 9.2. Other information

Molecular Weight 74.55  
VOC Content (%) No data available

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical Stability

Stable

### 10.3. Possibility of Hazardous Reactions

Will Not Occur

### 10.4. Conditions to Avoid

None anticipated

### 10.5. Incompatible Materials

None known.

### 10.6. Hazardous Decomposition Products

None known.

## 11. Toxicological Information

### Information on routes of exposure

Principle Route of Exposure Eye or skin contact, inhalation.

### Symptoms related to exposure

### Most Important Symptoms/Effects

No significant hazards expected.

### Numerical measures of toxicity

LD50 Oral: > 5000 mg/kg; (Rat)

### Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

**Immediate, delayed and chronic health effects from exposure**

<b>Inhalation</b>	May cause mild respiratory irritation.
<b>Eye Contact</b>	May cause mild eye irritation.
<b>Skin Contact</b>	May cause mild skin irritation.
<b>Ingestion</b>	May cause abdominal pain, vomiting, nausea, and diarrhea. Irritation of the mouth, throat, and stomach.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

Skin disorders.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Eye damage/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Skin Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Respiratory Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Mutagenic Effects
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Carcinogenic Effects
Contains no hazardous substances in	NA	Not applicable

concentrations above cut-off values according to the competent authority		
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Substances	CAS Number	Reproductive toxicity
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - single exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - repeated exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Aspiration hazard
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

### 12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

**13. Disposal Considerations****Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations. Substance should NOT be deposited into a sewage facility.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

UN Number:	Not restricted
UN Proper Shipping Name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

**15. Regulatory Information****Safety, health and environmental regulations specific for the product****International Inventories****Australian AICS Inventory**

All components listed on inventory or are exempt.

**New Zealand Inventory of Chemicals**

All components listed on inventory or are exempt.

**EINECS Inventory**

This product, and all its components, complies with EINECS

**US TSCA Inventory**

All components listed on inventory or are exempt.

**Canadian DSL Inventory**

All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

**16. Other information****Date of preparation or review**

Revision Date: 21-Sep-2015

Revision Note

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SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

None

**Full text of H-Statements referred to under sections 2 and 3**

None

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m<sup>3</sup> - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)  
NZ CCID

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**End of Safety Data Sheet**

## MATERIAL SAFETY DATA SHEET

**Product Trade Name:** KWIK SEAL ADDITIVE

**Revision Date:** 17-Jan-2013

### 1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
NewZealand: 06-7559274

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

### Identification of Substance or Preparation

**Product Trade Name:** KWIK SEAL ADDITIVE  
**Synonyms:** None  
**Chemical Family:** Blend of natural fibres  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** None  
**Poisons Schedule:** None  
**Application:** Loss Circulation Material

**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com

### 2. COMPOSITION/INFORMATION ON INGREDIENTS

Substance	CAS Number	Percent	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Contains no hazardous substances	Mixture	60 - 100%	Not determined	Not determined	Not applicable



### 3. HAZARDS IDENTIFICATION

**Hazard Overview** No significant hazards expected.

**Risk Phrases** None

**HSNO Classification** Not Determined

### 4. FIRST AID MEASURES

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Ingestion** Under normal conditions, first aid procedures are not required.

**Notes to Physician** Not Applicable

### 5. FIRE FIGHTING MEASURES

**Suitable Extinguishing Media** Water fog, carbon dioxide, foam, dry chemical.

**Unsuitable Extinguishing Media** None known

**Special Exposure Hazards** Decomposition in fire may produce toxic gases.

**Special Protective Equipment for Fire-Fighters** Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautionary Measures** Use Appropriate protective equipment. Avoid creating and breathing dust.

**Environmental Precautionary Measures** None known.

**Procedure for Cleaning/Absorption** Scoop up and remove.

### 7. HANDLING AND STORAGE

**Handling Precautions** Avoid creating or inhaling dust.

**Storage Information** Store away from oxidisers. Store in a cool, dry location.

### 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Engineering Controls** Use in a well ventilated area.

**Respiratory Protection** Not normally needed. But if significant exposures are possible then the following respirator is recommended. Dust/mist respirator. (N95,P2/P3)

<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Wear safety glasses or goggles to protect against exposure.
<b>Other Precautions</b>	None known.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State:</b>	Solid
<b>Colour:</b>	Brown
<b>Odour:</b>	Woody
<b>pH:</b>	Not Determined
<b>Specific Gravity @ 20 C (Water=1):</b>	0.3
<b>Density @ 20 C (kg/l):</b>	Not Determined
<b>Bulk Density @ 20 C (kg/l):</b>	Not Determined
<b>Boiling Point/Range (C):</b>	Not Determined
<b>Freezing Point/Range (C):</b>	Not Determined
<b>Pour Point/Range (C):</b>	Not Determined
<b>Flash Point/Range (C):</b>	Not Determined
<b>Flash Point Method:</b>	Not Determined
<b>Autoignition Temperature (C):</b>	Not Determined
<b>Flammability Limits in Air - Lower (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Lower (%):</b>	Not Determined
<b>Flammability Limits in Air - Upper (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Upper (%):</b>	Not Determined
<b>Vapour Pressure @ 20 C (mmHg):</b>	Not Determined
<b>Vapour Density (Air=1):</b>	Not Determined
<b>Percent Volatiles:</b>	Not Determined
<b>Evaporation Rate (Butyl Acetate = 1):</b>	Not determined.
<b>Solubility in Water (g/100ml):</b>	Insoluble
<b>Solubility in Solvents (g/100ml):</b>	Not Determined
<b>VOCs (g/l):</b>	Not Determined
<b>Viscosity, Dynamic @ 20 C (centipoise):</b>	Not Determined
<b>Viscosity, Kinematic @ 20 C (centistokes):</b>	Not Determined
<b>Partition Coefficient/n-Octanol/Water:</b>	Not Determined
<b>Molecular Weight (g/mole):</b>	Not Determined
<b>Decomposition Temperature (C):</b>	Not Determined

## 10. STABILITY AND REACTIVITY

<b>Stability Data:</b>	Stable
<b>Hazardous Polymerisation:</b>	Will Not Occur
<b>Conditions to Avoid</b>	None anticipated
<b>Incompatibility (Materials to Avoid)</b>	Strong oxidisers.
<b>Hazardous Decomposition Products</b>	Carbon monoxide and carbon dioxide.
<b>Additional Guidelines</b>	Not Applicable

## 11. TOXICOLOGICAL INFORMATION

<b>Principle Route of Exposure</b>	Eye or skin contact, inhalation.
<b>Symptoms related to exposure</b>	
<b>Inhalation</b>	None known.
<b>Skin Contact</b>	None known.
<b>Eye Contact</b>	May cause mechanical irritation to eye.
<b>Ingestion</b>	None known
<b>Aggravated Medical Conditions</b>	None known.
<b>Chronic Effects/Carcinogenicity</b>	No data available to indicate product or components present at greater than 1% are chronic health hazards.
<b>Other Information</b>	None known.
<b>Toxicity Tests</b>	
<b>Oral Toxicity:</b>	Not determined
<b>Dermal Toxicity:</b>	Not determined.
<b>Inhalation Toxicity:</b>	Not determined
<b>Primary Irritation Effect:</b>	Not determined
<b>Carcinogenicity:</b>	Not determined
<b>Genotoxicity:</b>	Not determined
<b>Reproductive/Developmental Toxicity:</b>	Not determined

## 12. ECOLOGICAL INFORMATION

<b>Mobility (Water/Soil/Air)</b>	Not determined
<b>Persistence/Degradability</b>	Readily biodegradable
<b>Bio-accumulation</b>	Not Determined

### Ecotoxicological Information

<b>Acute Fish Toxicity:</b>	Not determined
<b>Acute Crustaceans Toxicity:</b>	Not determined
<b>Acute Algae Toxicity:</b>	Not determined
<b>Chemical Fate Information</b>	Not determined
<b>Other Information</b>	Not applicable

## 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Bury in a licensed landfill according to federal, state, and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

## 14. TRANSPORT INFORMATION

### Land Transportation

ADR Not restricted

### Air Transportation

ICAO/IATA Not restricted

### Sea Transportation

IMDG Not restricted

### Other Shipping Information

Labels: None

## 15. REGULATORY INFORMATION

### Chemical Inventories

<b>Australian AICS Inventory</b>	All components listed.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>US TSCA Inventory</b>	All components listed.
<b>EINECS Inventory</b>	All components are listed on the inventory.

<b>Classification</b>	Not Determined
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<b>Risk Phrases</b>	None
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<b>Safety Phrases</b>	None
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## 16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS:

Not applicable

### Contact

#### Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

#### New Zealand National Poisons Centre

0800 764 766

### Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Product Stewardship at 1-580-251-4335.

**Disclaimer Statement**

This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**\*\*\*END OF MSDS\*\*\***

## MATERIAL SAFETY DATA SHEET

**Product Trade Name:** PAC™-LE

**Revision Date:** 25-Oct-2012

### 1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

**Product Emergency Telephone**

Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
New Zealand: 06-7559274

**Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

### Identification of Substance or Preparation

**Product Trade Name:** PAC™-LE  
**Synonyms:** None  
**Chemical Family:** Carbohydrate  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** None  
**Poisons Schedule:** None  
**Application:** Fluid Loss Additive

**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com

### 2. COMPOSITION/INFORMATION ON INGREDIENTS

Substance	CAS Number	Percent	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Contains no hazardous substances	Mixture	60 - 100%	Not determined	Not determined	Not applicable

## Non-hazardous Substance to Total of 100%

### 3. HAZARDS IDENTIFICATION

**Hazard Overview** May cause eye, skin and respiratory irritation. Explosive dust.

**Risk Phrases** None

**HSNO Classification** 9.1C Harmful in the aquatic environment

### 4. FIRST AID MEASURES

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 25 minutes and get medical attention if irritation persists.

**Ingestion** Under normal conditions, first aid procedures are not required.

**Notes to Physician** Not Applicable

### 5. FIRE FIGHTING MEASURES

**Suitable Extinguishing Media** Water fog, carbon dioxide, foam, dry chemical.

**Unsuitable Extinguishing Media** None known

**Special Exposure Hazards** Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimize this potential.

**Special Protective Equipment for Fire-Fighters** Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautionary Measures** Avoid creating and breathing dust.

**Environmental Precautionary Measures** None known.

**Procedure for Cleaning/Absorption** Scoop up and remove.

### 7. HANDLING AND STORAGE

**Handling Precautions** Avoid creating or inhaling dust. Avoid dust accumulations. Slippery when wet.

**Storage Information** Store away from oxidisers. Store in a dry location. Product has a shelf life of 36 months

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls	A well ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.
Respiratory Protection	Not normally needed. But if significant exposures are possible then the following respirator is recommended. Dust/mist respirator. (N95,P2/P3)
Hand Protection	Normal work gloves.
Skin Protection	Normal work coveralls.
Eye Protection	Wear safety glasses or goggles to protect against exposure.
Other Precautions	None known.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Colour:	White to off white
Odour:	Odourless
pH:	6.5-9 (1%)
Specific Gravity @ 20 C (Water=1):	1.6
Density @ 20 C (kg/l):	Not Determined
Bulk Density @ 20 C (kg/l):	750
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (C):	Not Determined
Pour Point/Range (C):	Not Determined
Flash Point/Range (C):	221
Flash Point Method:	Not Determined
Autoignition Temperature (C):	400
Flammability Limits in Air - Lower (g/m <sup>3</sup> ):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (g/m <sup>3</sup> ):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined
Vapour Pressure @ 20 C (mmHg):	Not Determined
Vapour Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate = 1):	Not determined.
Solubility in Water (g/100ml):	Forms gel
Solubility in Solvents (g/100ml):	Not Determined
VOCs (g/l):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined
Decomposition Temperature (C):	Not Determined

## 10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerisation:	Will Not Occur
Conditions to Avoid	None known.
Incompatibility (Materials to Avoid)	Strong oxidisers.



<b>Hazardous Decomposition Products</b>	Carbon monoxide and carbon dioxide.
<b>Additional Guidelines</b>	Not Applicable

## 11. TOXICOLOGICAL INFORMATION

<b>Principle Route of Exposure</b>	Eye or skin contact, inhalation.
<b><u>Symptoms related to exposure</u></b>	
<b>Inhalation</b>	May cause mild respiratory irritation.
<b>Skin Contact</b>	May cause mild skin irritation.
<b>Eye Contact</b>	May cause mild eye irritation.
<b>Ingestion</b>	None known
<b>Aggravated Medical Conditions</b>	None known.
<b>Chronic Effects/Carcinogenicity</b>	No data available to indicate product or components present at greater than 1% are chronic health hazards.
<b>Other Information</b>	None known.
<b>Toxicity Tests</b>	
<b>Oral Toxicity:</b>	LD50: 1260 mg/kg (Rat)
<b>Dermal Toxicity:</b>	Not determined.
<b>Inhalation Toxicity:</b>	Not determined
<b>Primary Irritation Effect:</b>	Not determined
<b>Carcinogenicity:</b>	Not determined
<b>Genotoxicity:</b>	Not determined
<b>Reproductive/Developmental Toxicity:</b>	Not determined

## 12. ECOLOGICAL INFORMATION

<b>Mobility (Water/Soil/Air)</b>	Not determined
<b>Persistence/Degradability</b>	Readily biodegradable
<b>Bio-accumulation</b>	Not Determined

### Ecotoxicological Information

<b>Acute Fish Toxicity:</b>	TLM96: > 500 mg/l (Golden orfe)
<b>Acute Crustaceans Toxicity:</b>	Not determined
<b>Acute Algae Toxicity:</b>	Not determined
<b>Chemical Fate Information</b>	Not determined
<b>Other Information</b>	Not applicable

### 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Bury in a licensed landfill according to federal, state, and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

### 14. TRANSPORT INFORMATION

#### Land Transportation

ADR Not restricted

#### Air Transportation

ICAO/IATA Not restricted

#### Sea Transportation

IMDG Not restricted

#### Other Shipping Information

Labels: None

### 15. REGULATORY INFORMATION

#### Chemical Inventories

<b>Australian AICS Inventory</b>	All components listed.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>US TSCA Inventory</b>	All components listed.
<b>EINECS Inventory</b>	All components are listed on the inventory.

**Classification** Not Determined

**Risk Phrases** None

**Safety Phrases** None

### 16. OTHER INFORMATION

The following sections have been revised since the last issue of this MSDS:

Not applicable

#### Contact

##### Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

##### New Zealand National Poisons Centre

0800 764 766

**Additional Information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Material Safety Data Sheet for this or other Halliburton products, contact Product Stewardship at 1-580-251-4335.

**Disclaimer Statement**

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**\*\*\*END OF MSDS\*\*\***

## SAFETY DATA SHEET

### SODA ASH

Revision Date: 21-Jun-2016

Revision Number: 40

#### 1. Product Identifier & Identity for the Chemical

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### 1.1. Product Identifier

**Product Name** SODA ASH

##### Other means of Identification

**Synonyms** None  
**Hazardous Material Number:** HM001822

##### Recommended use of the chemical and restrictions on use

**Recommended Use** Buffer  
**Uses advised against** No information available

##### Supplier's name, address and phone number

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-mail Address** fdunexchem@halliburton.com

##### Emergency phone number

+ 61 1 800 686 951

##### **Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

#### 2. Hazard Identification

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### Classification of the hazardous chemical

Serious Eye Damage/Irritation	Category 2 - H319
-------------------------------	-------------------

##### Label elements, including precautionary statements

**Hazard pictograms**



**Signal Word** Warning

**Hazard Statements:** H319 - Causes serious eye irritation

**Precautionary Statements**

**Prevention** P264 - Wash face, hands and any exposed skin thoroughly after handling  
P280 - Wear eye protection/face protection

**Response** P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing  
P337 + P313 - If eye irritation persists: Get medical advice/attention

**Storage** None

**Disposal** None

**Contains Substances**

Sodium carbonate

**CAS Number**

497-19-8

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

*For the full text of the H-phrases mentioned in this Section, see Section 16*

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Sodium carbonate	497-19-8	60 - 100%	Eye Irrit. 2 (H319)

### 4. First aid measures

**Description of necessary first aid measures**

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Ingestion** Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

**Symptoms caused by exposure**

Causes eye irritation

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

### 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

Water fog, carbon dioxide, foam, dry chemical.

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special exposure hazards in a fire**

Decomposition in fire may produce harmful gases.

**Special protective equipment and precautions for fire fighters****Special protective equipment for firefighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust. Avoid contact with skin, eyes and clothing. Ensure adequate ventilation.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Scoop up and remove.

## 7. Handling and storage

**7.1. Precautions for safe handling****Handling Precautions**

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from acids. Store in a cool, dry location. Product has a shelf life of 36 months.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

**Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Sodium carbonate	497-19-8	Not applicable	Not applicable

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area. Localized ventilation should be used to control dust levels.

**Personal protective equipment (PPE)****Personal Protective Equipment**

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

**Respiratory Protection**

If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and

instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Dust proof goggles.
<b>Other Precautions</b>	None known.
<b>Environmental Exposure Controls</b>	Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

<b>Physical State:</b>	Powder	<b>Color</b>	White
<b>Odor:</b>	Odorless	<b>Odor Threshold:</b>	No information available

<u>Property</u>	<u>Values</u>
<u>Remarks/ - Method</u>	
<b>pH:</b>	11.5
<b>Freezing Point / Range</b>	No data available
<b>Melting Point / Range</b>	851 °C
<b>Boiling Point / Range</b>	No data available
<b>Flash Point</b>	No data available
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	No data available
<b>Vapor Density</b>	No data available
<b>Specific Gravity</b>	2.5
<b>Water Solubility</b>	Partly soluble
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

### 9.2. Other information

<b>Molecular Weight</b>	105.99 g/mole
<b>VOC Content (%)</b>	No data available

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical stability

Stable

### 10.3. Possibility of hazardous reactions

Will Not Occur

### 10.4. Conditions to avoid

None anticipated

### 10.5. Incompatible materials

Strong acids.

### 10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide.

## 11. Toxicological Information

### Information on routes of exposure

**Principle Route of Exposure** Eye or skin contact, inhalation.

### Symptoms related to exposure

**Most Important Symptoms/Effects**

Causes eye irritation

### Numerical measures of toxicity

#### Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium carbonate	497-19-8	4090 mg/kg (Rat) 2800 mg/kg (Rat)	2210 mg/kg (Mouse) > 2000 mg/kg (Rabbit)	2.3 mg/L (Rat) 2h

#### Immediate, delayed and chronic health effects from exposure

<b>Inhalation</b>	May cause respiratory irritation.
<b>Eye Contact</b>	Causes eye irritation.
<b>Skin Contact</b>	Prolonged or repeated contact may cause skin irritation.
<b>Ingestion</b>	Irritation of the mouth, throat, and stomach.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

#### Exposure Levels

No data available

#### Interactive effects

None known.

#### Data limitations

No data available

Substances	CAS Number	Skin corrosion/irritation
Sodium carbonate	497-19-8	Non-irritating to the skin

Substances	CAS Number	Serious eye damage/irritation
Sodium carbonate	497-19-8	Irritating to eyes

Substances	CAS Number	Skin Sensitization
Sodium carbonate	497-19-8	Not classified

Substances	CAS Number	Respiratory Sensitization
Sodium carbonate	497-19-8	No information available

Substances	CAS Number	Mutagenic Effects
Sodium carbonate	497-19-8	In vivo tests did not show mutagenic effects.

Substances	CAS Number	Carcinogenic Effects
Sodium carbonate	497-19-8	No information available

Substances	CAS Number	Reproductive toxicity
Sodium carbonate	497-19-8	Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Sodium carbonate	497-19-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Sodium carbonate	497-19-8	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Sodium carbonate	497-19-8	Not applicable

## 12. Ecological Information

### Ecotoxicity



**Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium carbonate	497-19-8	EC50 242 mg/L (Nitzschia)	TLM24 385 mg/L (Lepomis macrochirus) LC50 310-1220 mg/L (Pimephales promelas) LC50 (96h) 300 mg/L (Lepomis macrochirus)	No information available	EC50 265 mg/L (Daphnia magna) EC50 (48h) 200 – 227 mg/L (Ceriodaphnia sp.)

**12.2. Persistence and degradability**

Substances	CAS Number	Persistence and Degradability
Sodium carbonate	497-19-8	The methods for determining biodegradability are not applicable to inorganic substances.

**12.3. Bioaccumulative potential**

Substances	CAS Number	Log Pow
Sodium carbonate	497-19-8	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Sodium carbonate	497-19-8	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

**13. Disposal Considerations****Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

UN Number	Not restricted
UN proper shipping name:	Not restricted
Transport Hazard Class(es):	Not applicable
Packing Group:	Not applicable
Environmental Hazards:	Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

**15. Regulatory Information**

**Safety, health and environmental regulations specific for the product****International Inventories****Australian AICS Inventory**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

**New Zealand Inventory of Chemicals**

All components are listed on the NZIoC or are subject to a relevant exemption, permit, or assessment certificate.

**EINECS (European Inventory of Existing Chemical Substances)**

This product, and all its components, complies with EINECS

**US TSCA Inventory**

All components listed on inventory or are exempt.

**Canadian Domestic Substances List (DSL)**

All components listed on inventory or are exempt.

**Poisons Schedule number**

None Allocated

**International Agreements****Montreal Protocol - Ozone Depleting Substances:**

Does not apply

**Stolkhom Convention - Persistent Organic Pollutants:**

Does not apply

**Rotterdam Convention - Prior Informed Consent:**

Does not apply

**Basel Convention - Hazardous Waste:**

Does not apply

**16. Other information****Date of preparation or review****Revision Date:**

21-Jun-2016

**Revision Note**

SDS sections updated: 2

**Full text of H-Statements referred to under sections 2 and 3**

H319 - Causes serious eye irritation

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight

CAS – Chemical Abstracts Service

EC50 – Effective Concentration 50%

LC50 – Lethal Concentration 50%

LD50 – Lethal Dose 50%

LL50 – Lethal Loading 50%

mg/kg – milligram/kilogram

mg/L – milligram/liter

NOEC – No Observed Effect Concentration

OEL – Occupational Exposure Limit

PBT – Persistent Bioaccumulative and Toxic

ppm – parts per million

STEL – Short Term Exposure Limit

TWA – Time-Weighted Average

vPvB – very Persistent and very Bioaccumulative

h - hour

mg/m<sup>3</sup> - milligram/cubic meter

mm - millimeter

mmHg - millimeter mercury

w/w - weight/weight

d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

**Disclaimer Statement**

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**End of Safety Data Sheet**

**SAFETY DATA SHEET****SODIUM CHLORIDE**

Revision Date: 08-Sep-2015

Revision Number: 23

**1. Product Identifier & Identity for the Chemical**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**1.1. Product Identifier**

**Product Name** SODIUM CHLORIDE

**Other means of Identification**

**Synonyms:** None  
**Product Code:** HM001682

**Recommended use of the chemical and restrictions on use**

**Recommended Use** Additive  
**Uses Advised Against** No information available

**Supplier's name, address and phone number**

**Manufacturer/Supplier** Halliburton Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia  
  
ACN Number: 009 000 775  
Telephone Number: + 61 1 800 686 951  
Fax Number: 61 (08) 9455 5300  
**E-Mail address:** fdunexchem@halliburton.com

**Emergency phone number**

+ 61 1 800 686 951

**Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

**2. Hazard Identification**

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Not classified

**Label elements, including precautionary statements****Hazard Pictograms**

**Signal Word** Not Hazardous

**Hazard Statements** Not Classified

**Precautionary Statements**

**Prevention** None

**Response** None

**Storage** None

**Disposal** None

**Contains**

**Substances**

Sodium chloride

**CAS Number**

7647-14-5

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification**

*For the full text of the H-phrases mentioned in this Section, see Section 16*

**Classification** Not Classified

**Risk Phrases** None

### 3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Sodium chloride	7647-14-5	60 - 100%	

### 4. First aid measures

**Description of necessary first aid measures**

**Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

**Skin** Wash with soap and water. Get medical attention if irritation persists.

**Ingestion** Under normal conditions, first aid procedures are not required.

**Symptoms caused by exposure**

Causes mild eye irritation.

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

### 5. Fire Fighting Measures

**Suitable extinguishing equipment**

**Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical**

**Special Exposure Hazards**

None anticipated

**Special protective equipment and precautions for fire fighters****Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

**6. Accidental release measures****6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Scoop up and remove.

**7. Handling and storage****7.1. Precautions for Safe Handling****Handling Precautions**

Avoid creating or inhaling dust.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store in a cool, dry location.

**Other Guidelines**

No information available

**8. Exposure Controls/Personal Protection****Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Sodium chloride	7647-14-5	Not applicable	Not applicable

**Appropriate engineering controls****Engineering Controls**

Use in a well ventilated area.

**Personal protective equipment (PPE)****Respiratory Protection**

If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Dust/mist respirator. (N95, P2/P3)

**Hand Protection**

Normal work gloves.

**Skin Protection**

Normal work coveralls.

**Eye Protection**

Wear safety glasses or goggles to protect against exposure.

**Other Precautions**

None known.

**Environmental Exposure Controls**

No information available

**9. Physical and Chemical Properties****9.1. Information on basic physical and chemical properties**

**Physical State:** Solid  
**Odor:** Odorless

**Color:** White  
**Odor Threshold:** No information available

PropertyRemarks/ - Method**pH:****Freezing Point/Range****Melting Point/Range****Boiling Point/Range****Flash Point****Evaporation rate****Vapor Pressure****Vapor Density****Specific Gravity****Water Solubility****Solubility in other solvents****Partition coefficient: n-octanol/water****Autoignition Temperature****Decomposition Temperature****Viscosity****Explosive Properties****Oxidizing Properties**Values

No data available

No data available

801 °C / 1473.8 °F

No data available

No data available

No data available

No data available

No data available

2.16

Very soluble

No data available

No data available

No data available

No data available

No data available

No information available

No information available

9.2. Other information**VOC Content (%)**

No data available

## 10. Stability and Reactivity

10.1. Reactivity

Not expected to be reactive.

10.2. Chemical Stability

Stable

10.3. Possibility of Hazardous Reactions

Will Not Occur

10.4. Conditions to Avoid

None anticipated

10.5. Incompatible Materials

None known.

10.6. Hazardous Decomposition Products

None known.

## 11. Toxicological Information

Information on routes of exposure**Principle Route of Exposure** Eye or skin contact, inhalation.Symptoms related to exposure**Most Important Symptoms/Effects**

Causes mild eye irritation.

Numerical measures of toxicityToxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Sodium chloride	7647-14-5	3000 mg/kg (Rat) 3550 mg/kg (Rat)	>10000 mg/kg (Rabbit)	42 mg/L (Rat) 1h

Immediate, delayed and chronic health effects from exposure**Inhalation** May cause mild respiratory irritation.**Eye Contact** Causes mild eye irritation.**Skin Contact** May cause mild skin irritation.

**Ingestion** None known.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

None known.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Sodium chloride	7647-14-5	Non-irritating to the skin (Rabbit)
Substances	CAS Number	Eye damage/irritation
Sodium chloride	7647-14-5	May cause mild eye irritation. (Rabbit)
Substances	CAS Number	Skin Sensitization
Sodium chloride	7647-14-5	No information available
Substances	CAS Number	Respiratory Sensitization
Sodium chloride	7647-14-5	No information available
Substances	CAS Number	Mutagenic Effects
Sodium chloride	7647-14-5	No information available
Substances	CAS Number	Carcinogenic Effects
Sodium chloride	7647-14-5	Did not show carcinogenic effects in animal experiments
Substances	CAS Number	Reproductive toxicity
Sodium chloride	7647-14-5	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.
Substances	CAS Number	STOT - single exposure
Sodium chloride	7647-14-5	No information available
Substances	CAS Number	STOT - repeated exposure
Sodium chloride	7647-14-5	No significant toxicity observed in animal studies at concentration requiring classification.
Substances	CAS Number	Aspiration hazard
Sodium chloride	7647-14-5	Not applicable

## 12. Ecological Information

**Ecotoxicity**

**Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Sodium chloride	7647-14-5	EC50 (120h) 2430 mg/L (Nitzschia sp.)	TLM96 > 1000 mg/L (Oncorhynchus mykiss) LC50 (96h) 5840 mg/L (Lepomis macrochirus) NOEC (33d) 252 mg/L (Pimephales promelas)	NOEC 5000 – 8000 mg/L (activated sludge) NOEC 292-584 mg/L (Escherichia coli)	TLM96 > 1,000,000 ppm (Mysidopsis bahia) LC50 (48h) 874-4136 mg/L (Daphnia magna) NOEC (21d) 314 mg/L (Daphnia pulex)

**12.2. Persistence and degradability**



Substances	CAS Number	Persistence and Degradability
Sodium chloride	7647-14-5	No information available

**12.3. Bioaccumulative potential**

Substances	CAS Number	Log Pow
Sodium chloride	7647-14-5	No information available

**12.4. Mobility in soil**

Substances	CAS Number	Mobility
Sodium chloride	7647-14-5	No information available

**12.6. Other adverse effects****Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

**13. Disposal Considerations****Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

**Disposal of any contaminated packaging**

Follow all applicable national or local regulations. Contaminated packaging may be disposed of by: rendering packaging incapable of containing any substance, or treating packaging to remove residual contents, or treating packaging to make sure the residual contents are no longer hazardous, or by disposing of packaging into commercial waste collection.

**Environmental regulations**

Not applicable

**14. Transport Information****Transportation Information**

UN Number: Not restricted  
UN Proper Shipping Name: Not restricted  
Transport Hazard Class(es): Not applicable  
Packing Group: Not applicable  
Environmental Hazards: Not applicable

**Special precautions during transport**

None

**HazChem Code**

None Allocated

**15. Regulatory Information****Safety, health and environmental regulations specific for the product****International Inventories**

Australian AICS Inventory

All components listed on inventory or are exempt.

New Zealand Inventory of Chemicals

All components listed on inventory or are exempt.

EINECS Inventory

This product, and all its components, complies with EINECS

US TSCA Inventory

All components listed on inventory or are exempt.

Canadian DSL Inventory

All components listed on inventory or are exempt.

**Poisons Schedule number**

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None Allocated

<b>16. Other information</b>
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**Date of preparation or review****Revision Date:** 08-Sep-2015**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

None

**Full text of H-Statements referred to under sections 2 and 3**

None

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m<sup>3</sup> - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

**Key literature references and sources for data**[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

NZ CCID

**Disclaimer Statement**

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**End of Safety Data Sheet**

## SAFETY DATA SHEET

### STEELSEAL®

Revision Date: 22-Sep-2015

Revision Number: 22

#### 1. Product Identifier & Identity for the Chemical

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### 1.1. Product Identifier

**Product Name** STEELSEAL®

##### Other means of Identification

**Synonyms:** None

**Product Code:** HM003768

##### Recommended use of the chemical and restrictions on use

**Recommended Use** Loss Circulation Material

**Uses Advised Against** No information available

##### Supplier's name, address and phone number

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

##### **Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

##### **Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-Mail address:** fdunexchem@halliburton.com

##### Emergency phone number

+ 61 1 800 686 951

##### **Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

#### 2. Hazard Identification

**Statement of Hazardous Nature** Non-Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Not classified

**Label elements, including precautionary statements****Hazard Pictograms****Signal Word** Not Hazardous**Hazard Statements** Not Classified**Precautionary Statements****Prevention** None**Response** None**Storage** None**Disposal** None**Contains****Substances**

Contains no hazardous substances in concentrations above cut-off values according to the competent authority

**CAS Number**

NA

**Other hazards which do not result in classification**

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT).

This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification***For the full text of the H-phrases mentioned in this Section, see Section 16***Classification** Not Classified**Risk Phrases** None**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not Applicable

**4. First aid measures****Description of necessary first aid measures****Inhalation** If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.**Eyes** In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.**Skin** Wash with soap and water. Get medical attention if irritation persists.**Ingestion** Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.**Symptoms caused by exposure**

No significant hazards expected.

**Medical Attention and Special Treatment**

**Notes to Physician**

Treat symptomatically

**5. Fire Fighting Measures****Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special Exposure Hazards**

Combustible dust when in finely divided and highly suspended state.

**Special protective equipment and precautions for fire fighters****Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

**6. Accidental release measures****6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Scoop up and remove.

**7. Handling and storage****7.1. Precautions for Safe Handling****Handling Precautions**

Avoid creating or inhaling dust. Avoid dust accumulations. Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and dark procedures for low oxygen levels should be taken to ensure ample oxygen availability. Ensure adequate ventilation. Avoid contact with eyes, skin, or clothing. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from oxidizers. Store in a dry location. Keep from heat, sparks, and open flames. Product has a shelf life of 60 months.

**Other Guidelines**

No information available

**8. Exposure Controls/Personal Protection****Control parameters - exposure standards, biological monitoring****Exposure Limits**

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable	Not applicable

**Appropriate engineering controls****Engineering Controls**

A well ventilated area to control dust levels.

**Personal protective equipment (PPE)**

<b>Respiratory Protection</b>	Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)
<b>Hand Protection</b>	Normal work gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Wear safety glasses or goggles to protect against exposure.
<b>Other Precautions</b>	None known.
<b>Environmental Exposure Controls</b>	Do not allow material to contaminate ground water system

**9. Physical and Chemical Properties****9.1. Information on basic physical and chemical properties**

<b>Physical State:</b>	Solid	<b>Color:</b>	Dark gray
<b>Odor:</b>	Odorless	<b>Odor Threshold:</b>	No information available

<u>Property</u>	<u>Values</u>
Remarks/ - Method	
<b>pH:</b>	No data available
<b>Freezing Point/Range</b>	No data available
<b>Melting Point/Range</b>	No data available
<b>Boiling Point/Range</b>	4200 °C / 7592 °F
<b>Flash Point</b>	> 356 °C / > 673 °F
<b>lower flammability limit</b>	0.07-0.12 oz/ft3
<b>Evaporation rate</b>	No data available
<b>Vapor Pressure</b>	1
<b>Vapor Density</b>	0.4
<b>Specific Gravity</b>	1.75
<b>Water Solubility</b>	Insoluble in water
<b>Solubility in other solvents</b>	No data available
<b>Partition coefficient: n-octanol/water</b>	No data available
<b>Autoignition Temperature</b>	No data available
<b>Decomposition Temperature</b>	No data available
<b>Viscosity</b>	No data available
<b>Explosive Properties</b>	No information available
<b>Oxidizing Properties</b>	No information available

**9.2. Other information**

<b>VOC Content (%)</b>	No data available
<b>Bulk Density</b>	38-45 lbs/ft3

**10. Stability and Reactivity****10.1. Reactivity**

Not expected to be reactive.

**10.2. Chemical Stability**

Stable

**10.3. Possibility of Hazardous Reactions**

Will Not Occur

**10.4. Conditions to Avoid**

None anticipated

**10.5. Incompatible Materials**

Strong acids. Strong alkalis.

**10.6. Hazardous Decomposition Products**

Carbon monoxide and carbon dioxide.

**11. Toxicological Information****Information on routes of exposure**

<b>Principle Route of Exposure</b>	Eye or skin contact, inhalation.
------------------------------------	----------------------------------

**Symptoms related to exposure****Most Important Symptoms/Effects**

No significant hazards expected.

**Numerical measures of toxicity****Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No data available	No data available	No data available

**Immediate, delayed and chronic health effects from exposure****Inhalation**

May cause mild respiratory irritation.

**Eye Contact**

May cause mechanical irritation to eye.

**Skin Contact**

May cause mild skin irritation.

**Ingestion**

May cause mild gastric distress.

**Chronic Effects/Carcinogenicity** No data available to indicate product or components present at greater than 0.1% are chronic health hazards.

**Exposure Levels**

No data available

**Interactive effects**

Skin disorders.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Eye damage/irritation
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable.

Substances	CAS Number	Skin Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Respiratory Sensitization
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Mutagenic Effects
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Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable
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Substances	CAS Number	Carcinogenic Effects
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Reproductive toxicity
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - single exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	STOT - repeated exposure
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

Substances	CAS Number	Aspiration hazard
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	Not applicable

## 12. Ecological Information

### Ecotoxicity

#### Product Ecotoxicity Data

No data available

#### Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available	No information available	No information available	No information available

### 12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

### 12.3. Bioaccumulative potential



Substances	CAS Number	Log Pow
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

#### **12.4. Mobility in soil**

Substances	CAS Number	Mobility
Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	No information available

#### **12.6. Other adverse effects**

##### **Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

### **13. Disposal Considerations**

#### **Safe handling and disposal methods**

Bury in a licensed landfill according to federal, state, and local regulations.

#### **Disposal of any contaminated packaging**

Follow all applicable national or local regulations.

#### **Environmental regulations**

Not applicable

### **14. Transport Information**

#### **Transportation Information**

<b>UN Number:</b>	Not restricted
<b>UN Proper Shipping Name:</b>	Not restricted
<b>Transport Hazard Class(es):</b>	Not applicable
<b>Packing Group:</b>	Not applicable
<b>Environmental Hazards:</b>	Not applicable

#### **Special precautions during transport**

None

#### **HazChem Code**

None Allocated

### **15. Regulatory Information**

#### **Safety, health and environmental regulations specific for the product**

##### **International Inventories**

<b>Australian AICS Inventory</b>	All components listed on inventory or are exempt.
<b>New Zealand Inventory of Chemicals</b>	All components listed on inventory or are exempt.
<b>EINECS Inventory</b>	This product, and all its components, complies with EINECS
<b>US TSCA Inventory</b>	All components listed on inventory or are exempt.
<b>Canadian DSL Inventory</b>	All components listed on inventory or are exempt.

#### **Poisons Schedule number**

None Allocated

### **16. Other information**

**Date of preparation or review**

**Revision Date:** 22-Sep-2015

**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

None

**Full text of H-Statements referred to under sections 2 and 3**

None

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight CAS – Chemical Abstracts Service EC50 – Effective Concentration 50% LC50 – Lethal Concentration 50% LD50 – Lethal Dose 50% LL50 – Lethal Loading 50% mg/kg – milligram/kilogram mg/L – milligram/liter NOEC – No Observed Effect Concentration OEL – Occupational Exposure Limit PBT – Persistent Bioaccumulative and Toxic ppm – parts per million STEL – Short Term Exposure Limit TWA – Time-Weighted Average vPvB – very Persistent and very Bioaccumulative h - hour mg/m<sup>3</sup> - milligram/cubic meter mm - millimeter mmHg - millimeter mercury w/w - weight/weight d - day

**Key literature references and sources for data**

[www.ChemADVISOR.com/](http://www.ChemADVISOR.com/)

NZ CCID

**Disclaimer Statement**

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**End of Safety Data Sheet**

## SAFETY DATA SHEET

### STOPPIT®

Revision Date: 17-Dec-2015

Revision Number: 15

#### 1. Product Identifier & Identity for the Chemical

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

##### 1.1. Product Identifier

**Product Name** STOPPIT®

##### Other means of Identification

**Synonyms:** None  
**Product Code:** HM007395

##### Recommended use of the chemical and restrictions on use

**Recommended Use** Loss Circulation Material  
**Uses Advised Against** No information available

##### Supplier's name, address and phone number

**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
Australia

ACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300

##### **Product Emergency Telephone**

Australia: + 61 1 800 686 951  
Papua New Guinea: + 61 1 800 686 951  
NewZealand: +64 800 451719

##### **Fire, Police & Ambulance - Emergency Telephone**

Australia: 000  
Papua New Guinea: 000  
New Zealand: 111

**E-Mail address:** fdunexchem@halliburton.com

##### Emergency phone number

+ 61 1 800 686 951

##### **Australian Poisons Information Centre**

24 Hour Service: - 13 11 26  
Police or Fire Brigade: - 000 (exchange): - 1100

#### 2. Hazard Identification

**Statement of Hazardous Nature** Hazardous according to the criteria of the 3rd Revised Edition of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS), Non-Dangerous Goods according to the criteria of ADG.

**Classification of the hazardous chemical**

Carcinogenicity

Category 2 - H351

**Label elements, including precautionary statements****Hazard Pictograms****Signal Word**

Warning

**Hazard Statements**

H351 - Suspected of causing cancer if inhaled

**Precautionary Statements****Prevention**

P201 - Obtain special instructions before use  
P202 - Do not handle until all safety precautions have been read and understood  
P281 - Use personal protective equipment as required

**Response**

P308 + P313 - IF exposed or concerned: Get medical advice/attention

**Storage**

P405 - Store locked up

**Disposal**

P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

**Contains Substances**

Crystalline silica, quartz

**CAS Number**

14808-60-7

**Other hazards which do not result in classification**

This mixture contains no substance considered to be persistent, bioaccumulating nor toxic (PBT).  
This mixture contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

**Australia Classification***For the full text of the H-phrases mentioned in this Section, see Section 16***Classification**

T - Toxic.

**Risk Phrases**

R49 May cause cancer by inhalation.

**3. Composition/information on Ingredients**

Substances	CAS Number	PERCENT (w/w)	GHS Classification - Australia
Crystalline silica, quartz	14808-60-7	0.1 - 1%	Carc. 2 (H351) STOT RE 1 (H372)

**4. First aid measures****Description of necessary first aid measures****Inhalation**

If inhaled, remove from area to fresh air. Get medical attention if respiratory

<b>Eyes</b>	irritation develops or if breathing becomes difficult. Immediately flush eyes with large amounts of water for at least 15 minutes. Get immediate medical attention.
<b>Skin</b>	Wash with soap and water. Get medical attention if irritation persists.
<b>Ingestion</b>	Under normal conditions, first aid procedures are not required.

**Symptoms caused by exposure**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

**Medical Attention and Special Treatment**

**Notes to Physician** Treat symptomatically

## 5. Fire Fighting Measures

**Suitable extinguishing equipment****Suitable Extinguishing Media**

All standard fire fighting media

**Extinguishing media which must not be used for safety reasons**

None known.

**Specific hazards arising from the chemical****Special Exposure Hazards**

Not applicable.

**Special protective equipment and precautions for fire fighters****Special Protective Equipment for Fire-Fighters**

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

## 6. Accidental release measures

**6.1. Personal precautions, protective equipment and emergency procedures**

Use appropriate protective equipment. Avoid creating and breathing dust. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing.

**6.2. Environmental precautions**

Prevent from entering sewers, waterways, or low areas.

**6.3. Methods and material for containment and cleaning up**

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

## 7. Handling and storage

**7.1. Precautions for Safe Handling****Handling Precautions**

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet. Avoid contact with eyes, skin, or clothing.

**Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

**7.2. Conditions for safe storage, including any incompatibilities****Storage Information**

Store away from acids. Store in a cool, dry location. Store locked up. Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 60 months.

**Other Guidelines**

No information available

## 8. Exposure Controls/Personal Protection

### Control parameters - exposure standards, biological monitoring

#### Exposure Limits

Substances	CAS Number	Australia NOHSC	ACGIH TLV-TWA
Crystalline silica, quartz	14808-60-7	TWA: 0.1 mg/m <sup>3</sup>	TWA: 0.025 mg/m <sup>3</sup>

### Appropriate engineering controls

#### Engineering Controls

Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

### Personal protective equipment (PPE)

#### Respiratory Protection

Wear a NIOSH certified, European Standard EN 149 (FFP2/FFP3), AS/NZS 1715, or equivalent respirator when using this product.

#### Hand Protection

Normal work gloves.

#### Skin Protection

Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

#### Eye Protection

Wear safety glasses or goggles to protect against exposure.

#### Other Precautions

None known.

#### Environmental Exposure Controls

Do not allow material to contaminate ground water system

## 9. Physical and Chemical Properties

### 9.1. Information on basic physical and chemical properties

**Physical State:** Solid Powder

**Color:** Brown

**Odor:** Odorless

**Odor Threshold:** No information available

#### Property

#### Values

#### Remarks/ - Method

#### pH:

No data available

#### Freezing Point/Range

No data available

#### Melting Point/Range

No data available

#### Boiling Point/Range

No data available

#### Flash Point

No data available

#### Evaporation rate

No data available

#### Vapor Pressure

No data available

#### Vapor Density

No data available

#### Specific Gravity

No data available

#### Water Solubility

No data available

#### Solubility in other solvents

No data available

#### Partition coefficient: n-octanol/water

No data available

#### Autoignition Temperature

No data available

#### Decomposition Temperature

No data available

#### Viscosity

No data available

#### Explosive Properties

No information available

#### Oxidizing Properties

No information available

### 9.2. Other information

#### VOC Content (%)

No data available

## 10. Stability and Reactivity

### 10.1. Reactivity

Not expected to be reactive.

### 10.2. Chemical Stability

Stable

### 10.3. Possibility of Hazardous Reactions

Will Not Occur

#### **10.4. Conditions to Avoid**

None anticipated

#### **10.5. Incompatible Materials**

Strong acids.

#### **10.6. Hazardous Decomposition Products**

Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C). Carbon monoxide and carbon dioxide.

## **11. Toxicological Information**

#### **Information on routes of exposure**

**Principle Route of Exposure** Eye or skin contact, inhalation.

#### **Symptoms related to exposure**

#### **Most Important Symptoms/Effects**

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

#### **Numerical measures of toxicity**

#### **Toxicology data for the components**

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica, quartz	14808-60-7	>15,000 mg/kg (Human)	No data available	No data available

#### **Immediate, delayed and chronic health effects from exposure**

##### **Inhalation**

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

##### **Eye Contact**

May cause mechanical irritation to eye.

##### **Skin Contact**

May cause mechanical skin irritation.

##### **Ingestion**

None known.

#### **Chronic Effects/Carcinogenicity**

**Silicosis:** Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

**Cancer Status:** The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2). There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

**Exposure Levels**

No data available

**Interactive effects**

Individuals with respiratory disease, including but not limited to asthma and bronchitis, or subject to eye irritation, should not be exposed to quartz dust.

**Data limitations**

No data available

Substances	CAS Number	Skin corrosion/irritation
Crystalline silica, quartz	14808-60-7	Non-irritating to the skin

Substances	CAS Number	Eye damage/irritation
Crystalline silica, quartz	14808-60-7	Mechanical irritation of the eyes is possible.

Substances	CAS Number	Skin Sensitization
Crystalline silica, quartz	14808-60-7	No information available.

Substances	CAS Number	Respiratory Sensitization
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	Mutagenic Effects
Crystalline silica, quartz	14808-60-7	Not regarded as mutagenic.

Substances	CAS Number	Carcinogenic Effects
Crystalline silica, quartz	14808-60-7	Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.

Substances	CAS Number	Reproductive toxicity
Crystalline silica, quartz	14808-60-7	No information available

Substances	CAS Number	STOT - single exposure
Crystalline silica, quartz	14808-60-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	STOT - repeated exposure
Crystalline silica, quartz	14808-60-7	Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)

Substances	CAS Number	Aspiration hazard
Crystalline silica, quartz	14808-60-7	Not applicable

## 12. Ecological Information

**Ecotoxicity****Product Ecotoxicity Data**

No data available

**Substance Ecotoxicity Data**

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Crystalline silica, quartz	14808-60-7	No information available	LL0 (96h) 10,000 mg/L (Danio rerio) (similar substance)	No information available	LL50 (24h) > 10,000 mg/L (Daphnia magna) (similar substance)

**12.2. Persistence and degradability**



Substances	CAS Number	Persistence and Degradability
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.

### 12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Crystalline silica, quartz	14808-60-7	No information available

### 12.4. Mobility in soil

Substances	CAS Number	Mobility
Crystalline silica, quartz	14808-60-7	No information available

### 12.6. Other adverse effects

#### **Endocrine Disruptor Information**

This product does not contain any known or suspected endocrine disruptors

## **13. Disposal Considerations**

### Safe handling and disposal methods

Bury in a licensed landfill according to federal, state, and local regulations.

### Disposal of any contaminated packaging

Follow all applicable national or local regulations.

### Environmental regulations

Not applicable

## **14. Transport Information**

### Transportation Information

<b>UN Number:</b>	Not restricted
<b>UN Proper Shipping Name:</b>	Not restricted
<b>Transport Hazard Class(es):</b>	Not applicable
<b>Packing Group:</b>	Not applicable
<b>Environmental Hazards:</b>	Not applicable

### Special precautions during transport

None

### HazChem Code

None Allocated

## **15. Regulatory Information**

### Safety, health and environmental regulations specific for the product

#### International Inventories

##### **Australian AICS Inventory**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

##### **New Zealand Inventory of Chemicals**

All components are listed on the AICS or are subject to a relevant exemption, permit, or assessment certificate.

##### **EINECS Inventory**

This product, and all its components, complies with EINECS

##### **US TSCA Inventory**

All components listed on inventory or are exempt.

##### **Canadian DSL Inventory**

All components listed on inventory or are exempt.

### Poisons Schedule number

None Allocated

**International Agreements**

Montreal Protocol - Ozone Depleting Substances:  
Stolkhom Convention - Persistent Organic Pollutants:  
Rotterdam Convention - Prior Informed Consent:  
Basel Convention - Hazardous Waste:

Does not apply  
Does not apply  
Does not apply  
Does not apply

**16. Other information****Date of preparation or review**

Revision Date: 17-Dec-2015

**Revision Note**

SDS sections updated: 2

**Full text of R-phrases referred to under Sections 2 and 3**

R49 May cause cancer by inhalation.

**Full text of H-Statements referred to under sections 2 and 3**

H351 - Suspected of causing cancer if inhaled

H372 - Causes damage to organs through prolonged or repeated exposure if inhaled

**Additional information**

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

**Key abbreviations or acronyms used**

bw – body weight  
CAS – Chemical Abstracts Service  
EC50 – Effective Concentration 50%  
LC50 – Lethal Concentration 50%  
LD50 – Lethal Dose 50%  
LL50 – Lethal Loading 50%  
mg/kg – milligram/kilogram  
mg/L – milligram/liter  
NOEC – No Observed Effect Concentration  
OEL – Occupational Exposure Limit  
PBT – Persistent Bioaccumulative and Toxic  
ppm – parts per million  
STEL – Short Term Exposure Limit  
TWA – Time-Weighted Average  
vPvB – very Persistent and very Bioaccumulative  
h - hour  
mg/m<sup>3</sup> - milligram/cubic meter  
mm - millimeter  
mmHg - millimeter mercury  
w/w - weight/weight  
d - day

**Key literature references and sources for data**

www.ChemADVISOR.com/  
NZ CCID  
OSHA  
ECHA C&L

**Disclaimer Statement**

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conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

**End of Safety Data Sheet**

**MATERIAL SAFETY DATA SHEET****Product Trade Name:** THERMA-THIN®**Revision Date:** 29-Jan-2013**1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING****Statement of Hazardous Nature** Non-Hazardous according to the criteria of NOHSC, Non-Dangerous Goods according to the criteria of ADG.**Manufacturer/Supplier** Halliburton/Baroid Australia Pty. Ltd.  
15 Marriott Road  
Jandakot  
WA 6164  
AustraliaACN Number: 009 000 775  
Telephone Number: 61 (08) 9455 8300  
Fax Number: 61 (08) 9455 5300**Product Emergency Telephone**Australia: 08-64244950  
Papua New Guinea: 05 1 281 575 5000  
New Zealand: 06-7559274**Fire, Police & Ambulance - Emergency Telephone**Australia: 000  
Papua New Guinea: 000  
New Zealand: 111**Identification of Substances or Preparation****Product Trade Name:** THERMA-THIN®  
**Synonyms:** None  
**Chemical Family:** Polymer  
**UN Number:** None  
**Dangerous Goods Class:** None  
**Subsidiary Risk:** None  
**Hazchem Code:** 3[Y]E  
**Poisons Schedule:** None Allocated  
**Application:** Thinner**Prepared By** Chemical Compliance  
Telephone: 1-580-251-4335  
e-mail: fdunexchem@halliburton.com**2. COMPOSITION/INFORMATION ON INGREDIENTS**

Substances	CAS Number	PERCENT	Australia NOHSC	New Zealand WES	ACGIH TLV-TWA
Contains no hazardous substances	Mixture	60 - 100%	Not applicable	Not applicable	Not applicable

## Non-Hazardous Substance to Total of 100%

### 3. HAZARDS IDENTIFICATION

<b>Hazard Overview</b>	May cause eye and skin irritation.
<b>Risk Phrases</b>	None
<b>HSNO Classification</b>	Not Determined

### 4. FIRST AID MEASURES

<b>Inhalation</b>	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
<b>Skin</b>	Wash with soap and water. Get medical attention if irritation persists.
<b>Eyes</b>	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
<b>Ingestion</b>	Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.
<b>Notes to Physician</b>	Not Applicable

### 5. FIRE FIGHTING MEASURES

<b>Suitable Extinguishing Media</b>	All standard fire fighting media
<b>Extinguishing media which must not be used for safety reasons</b>	None known.
<b>Special Exposure Hazards</b>	Decomposition in fire may produce toxic gases.
<b>Special Protective Equipment for Fire-Fighters</b>	Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

### 6. ACCIDENTAL RELEASE MEASURES

<b>Personal Precautionary Measures</b>	Use appropriate protective equipment.
<b>Environmental Precautionary Measures</b>	Prevent from entering sewers, waterways, or low areas.
<b>Procedure for Cleaning / Absorption</b>	Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

### 7. HANDLING AND STORAGE

<b>Handling Precautions</b>	Avoid contact with eyes, skin, or clothing.
<b>Storage Information</b>	Store away from oxidizers. Product has a shelf life of 12 months.

### 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

<b>Engineering Controls</b>	Use in a well ventilated area.
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<b>Respiratory Protection</b>	Not normally necessary.
<b>Hand Protection</b>	Butyl rubber gloves.
<b>Skin Protection</b>	Normal work coveralls.
<b>Eye Protection</b>	Chemical goggles; also wear a face shield if splashing hazard exists.
<b>Other Precautions</b>	Eyewash fountains and safety showers must be easily accessible.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical State:</b>	Liquid
<b>Color:</b>	Pale clear to light amber
<b>Odor:</b>	Mild
<b>pH:</b>	6-8
<b>Specific Gravity @ 20 C (Water=1):</b>	1.24
<b>Density @ 20 C (kg/l):</b>	1.24
<b>Bulk Density @ 20 C (kg/m<sup>3</sup>):</b>	Not Determined
<b>Boiling Point/Range (C):</b>	100
<b>Freezing Point/Range (C):</b>	0
<b>Pour Point/Range (C):</b>	Not Determined
<b>Flash Point/Range (C):</b>	Not Determined <b>Min:</b> > 95
<b>Flash Point Method:</b>	ASTM D3278-78
<b>Autoignition Temperature (C):</b>	Not Determined
<b>Flammability Limits in Air - Lower (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Lower (%):</b>	Not Determined
<b>Flammability Limits in Air - Upper (g/m<sup>3</sup>):</b>	Not Determined
<b>Flammability Limits in Air - Upper (%):</b>	Not Determined
<b>Vapor Pressure @ 20 C (mmHg):</b>	18
<b>Vapor Density (Air=1):</b>	> 1
<b>Percent Volatiles:</b>	59
<b>Evaporation Rate (Butyl Acetate=1):</b>	< 1
<b>Solubility in Water (g/100ml):</b>	Soluble
<b>Solubility in Solvents (g/100ml):</b>	Not Determined
<b>VOCs (g/l):</b>	Not Determined
<b>Viscosity, Dynamic @ 20 C (centipoise):</b>	300
<b>Viscosity, Kinematic @ 20 C (centistokes):</b>	Not Determined
<b>Partition Coefficient/n-Octanol/Water:</b>	1.2 (OECD117)
<b>Molecular Weight (g/mole):</b>	Not Determined
<b>Decomposition Temperature (C):</b>	Not Determined

## 10. STABILITY AND REACTIVITY

<b>Stability Data:</b>	Stable
<b>Hazardous Polymerization:</b>	Will Not Occur
<b>Conditions to Avoid</b>	None known.
<b>Incompatibility (Materials to Avoid)</b>	Strong oxidizers.
<b>Hazardous Decomposition Products</b>	Carbon monoxide and carbon dioxide.
<b>Additional Guidelines</b>	Not Applicable

## 11. TOXICOLOGICAL INFORMATION

<b>Principle Route of Exposure</b>	Eye and skin contact.
<b>Symptoms related to exposure</b>	
<b>Inhalation</b>	May cause mild respiratory irritation.
<b>Skin Contact</b>	May cause mild skin irritation.
<b>Eye Contact</b>	May cause mild eye irritation.
<b>Ingestion</b>	Irritation of the mouth, throat, and stomach.
<b>Aggravated Medical Conditions</b>	None known.
<b>Chronic Effects/Carcinogenicity</b>	No data available to indicate product or components present at greater than 1% are chronic health hazards.
<b>Other Information</b>	None known.
<b>Toxicity Tests</b>	
<b>Oral Toxicity:</b>	LD50: > 5000 mg/kg (Rat)
<b>Dermal Toxicity:</b>	Not determined
<b>Inhalation Toxicity:</b>	Not determined
<b>Primary Irritation Effect:</b>	Not determined
<b>Carcinogenicity</b>	Not determined
<b>Genotoxicity:</b>	Not determined
<b>Reproductive / Developmental Toxicity:</b>	Not determined

## 12. ECOLOGICAL INFORMATION

<b>Mobility (Water/Soil/Air)</b>	Not determined
<b>Persistence/Degradability</b>	BOD(28 Day): 37% of COD
<b>Bio-accumulation</b>	Not determined

### Ecotoxicological Information

<b>Acute Fish Toxicity:</b>	LC50: 2390-6080 mg/l (Cyprinus carpio)
<b>Acute Crustaceans Toxicity:</b>	TLM96: 9400 mg/l (Crangon crangon)
<b>Acute Algae Toxicity:</b>	Not determined
<b>Chemical Fate Information</b>	Not determined
<b>Other Information</b>	Not applicable

## 13. DISPOSAL CONSIDERATIONS

<b>Disposal Method</b>	Disposal should be made in accordance with federal, state, and local regulations.
<b>Contaminated Packaging</b>	Follow all applicable national or local regulations.

## 14. TRANSPORT INFORMATION

### Land Transportation

#### ADR

Not restricted

### Air Transportation

#### ICAO/IATA

Not restricted

### Sea Transportation

#### IMDG

Not restricted

### Other Transportation Information

Labels: None

## 15. REGULATORY INFORMATION

### Chemical Inventories

#### Australian AICS Inventory New Zealand Inventory of Chemicals

All components listed on inventory or are exempt.

All components listed on inventory or are exempt.

#### US TSCA Inventory EINECS Inventory

All components listed on inventory or are exempt.

This product, and all its components, complies with EINECS

#### Classification

Not Classified

#### Risk Phrases

None

#### Safety Phrases

None

## 16. OTHER INFORMATION

### The following sections have been revised since the last issue of this SDS

Not applicable

### Contact

#### Australian Poisons Information Centre

24 Hour Service: - 13 11 26

Police or Fire Brigade: - 000 (exchange): - 1100

#### New Zealand National Poisons Centre

0800 764 766

#### Additional Information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.



**Disclaimer Statement**

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**\*\*\*END OF MSDS\*\*\***

# CALCIUM CHLORIDE

Osmoflo Water Management Pty Ltd

Chemwatch Hazard Alert Code: 2

Chemwatch: 20922  
Version No: 6.1.1.1  
Safety Data Sheet according to WHS and ADG requirements

Issue Date: 04/02/2016  
Print Date: 10/06/2016  
Initial Date: Not Available  
S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	CALCIUM CHLORIDE
Chemical Name	calcium chloride
Synonyms	B834 (DE3) Competent Cells, B834 (DE3)pLysS Competent Cells, BL21 Competent Cell Set, BL21(DE3) Singles Competent Cells, BL21(DE3)pLysS Single Competent Cells, BLR Competent Cells, BLR(DE3)pLysS Competent Cells, CaCl <sub>2</sub> , Calplus, Caltac, Dowflake, Liquidow, Mineral salt 508, Peladow, Peladow snow and ice melt, Snomelt, Superflake anhydrous, anhydrous calcium chloride, calcii chloridum, calcium (II) chloride, calcium atomic spectroscopy standard, calcium chloride, calcium chloride 2-hydrate, calcium chloride 2H <sub>2</sub> O, calcium chloride TS, calcium chloride anhydrous, calcium chloride dehydrated, calcium chloride dihydrate, calcium chloride fused, calcium chloride solution, calcium chloride standard, calcium chloride, flake, calcium ion standard, chloro calcium
Chemical formula	Ca-Cl <sub>2</sub>
Other means of identification	Not Available
CAS number	10043-52-4

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Used as a drying, dehydrating, desiccating agent for organic liquids, gases. Obsolescent use as refrigerant brine. Dust control for roads. De-icing fluid, freeze proofing and thawing coal, coke, stone, sand, ore.
--------------------------	--

### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton SA 5110 Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008
Other emergency telephone numbers	+61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.

### CHEMWATCH HAZARD RATINGS


	Min	Max
Flammability	0	
Toxicity	2	
Body Contact	2	
Reactivity	0	
Chronic	0	

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

## CALCIUM CHLORIDE

Poisons Schedule	Not Applicable
Classification [2]	Eye Irritation Category 2A
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

## Label elements

GHS label elements	
--------------------	---

SIGNAL WORD **WARNING**

## Hazard statement(s)

H319 Causes serious eye irritation.

## Precautionary statement(s) Prevention

P280 Wear protective gloves/protective clothing/eye protection/face protection.

## Precautionary statement(s) Response

P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P337+P313 If eye irritation persists: Get medical advice/attention.

## Precautionary statement(s) Storage

Not Applicable

## Precautionary statement(s) Disposal

Not Applicable

## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

CAS No	%[weight]	Name
10043-52-4	>85	<u>calcium chloride</u>
		commercial materials may contain up to
		3% sodium chloride

## Mixtures

See section above for composition of Substances

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Wash out immediately with fresh running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Seek medical attention without delay; if pain persists or recurs seek medical attention.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin or hair contact occurs:</p> <ul style="list-style-type: none"> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes, aerosols or combustion products are inhaled remove from contaminated area.</li> <li>Other measures are usually unnecessary.</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li><b>IF SWALLOWED, REFER FOR MEDICAL ATTENTION, WHERE POSSIBLE, WITHOUT DELAY.</b></li> <li>For advice, contact a Poisons Information Centre or a doctor.</li> <li>Urgent hospital treatment is likely to be needed.</li> <li>In the mean time, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition.</li> <li>If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the SDS should be provided. Further action will be the responsibility of the medical specialist.</li> <li>If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the SDS.</li> </ul> <p><b>Where medical attention is not immediately available or where the patient is more than 15 minutes from a hospital or unless instructed otherwise:</b></p> <ul style="list-style-type: none"> <li><b>INDUCE</b> vomiting with fingers down the back of the throat, <b>ONLY IF CONSCIOUS</b>. Lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> </ul> <p><b>NOTE:</b> Wear a protective glove when inducing vomiting by mechanical means.</p>

## Indication of any immediate medical attention and special treatment needed

As in all cases of suspected poisoning, follow the ABCDEs of emergency medicine (airway, breathing, circulation, disability, exposure), then the ABCDEs of toxicology (antidotes, basics, change absorption, change distribution, change elimination).

For poisons (where specific treatment regime is absent):

Continued...

## CALCIUM CHLORIDE

### BASIC TREATMENT

- ▶ Establish a patent airway with suction where necessary.
- ▶ Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- ▶ Administer oxygen by non-rebreather mask at 10 to 15 L/min.
- ▶ Monitor and treat, where necessary, for pulmonary oedema.
- ▶ Monitor and treat, where necessary, for shock.
- ▶ Anticipate seizures.
- ▶ **DO NOT** use emetics. Where ingestion is suspected rinse mouth and give up to 200 ml water (5 ml/kg recommended) for dilution where patient is able to swallow, has a strong gag reflex and does not drool.

### ADVANCED TREATMENT

- ▶ Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- ▶ Positive-pressure ventilation using a bag-valve mask might be of use.
- ▶ Monitor and treat, where necessary, for arrhythmias.
- ▶ Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- ▶ Drug therapy should be considered for pulmonary oedema.
- ▶ Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- ▶ Treat seizures with diazepam.
- ▶ Proparacaine hydrochloride should be used to assist eye irrigation.

BRONSTEIN, A.C. and CURRANCE, P.L.

EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

Treat symptomatically.

## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

- ▶ There is no restriction on the type of extinguisher which may be used.
- ▶ Use extinguishing media suitable for surrounding area.

### Special hazards arising from the substrate or mixture

<b>Fire Incompatibility</b>	None known.
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### Advice for firefighters

<b>Fire Fighting</b>	<ul style="list-style-type: none"> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear breathing apparatus plus protective gloves in the event of a fire.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water courses.</li> <li>▶ Use fire fighting procedures suitable for surrounding area.</li> </ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>▶ Non combustible.</li> <li>▶ Not considered a significant fire risk, however containers may burn.</li> </ul> <p>Decomposition may produce toxic fumes of; hydrogen chloride metal oxides May emit poisonous fumes. May emit corrosive fumes.</p>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>▶ Remove all ignition sources.</li> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid contact with skin and eyes.</li> <li>▶ Control personal contact with the substance, by using protective equipment.</li> </ul>
<b>Major Spills</b>	<p>Moderate hazard.</p> <ul style="list-style-type: none"> <li>▶ <b>CAUTION:</b> Advise personnel in area.</li> <li>▶ Alert Emergency Services and tell them location and nature of hazard.</li> <li>▶ Control personal contact by wearing protective clothing.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

<b>Safe handling</b>	<ul style="list-style-type: none"> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ Prevent concentration in hollows and sumps.</li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>▶ Material is hygroscopic, i.e. absorbs moisture from the air. Keep containers well sealed in storage.</li> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry area protected from environmental extremes.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> </ul>

### Conditions for safe storage, including any incompatibilities

<b>Suitable container</b>	<ul style="list-style-type: none"> <li>▶ <b>DO NOT</b> use aluminium or galvanised containers</li> <li>▶ Polyethylene or polypropylene container.</li> <li>▶ Check all containers are clearly labelled and free from leaks.</li> </ul>
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## CALCIUM CHLORIDE

## Storage incompatibility

Inorganic alkaline earth metal derivative.

Derivative of very electropositive metal.

Calcium chloride (and its hydrates):

- ▶ are incompatible with boric acid, calcium oxide, bromine trifluoride, 2-furan, percarboxylic acid
- ▶ may produce explosive hydrogen gas on contact with zinc
- ▶ catalyse exothermic polymerisation of methyl vinyl ether
- ▶ produce heat on contact with water
- ▶ attack metals

Addition of a quantity of calcium chloride to boiling water has generated heat sufficient to cause a violent steam explosion on several occasions

- ▶ Metals and their oxides or salts may react violently with chlorine trifluoride and bromine trifluoride.
- ▶ These trifluorides are hypergolic oxidisers. They ignite on contact (without external source of heat or ignition) with recognised fuels - contact with these materials, following an ambient or slightly elevated temperature, is often violent and may produce ignition.
- ▶ The state of subdivision may affect the results.
- ▶ In presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas.

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA

Not Available


## EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
calcium chloride	Calcium chloride	3 mg/m3	33 mg/m3	200 mg/m3

Ingredient	Original IDLH	Revised IDLH
calcium chloride	Not Available	Not Available

## Exposure controls

Appropriate engineering controls	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
Personal protection	
Eye and face protection	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields.</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
Skin protection	See Hand protection below
Hands/feet protection	<p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p> <p>Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present.</p> <ul style="list-style-type: none"> <li>▶ polychloroprene.</li> <li>▶ nitrile rubber.</li> <li>▶ butyl rubber.</li> </ul>
Body protection	See Other protection below
Other protection	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ P.V.C. apron.</li> <li>▶ Barrier cream.</li> </ul>
Thermal hazards	Not Available

## Respiratory protection

Particulate. (AS/NZS 1716 & 1715, EN 143:000 & 149:001, ANSI Z88 or national equivalent)

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	P1 Air-line*	- -	PAPR-P1 -
up to 50 x ES	Air-line**	P2	PAPR-P2
up to 100 x ES	-	P3	-
		Air-line*	-

Continued...

## CALCIUM CHLORIDE

100+ x ES	-	Air-line**	PAPR-P3
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\* - Negative pressure demand \*\* - Continuous flow

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	Material is hygroscopic, absorbs moisture from surrounding air.  Small white crystals, granules, or flakes. No odour. Soluble in water. Solution in water accompanied by evolution of heat.		
<b>Physical state</b>	Divided Solid	<b>Relative density (Water = 1)</b>	2.15
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Applicable
<b>pH (as supplied)</b>	Not Applicable	<b>Decomposition temperature</b>	Not available.
<b>Melting point / freezing point (°C)</b>	772	<b>Viscosity (cSt)</b>	Not Applicable
<b>Initial boiling point and boiling range (°C)</b>	>1600	<b>Molecular weight (g/mol)</b>	110.99
<b>Flash point (°C)</b>	Not Applicable	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Applicable	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Applicable
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	Nil
<b>Vapour pressure (kPa)</b>	Negligible	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	Not available.
<b>Vapour density (Air = 1)</b>	Not Applicable	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Unstable in the presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	<p>The material is not thought to produce either adverse health effects or irritation of the respiratory tract following inhalation (as classified by EC Directives using animal models). Nevertheless, adverse systemic effects have been produced following exposure of animals by at least one other route and good hygiene practice requires that exposure be kept to a minimum and that suitable control measures be used in an occupational setting. Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled.</p> <p>If prior damage to the circulatory or nervous systems has occurred or if kidney damage has been sustained, proper screenings should be conducted on individuals who may be exposed to further risk if handling and use of the material result in excessive exposures.</p>
<b>Ingestion</b>	<p>Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual.</p> <p>Compared with other metals, the calcium ion and most calcium compounds have low toxicity. Acute calcium poisoning is rare, and difficult to achieve unless calcium compounds are administered intravenously or taken in high doses over a prolonged period..</p> <p>Excessive consumption of calcium carbonate antacids/dietary supplements over a period of weeks or months can cause milk-alkali syndrome, with symptoms ranging from hypercalcaemia to potentially fatal renal failure.</p> <p>A study investigating the effects of personal calcium supplement use on cardiovascular risk found a modestly increased risk of cardiovascular events, particularly myocardial infarction in postmenopausal women.</p> <p> Use as a food additive indicates tolerance of small amounts, but irritant properties and toxic effects of large amounts are well documented. Estimated lethal dose for adult is 30 grams.</p>
<b>Skin Contact</b>	<p>Skin contact is not thought to produce harmful health effects (as classified under EC Directives using animal models). Systemic harm, however, has been identified following exposure of animals by at least one other route and the material may still produce health damage following entry through wounds, lesions or abrasions.</p> <p>Repeated exposure may cause skin cracking, flaking or drying following normal handling and use.</p> <p>Open cuts, abraded or irritated skin should not be exposed to this material</p>

Continued...

## CALCIUM CHLORIDE

	<p>Solution of material in moisture on the skin, or perspiration, may increase irritant effects</p> <p>Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.</p> <p>If skin is wet or moist with perspiration, superficial burns may result. Contact with abraded skin or cuts may rapidly cause severe skin burns.</p>
Eye	There is evidence that material may produce eye irritation in some persons and produce eye damage 24 hours or more after instillation. Severe inflammation may be expected with pain.
Chronic	<p>Prolonged or repeated skin contact may cause drying with cracking, irritation and possible dermatitis following.</p> <p>Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.</p> <p>High blood concentrations of calcium ion may give rise to vasodilation and depress cardiac function leading to hypotension and syncope. Calcium ions enhance the effects of digitalis on the heart and may precipitate digitalis intoxication. Calcium salts also reduce the absorption of tetracyclines</p> <p>In neonates calcification of soft-tissue has been observed following therapeutic administration.</p> <p>Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis, caused by particles less than 0.5 micron penetrating and remaining in the lung.</p>

calcium chloride	TOXICITY	IRRITATION
	Dermal (rabbit) LD50: >5000 mg/kg <sup>[1]</sup>	Eye (unknown): severe* [IC]
	Oral (rat) LD50: 1000 mg/kg <sup>[2]</sup>	Skin (unknown): moderate*

**Legend:** 1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. \* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances

<b>CALCIUM CHLORIDE</b>	<p>for calcium:</p> <p>Toxicity from calcium is not common because the gastrointestinal tract normally limits the amount of calcium absorbed. Therefore, short-term intake of large amounts of calcium does not generally produce any ill effects aside from <b>constipation</b> and an increased risk of kidney stones. However, more severe toxicity can occur when excess calcium is ingested over long periods, or when calcium is combined with increased amounts of vitamin D, which increases calcium absorption. Calcium toxicity is also sometimes found after excessive intravenous administration of calcium.</p> <p>The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.</p> <p>The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin.</p>
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Acute Toxicity	✗	Carcinogenicity	⊖
Skin Irritation/Corrosion	⊖	Reproductivity	⊖
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	⊖
Respiratory or Skin sensitisation	⊖	STOT - Repeated Exposure	⊖
Mutagenicity	⊖	Aspiration Hazard	⊖

**Legend:** ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊖ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
calcium chloride	EC50	48	Crustacea	=52mg/L	1
calcium chloride	BCFD	48	Crustacea	0.0832425mg/L	4
calcium chloride	EC50	48	Crustacea	52mg/L	4
calcium chloride	NOEC	336	Algae or other aquatic plants	5.5495000mg/L	4
calcium chloride	LC50	96	Fish	=3mg/L	1
calcium chloride	EC50	72	Algae or other aquatic plants	2900mg/L	2

**Legend:**

Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

for calcium chloride:

**Environmental fate:**

Calcium chlorides vapour pressure is negligible and its water solubility is 745 g/L at 20 deg C. Calcium chloride is readily dissociated into calcium and chloride ions in water. These physico-chemical properties indicate that calcium chloride released into the environment is distributed into the water compartment in the form of calcium and chloride ions.

**Ecotoxicity:**

Fish LC50 (96 h): Pimephales promelas 4630 mg/l

Algae EC50 (72 h): Selenastrum capricornutum 2900 mg/l

Daphnia magna EC50 (48 h): 1062 mg/l

The chronic toxicity study with Daphnia magna shows that a 16% impairment of reproduction (EC16) is caused at the concentration of 320 mg/L. The 72-hour EC20 for Selenastrum capricornutum determined by the OECD TG 201 study is 1000 mg/L.

Calcium provides an important link between tectonics, climate and the carbon cycle. In the simplest terms, uplift of mountains exposes Ca-bearing rocks to chemical weathering and releases Ca<sup>2+</sup> into surface water. This Ca<sup>2+</sup> eventually is transported to the ocean where it reacts with dissolved CO<sub>2</sub> to form limestone. Some of this limestone settles to the sea floor where it is incorporated into new rocks.

For Chloride: Although inorganic chloride ions are not normally considered toxic they can exist in effluents at acutely toxic levels. Incidental exposure to inorganic chloride may occur in occupational settings where chemicals management policies are improperly applied. The toxicity of chloride salts depends on the counter-ion (cation) present; that of chloride itself is unknown. Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure.

**DO NOT discharge into sewer or waterways.**

## CALCIUM CHLORIDE

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
	No Data available for all ingredients	No Data available for all ingredients

## Bioaccumulative potential

Ingredient	Bioaccumulation
	No Data available for all ingredients

## Mobility in soil

Ingredient	Mobility
	No Data available for all ingredients

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"> <li>Containers may still present a chemical hazard/ danger when empty.</li> <li>Return to supplier for reuse/ recycling if possible.</li> </ul> <p>Otherwise:</p> <ul style="list-style-type: none"> <li>If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill.</li> <li>Where possible retain label warnings and SDS and observe all notices pertaining to the product.</li> </ul> <p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>Reduction</li> <li>Reuse</li> <li>Recycling</li> <li>Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li><b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>It may be necessary to collect all wash water for treatment before disposal.</li> <li>In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>Where in doubt contact the responsible authority.</li> <li>Recycle wherever possible or consult manufacturer for recycling options.</li> <li>Consult State Land Waste Management Authority for disposal.</li> <li>Bury residue in an authorised landfill.</li> <li>Recycle containers if possible, or dispose of in an authorised landfill.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

## Labels Required

Marine Pollutant	NO
HAZCHEM	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

## SECTION 15 REGULATORY INFORMATION

## Safety, health and environmental regulations / legislation specific for the substance or mixture

## CALCIUM CHLORIDE(10043-52-4) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Hazardous Substances Information System - Consolidated Lists	Australia Inventory of Chemical Substances (AICS)
National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (calcium chloride)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y

Continued...



## CALCIUM CHLORIDE

Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing (see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

## Definitions and abbreviations

PC – TWA: Permissible Concentration-Time Weighted Average  
PC – STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer  
ACGIH: American Conference of Governmental Industrial Hygienists  
STEL: Short Term Exposure Limit  
TEEL: Temporary Emergency Exposure Limit.  
IDLH: Immediately Dangerous to Life or Health Concentrations  
OSF: Odour Safety Factor  
NOAEL :No Observed Adverse Effect Level  
LOAEL: Lowest Observed Adverse Effect Level  
TLV: Threshold Limit Value  
LOD: Limit Of Detection  
OTV: Odour Threshold Value  
BCF: BioConcentration Factors  
BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.

# Caustic Soda 50%

Osmoflo Water Management Pty Ltd

Chemwatch: 86044

Version No: 5.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 4

Issue Date: 15/11/2013

Print Date: 08/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Caustic Soda 50%
Synonyms	Not Available
Proper shipping name	SODIUM HYDROXIDE SOLUTION
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	► Material is mixed and used in accordance with manufacturers directions pH control agent.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.


#### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	2	
Body Contact	4	
Reactivity	0	
Chronic	2	

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	S6
Classification <sup>[1]</sup>	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1A, Serious Eye Damage Category 1
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

GHS label elements	
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Continued...

## Caustic Soda 50%

SIGNAL WORD **DANGER**

## Hazard statement(s)

<b>H290</b>	May be corrosive to metals
<b>H314</b>	Causes severe skin burns and eye damage
<b>H318</b>	Causes serious eye damage

## Precautionary statement(s) Prevention

<b>P260</b>	Do not breathe dust/fume/gas/mist/vapours/spray.
<b>P280</b>	Wear protective gloves/protective clothing/eye protection/face protection.
<b>P234</b>	Keep only in original container.

## Precautionary statement(s) Response

<b>P301+P330+P331</b>	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
<b>P303+P361+P353</b>	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
<b>P305+P351+P338</b>	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
<b>P310</b>	Immediately call a POISON CENTER or doctor/physician.

## Precautionary statement(s) Storage

<b>P405</b>	Store locked up.
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## Precautionary statement(s) Disposal

<b>P501</b>	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
1310-73-2	48-50	<u>sodium hydroxide</u>
7732-18-5	50-52	<u>water</u>

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

<b>Eye Contact</b>	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>Transport to hospital or doctor without delay.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
<b>Skin Contact</b>	<p>If skin or hair contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately flush body and clothes with large amounts of water, using safety shower if available.</li> <li>Quickly remove all contaminated clothing, including footwear.</li> <li>Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.</li> <li>Transport to hospital, or doctor.</li> </ul>
<b>Inhalation</b>	<ul style="list-style-type: none"> <li>If fumes or combustion products are inhaled remove from contaminated area.</li> <li>Lay patient down. Keep warm and rested.</li> <li>Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>Transport to hospital, or doctor, without delay.</li> <li>Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.</li> <li>Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).</li> <li>As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.</li> <li>Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.</li> </ul> <p><b>This must definitely be left to a doctor or person authorised by him/her.</b> (ICSC13719)</p>
<b>Ingestion</b>	<ul style="list-style-type: none"> <li>For advice, contact a Poisons Information Centre or a doctor at once.</li> <li>Urgent hospital treatment is likely to be needed.</li> <li><b>If swallowed do NOT induce vomiting.</b></li> <li>If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> <li>Observe the patient carefully.</li> <li>Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.</li> <li>Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink.</li> <li>Transport to hospital or doctor without delay.</li> </ul>

## Indication of any immediate medical attention and special treatment needed

Continued...

## Caustic Soda 50%

Treat symptomatically.

For acute or short-term repeated exposures to highly alkaline materials:

- ▶ Respiratory stress is uncommon but present occasionally because of soft tissue edema.
- ▶ Unless endotracheal intubation can be accomplished under direct vision, cricothyroidotomy or tracheotomy may be necessary.
- ▶ Oxygen is given as indicated.
- ▶ The presence of shock suggests perforation and mandates an intravenous line and fluid administration.
- ▶ Damage due to alkaline corrosives occurs by liquefaction necrosis whereby the saponification of fats and solubilisation of proteins allow deep penetration into the tissue.

Alkalis continue to cause damage after exposure.

INGESTION:

- ▶ Milk and water are the preferred diluents

No more than 2 glasses of water should be given to an adult.

- ▶ Neutralising agents should never be given since exothermic heat reaction may compound injury.

\* Catharsis and emesis are absolutely contra-indicated.

\* Activated charcoal does not absorb alkali.

\* Gastric lavage should not be used.

Supportive care involves the following:

- ▶ Withhold oral feedings initially.
- ▶ If endoscopy confirms transmucosal injury start steroids only within the first 48 hours.
- ▶ Carefully evaluate the amount of tissue necrosis before assessing the need for surgical intervention.
- ▶ Patients should be instructed to seek medical attention whenever they develop difficulty in swallowing (dysphagia).

SKIN AND EYE:

- ▶ Injury should be irrigated for 20-30 minutes.

Eye injuries require saline. [Ellenhorn & Barceloux: Medical Toxicology]

## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

- ▶ Water spray or fog.
- ▶ Foam.
- ▶ Dry chemical powder.
- ▶ BCF (where regulations permit).

### Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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### Advice for firefighters

Fire Fighting	<ul style="list-style-type: none"> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear full body protective clothing with breathing apparatus.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water course.</li> <li>▶ Use fire fighting procedures suitable for surrounding area.</li> </ul>
Fire/Explosion Hazard	<ul style="list-style-type: none"> <li>▶ Non combustible.</li> <li>▶ Not considered a significant fire risk, however containers may burn.</li> </ul> <p>May emit corrosive fumes.</p>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

Minor Spills	<ul style="list-style-type: none"> <li>▶ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.</li> <li>▶ Check regularly for spills and leaks.</li> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid breathing vapours and contact with skin and eyes.</li> <li>▶ Control personal contact with the substance, by using protective equipment.</li> <li>▶ Contain and absorb spill with sand, earth, inert material or vermiculite.</li> </ul>
Major Spills	<ul style="list-style-type: none"> <li>▶ Clear area of personnel and move upwind.</li> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear full body protective clothing with breathing apparatus.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water course.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

Safe handling	<ul style="list-style-type: none"> <li>▶ <b>DO NOT</b> allow clothing wet with material to stay in contact with skin</li> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ <b>WARNING:</b> To avoid violent reaction, <b>ALWAYS</b> add material to water and <b>NEVER</b> water to material.</li> </ul>
Other information	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> <li>▶ <b>DO NOT</b> store near acids, or oxidising agents</li> <li>▶ No smoking, naked lights, heat or ignition sources.</li> </ul>

### Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> <li>▶ <b>DO NOT</b> use aluminium, galvanised or tin-plated containers</li> <li>▶ Lined metal can, lined metal pail/ can.</li> </ul>
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## Caustic Soda 50%

	<ul style="list-style-type: none"> <li>Plastic pail.</li> <li>Polyliner drum.</li> <li>Packing as recommended by manufacturer.</li> </ul> <p>For low viscosity materials</p> <ul style="list-style-type: none"> <li>Drums and jerricans must be of the non-removable head type.</li> <li>Where a can is to be used as an inner package, the can must have a screwed enclosure.</li> </ul> <p>For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):</p> <ul style="list-style-type: none"> <li>Removable head packaging;</li> <li>Cans with friction closures and</li> <li>low pressure tubes and cartridges</li> </ul> <p>may be used.</p>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"> <li>Avoid strong acids, acid chlorides, acid anhydrides and chloroformates.</li> <li>Avoid contact with copper, aluminium and their alloys.</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA


Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sodium hydroxide	Sodium hydroxide	Not Available	Not Available	2 mg/m3	Not Available

## EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sodium hydroxide	Sodium hydroxide	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sodium hydroxide	250 mg/m3	10 mg/m3
water	Not Available	Not Available

## Exposure controls

<b>Appropriate engineering controls</b>	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>Safety glasses with unperforated side shields may be used where continuous eye protection is desirable, as in laboratories; spectacles are not sufficient where complete eye protection is needed such as when handling bulk-quantities, where there is a danger of splashing, or if the material may be under pressure.</li> <li>Chemical goggles whenever there is a danger of the material coming in contact with the eyes; goggles must be properly fitted.</li> <li>Full face shield (20 cm, 8 in minimum) may be required for supplementary but never for primary protection of eyes; these afford face protection.</li> <li>Alternatively a gas mask may replace splash goggles and face shields.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<ul style="list-style-type: none"> <li>Elbow length PVC gloves</li> <li>When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>Overalls.</li> <li>PVC Apron.</li> <li>PVC protective suit may be required if exposure severe.</li> <li>Eyewash unit.</li> </ul>
<b>Thermal hazards</b>	Not Available

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

"Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

Caustic Soda 50%

Material	CPI
BUTYL	A

## Respiratory protection

Particulate. (AS/NZS 1716 & 1715, EN 143:000 & 149:001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.

Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
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Continued...

## Caustic Soda 50%

NEOPRENE	A
NATURAL RUBBER	B
VITON	C
##sodium	hydroxide

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

up to 10 x ES	-AUS P2	-	-PAPR-AUS / Class 1 P2
up to 50 x ES	-	-AUS / Class 1 P2	-
up to 100 x ES	-	-2 P2	-PAPR-2 P2 ^

^ - Full-face

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	Clear slightly hazy water-white strongly alkaline corrosive liquid. Miscible with water. Exothermic reaction on dilution with water.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.48-1.52
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Applicable
<b>pH (as supplied)</b>	Not Available	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	approx. 12	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	approx. 140	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Applicable	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Very Slow	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	50 approx
<b>Vapour pressure (kPa)</b>	Not available.	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	12.7
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Unstable in the presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Inhaling corrosive bases may irritate the respiratory tract. Symptoms include cough, choking, pain and damage to the mucous membrane. Sudden inhalation of sodium hydroxide dust may produce fatal outcome such as spasm, inflammation of the throat and airway, burns, severe lung inflammation and fluid accumulated in the lungs These manifest as coughing, wheezing, shortness of breath, headache, nausea and vomiting.
<b>Ingestion</b>	Ingestion of alkaline corrosives may produce burns around the mouth, ulcerations and swellings of the mucous membranes, profuse saliva production, with an inability to speak or swallow. Both the oesophagus and stomach may experience burning pain; vomiting and diarrhoea may follow. Accidental ingestion of the material may be damaging to the health of the individual. Ingestion of sodium hydroxide may result in severe pain, burns to the mouth, throat, stomach, nausea and vomiting, swelling of the throat and subsequent perforation of the gastro-intestinal tract and suffocation but a 1% solution (pH 13.4) of sodium hydroxide in water failed to cause any damage of the stomach or gullet in rabbits.
<b>Skin Contact</b>	The material can produce severe chemical burns following direct contact with the skin. Skin contact with alkaline corrosives may produce severe pain and burns; brownish stains may develop. The corroded area may be soft, gelatinous and necrotic; tissue destruction may be deep. Open cuts, abraded or irritated skin should not be exposed to this material

Continued...

## Caustic Soda 50%

	Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	If applied to the eyes, this material causes severe eye damage. Direct eye contact with corrosive bases can cause pain and burns. There may be swelling, epithelium destruction, clouding of the cornea and inflammation of the iris. Mild cases often resolve; severe cases can be prolonged with complications such as persistent swelling, scarring, permanent cloudiness, bulging of the eye, cataracts, eyelids glued to the eyeball and blindness.
Chronic	Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue. Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems. Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.

Caustic Soda 50%	TOXICITY	IRRITATION
	Not Available	Not Available
sodium hydroxide	TOXICITY	IRRITATION
	Oral (rabbit) LD50: 325 mg/kg <sup>[1]</sup>	Eye (rabbit): 0.05 mg/24h SEVERE
		Eye (rabbit): 1 mg/24h SEVERE
		Eye (rabbit): 1 mg/30s rinsed-SEVERE
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

SODIUM HYDROXIDE	The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.
	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.
WATER	No significant acute toxicological data identified in literature search.

Acute Toxicity	☐	Carcinogenicity	☐
Skin Irritation/Corrosion	✓	Reproductivity	☐
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	☐
Respiratory or Skin sensitisation	☐	STOT - Repeated Exposure	☐
Mutagenicity	☐	Aspiration Hazard	☐

Legend:   
 ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ☐ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
sodium hydroxide	EC50	384	Crustacea	27901.643mg/L	3
sodium hydroxide	EC50	96	Algae or other aquatic plants	1034.10043mg/L	3
sodium hydroxide	LC50	96	Fish	4.16158mg/L	3
sodium hydroxide	NOEC	96	Fish	56mg/L	4
sodium hydroxide	EC50	48	Crustacea	40.4mg/L	2
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3

## Legend:

Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

Prevent, by any means available, spillage from entering drains or water courses.

**DO NOT** discharge into sewer or waterways.

## Persistence and degradability

Continued...

## Caustic Soda 50%

Ingredient	Persistence: Water/Soil	Persistence: Air
sodium hydroxide	LOW	LOW
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
sodium hydroxide	LOW (LogKOW = -3.8796)
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
sodium hydroxide	LOW (KOC = 14.3)
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"> <li>▶ <b>DO NOT</b> allow wash water from cleaning or process equipment to enter drains.</li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Where in doubt contact the responsible authority.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Treat and neutralise at an approved treatment plant.</li> <li>▶ Treatment should involve: Neutralisation with suitable dilute acid followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material).</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

## Labels Required

	
Marine Pollutant	NO
HAZCHEM	2R

## Land transport (ADG)

UN number	1824				
Packing group	II				
UN proper shipping name	SODIUM HYDROXIDE SOLUTION				
Environmental hazard	Not Applicable				
Transport hazard class(es)	<table> <tr> <td>Class</td><td>8</td></tr> <tr> <td>Subrisk</td><td>Not Applicable</td></tr> </table>	Class	8	Subrisk	Not Applicable
Class	8				
Subrisk	Not Applicable				
Special precautions for user	<table> <tr> <td>Special provisions</td><td>Not Applicable</td></tr> <tr> <td>Limited quantity</td><td>1 L</td></tr> </table>	Special provisions	Not Applicable	Limited quantity	1 L
Special provisions	Not Applicable				
Limited quantity	1 L				

## Air transport (ICAO-IATA / DGR)

UN number	1824								
Packing group	II								
UN proper shipping name	Sodium hydroxide solution								
Environmental hazard	Not Applicable								
Transport hazard class(es)	<table> <tr> <td>ICAO/IATA Class</td><td>8</td></tr> <tr> <td>ICAO / IATA Subrisk</td><td>Not Applicable</td></tr> <tr> <td>ERG Code</td><td>8L</td></tr> </table>	ICAO/IATA Class	8	ICAO / IATA Subrisk	Not Applicable	ERG Code	8L		
ICAO/IATA Class	8								
ICAO / IATA Subrisk	Not Applicable								
ERG Code	8L								
Special precautions for user	<table> <tr> <td>Special provisions</td><td>A3A803</td></tr> <tr> <td>Cargo Only Packing Instructions</td><td>855</td></tr> <tr> <td>Cargo Only Maximum Qty / Pack</td><td>30 L</td></tr> <tr> <td>Passenger and Cargo Packing Instructions</td><td>851</td></tr> </table>	Special provisions	A3A803	Cargo Only Packing Instructions	855	Cargo Only Maximum Qty / Pack	30 L	Passenger and Cargo Packing Instructions	851
Special provisions	A3A803								
Cargo Only Packing Instructions	855								
Cargo Only Maximum Qty / Pack	30 L								
Passenger and Cargo Packing Instructions	851								



## Caustic Soda 50%

Passenger and Cargo Maximum Qty / Pack	1 L
Passenger and Cargo Limited Quantity Packing Instructions	Y840
Passenger and Cargo Limited Maximum Qty / Pack	0.5 L

## Sea transport (IMDG-Code / GGVSee)

UN number	1824
Packing group	II
UN proper shipping name	SODIUM HYDROXIDE SOLUTION
Environmental hazard	Not Applicable
Transport hazard class(es)	IMDG Class 8 IMDG Subrisk Not Applicable
Special precautions for user	EMS Number F-A, S-B Special provisions Not Applicable Limited Quantities 1 L

## Transport in bulk according to Annex II of MARPOL and the IBC code

Source	Product name	Pollution Category	Ship Type
IMO MARPOL (Annex II) - List of Noxious Liquid Substances Carried in Bulk			

## SECTION 15 REGULATORY INFORMATION

## Safety, health and environmental regulations / legislation specific for the substance or mixture

## SODIUM HYDROXIDE(1310-73-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards	Australia Inventory of Chemical Substances (AICS)
Australia Hazardous Substances Information System - Consolidated Lists	

## WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)
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National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water; sodium hydroxide)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## Other information

## Ingredients with multiple cas numbers

Name	CAS No
sodium hydroxide	12200-64-5, 1310-73-2

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:  
[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

## Definitions and abbreviations

PC — TWA: Permissible Concentration-Time Weighted Average  
PC — STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer

Continued...

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**Caustic Soda 50%**

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ACGIH: American Conference of Governmental Industrial Hygienists

STEL: Short Term Exposure Limit

TEEL: Temporary Emergency Exposure Limit,

IDLH: Immediately Dangerous to Life or Health Concentrations

OSF: Odour Safety Factor

NOAEL :No Observed Adverse Effect Level

LOAEL: Lowest Observed Adverse Effect Level

TLV: Threshold Limit Value

LOD: Limit Of Detection

OTV: Odour Threshold Value

BCF: BioConcentration Factors

BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.

# Citric Acid Solution (50%)

Osmoflo Water Management Pty Ltd

Chemwatch: 6614-97

Version No: 3.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 3

Issue Date: 01/01/2013

Print Date: 08/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Citric Acid Solution (50%)
Synonyms	1,2,3-Propanetricarboxylic acid, 2-hydroxy-, 2-Hydroxy-1,2,3-propanetricarboxylic acid, 2-Hydroxypropane-1,2,3-tricarboxylic acid, 2-hydroxy-1,2,3-propanetricarboxylic acid, CITRIC ACID
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Preparation of citrates, flavouring extracts, confections, soft drinks, effervescent salts, acidifier, dispersing agent, medicines, acidulant and antioxidant in foods, sequestering agent, water-conditioning agent and detergent builder, cleaning and polishing stainless steel and other metals, alkyd resins, mordant, removal of sulfur dioxide from smelter waste gases.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.

### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	2	
Body Contact	3	
Reactivity	0	
Chronic	0	



0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	Not Applicable
Classification [1]	Skin Corrosion/Irritation Category 2, Serious Eye Damage Category 1, Specific target organ toxicity - single exposure Category 3 (respiratory tract irritation), Acute Aquatic Hazard Category 2
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

Continued...

## Citric Acid Solution (50%)

GHS label elements	 
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SIGNAL WORD	DANGER
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## Hazard statement(s)

H315	Causes skin irritation
H318	Causes serious eye damage
H335	May cause respiratory irritation
H401	Toxic to aquatic life

## Precautionary statement(s) Prevention

P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P273	Avoid release to the environment.

## Precautionary statement(s) Response

P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.
P362	Take off contaminated clothing and wash before reuse.
P302+P352	IF ON SKIN: Wash with plenty of soap and water.

## Precautionary statement(s) Storage

P405	Store locked up.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.

## Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
77-92-9	50	<u>citric acid</u>
7732-18-5	50	<u>water</u>

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>Transport to hospital or doctor without delay.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes or combustion products are inhaled remove from contaminated area.</li> <li>Lay patient down. Keep warm and rested.</li> <li>Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>Transport to hospital, or doctor, without delay.</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>If swallowed do <b>NOT</b> induce vomiting.</li> <li>If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> <li>Observe the patient carefully.</li> <li>Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.</li> <li>Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink.</li> <li>Seek medical advice.</li> </ul>

Continued...

**Indication of any immediate medical attention and special treatment needed**

Treat symptomatically.

**SECTION 5 FIREFIGHTING MEASURES****Extinguishing media**

The product contains a substantial proportion of water, therefore there are no restrictions on the type of extinguishing media which may be used. Choice of extinguishing media should take into account surrounding areas.

Though the material is non-combustible, evaporation of water from the mixture, caused by the heat of nearby fire, may produce floating layers of combustible substances.

In such an event consider:

- ▶ foam.

**Special hazards arising from the substrate or mixture**

<b>Fire Incompatibility</b>	None known.
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**Advice for firefighters**

<b>Fire Fighting</b>	<ul style="list-style-type: none"><li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li><li>▶ Wear breathing apparatus plus protective gloves in the event of a fire.</li><li>▶ Prevent, by any means available, spillage from entering drains or water courses.</li><li>▶ Use fire fighting procedures suitable for surrounding area.</li></ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"><li>▶ The material is not readily combustible under normal conditions.</li><li>▶ However, it will break down under fire conditions and the organic component may burn.</li><li>▶ Not considered to be a significant fire risk.</li><li>▶ Heat may cause expansion or decomposition with violent rupture of containers.</li></ul> <p>Decomposes on heating and produces toxic fumes of; carbon dioxide (CO2) other pyrolysis products typical of burning organic materialMay emit poisonous fumes.May emit corrosive fumes.</p>

**SECTION 6 ACCIDENTAL RELEASE MEASURES****Personal precautions, protective equipment and emergency procedures**

<b>Minor Spills</b>	<ul style="list-style-type: none"><li>▶ Clean up all spills immediately.</li><li>▶ Avoid breathing vapours and contact with skin and eyes.</li><li>▶ Control personal contact with the substance, by using protective equipment.</li><li>▶ Contain and absorb spill with sand, earth, inert material or vermiculite.</li></ul>
<b>Major Spills</b>	<p>Moderate hazard.</p> <ul style="list-style-type: none"><li>▶ Clear area of personnel and move upwind.</li><li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li><li>▶ Wear breathing apparatus plus protective gloves.</li></ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

**SECTION 7 HANDLING AND STORAGE****Precautions for safe handling**

<b>Safe handling</b>	<ul style="list-style-type: none"><li>▶ <b>DO NOT</b> allow clothing wet with material to stay in contact with skin</li><li>▶ Avoid all personal contact, including inhalation.</li><li>▶ Wear protective clothing when risk of exposure occurs.</li><li>▶ Use in a well-ventilated area.</li><li>▶ Prevent concentration in hollows and sumps.</li></ul>
<b>Other information</b>	<ul style="list-style-type: none"><li>▶ Store in original containers.</li><li>▶ Keep containers securely sealed.</li><li>▶ Store in a cool, dry, well-ventilated area.</li><li>▶ Store away from incompatible materials and foodstuff containers.</li></ul>

**Conditions for safe storage, including any incompatibilities**

<b>Suitable container</b>	<ul style="list-style-type: none"><li>▶ Polyethylene or polypropylene container.</li><li>▶ Packing as recommended by manufacturer.</li><li>▶ Check all containers are clearly labelled and free from leaks.</li></ul>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"><li>▶ Avoid strong bases.</li></ul>

**SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION****Control parameters****OCCUPATIONAL EXPOSURE LIMITS (OEL)****INGREDIENT DATA**

Not Available

**EMERGENCY LIMITS**


Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
citric acid	Citric acid	0.37 mg/m3	4 mg/m3	590 mg/m3
Ingredient	Original IDLH	Revised IDLH		

Continued...

## Citric Acid Solution (50%)

citric acid	Not Available	Not Available
water	Not Available	Not Available

## Exposure controls

Appropriate engineering controls	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
Personal protection	
Eye and face protection	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields.</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
Skin protection	See Hand protection below
Hands/feet protection	<ul style="list-style-type: none"> <li>▶ Wear chemical protective gloves, e.g. PVC.</li> <li>▶ Wear safety footwear or safety gumboots, e.g. Rubber</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p>
Body protection	See Other protection below
Other protection	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ P.V.C. apron.</li> <li>▶ Barrier cream.</li> </ul>
Thermal hazards	Not Available

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

**"Forsberg Clothing Performance Index".**

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

Citric Acid Solution (50%)

Material	CPI
BUTYL	A
NEOPRENE	A
VITON	A
NATURAL RUBBER	C
PVA	C

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

Appearance	Clear odourless liquid; mixes with water.		
Physical state	Liquid	Relative density (Water = 1)	Not Available
Odour	Not Available	Partition coefficient n-octanol / water	Not Available
Odour threshold	Not Available	Auto-ignition temperature (°C)	345
pH (as supplied)	Not Available	Decomposition temperature	>170
Melting point / freezing point (°C)	Not Available	Viscosity (cSt)	Not Available
Initial boiling point and boiling range (°C)	Not Available	Molecular weight (g/mol)	Not Applicable

Continued...

## Citric Acid Solution (50%)

Flash point (°C)	Not Available	Taste	Not Available
Evaporation rate	Not Available	Explosive properties	Not Available
Flammability	Not Available	Oxidising properties	Not Available
Upper Explosive Limit (%)	Not Applicable	Surface Tension (dyn/cm or mN/m)	Not Available
Lower Explosive Limit (%)	Not Applicable	Volatile Component (%vol)	Not Available
Vapour pressure (kPa)	Not Available	Gas group	Not Available
Solubility in water (g/L)	Miscible	pH as a solution (1%)	Not Available
Vapour density (Air = 1)	Not Available	VOC g/L	Not Available

## SECTION 10 STABILITY AND REACTIVITY



Reactivity	See section 7
Chemical stability	<ul style="list-style-type: none"> <li>Unstable in the presence of incompatible materials.</li> <li>Product is considered stable.</li> <li>Hazardous polymerisation will not occur.</li> </ul>
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

Inhaled	The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Not normally a hazard due to non-volatile nature of product
Ingestion	Accidental ingestion of the material may be damaging to the health of the individual. Ingestion of low-molecular organic acid solutions may produce spontaneous haemorrhaging, production of blood clots, gastrointestinal damage and narrowing of the oesophagus and stomach entry.
Skin Contact	The material may cause mild but significant inflammation of the skin either following direct contact or after a delay of some time. Repeated exposure can cause contact dermatitis which is characterised by redness, swelling and blistering. Open cuts, abraded or irritated skin should not be exposed to this material. Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	If applied to the eyes, this material causes severe eye damage. Solutions of low-molecular weight organic acids cause pain and injury to the eyes.
Chronic	Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems. As with any chemical product, contact with unprotected bare skin; inhalation of vapour, mist or dust in work place atmosphere; or ingestion in any form, should be avoided by observing good occupational work practice.

Citric Acid Solution (50%)	TOXICITY	IRRITATION
	Oral (Rat) LD50: 11500 mg/kg <sup>[2]</sup>	Not Available
citric acid	TOXICITY	IRRITATION
	dermal (rat) LD50: >2000 mg/kg <sup>[1]</sup> Oral (rat) LD50: 3000 mg/kgd <sup>[2]</sup>	Eye (rabbit): 0.75 mg/24h-SEVERE Skin (rabbit): 500 mg/24h - mild
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

CITRIC ACID	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.		
	for citric acid (and its inorganic citrate salts)		
	Based on many experimental data in animals and on human experience, citric acid is of low acute toxicity. The NOAEL for repeated dose toxicity for rats is 1200 mg/kg/d. The major, reversible (sub)chronic toxic effects seem to be limited to changes in blood chemistry and metal absorption/excretion kinetics. Citric acid is not suspected of being a carcinogen nor a reprotoxic or teratogenic agent.		
	The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin.		
WATER	No significant acute toxicological data identified in literature search.		
Acute Toxicity		Carcinogenicity	

## Citric Acid Solution (50%)

Skin Irritation/Corrosion	✓	Reproductivity	⊘
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	⊘
Respiratory or Skin sensitisation	⊘	STOT - Repeated Exposure	⊘
Mutagenicity	⊘	Aspiration Hazard	⊘

Legend:   
 ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊘ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
citric acid	EC0	72	Crustacea	<80mg/L	1
citric acid	EC50	96	Algae or other aquatic plants	23.29809mg/L	3
citric acid	LC50	96	Fish	9.23896mg/L	3
citric acid	NOEC	16	Crustacea	153mg/L	4
citric acid	EC50	48	Crustacea	>50mg/L	2
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3

## Legend:

Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

Toxic to aquatic organisms.

**DO NOT** discharge into sewer or waterways.

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
citric acid	LOW	LOW
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
citric acid	LOW (LogKOW = -1.64)
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
citric acid	LOW (KOC = 10)
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>▶ Reduction</li> <li>▶ Reuse</li> <li>▶ Recycling</li> <li>▶ Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li>▶ <b>DO NOT</b> allow wash water from cleaning or process equipment to enter drains.</li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Where in doubt contact the responsible authority.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Dispose of by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or incineration in a licenced apparatus (after admixture with suitable combustible material).</li> <li>▶ Decontaminate empty containers.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION



## Citric Acid Solution (50%)

## Labels Required

Marine Pollutant	NO
HAZCHEM	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL and the IBC code

Source	Product name	Pollution Category	Ship Type
IMO MARPOL (Annex II) - List of Noxious Liquid Substances Carried in Bulk	Citric acid (70% or less)	Z	3

## SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

## CITRIC ACID(77-92-9) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Hazardous Substances Information System - Consolidated Lists	Australia Inventory of Chemical Substances (AICS)
--	---

## WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)
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National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (citric acid; water)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## Other information

## Ingredients with multiple cas numbers

Name	CAS No
citric acid	1192555-95-5, 12262-73-6, 136108-93-5, 245654-34-6, 43136-35-2, 623158-96-3, 77-92-9, 856568-15-5, 878903-72-1, 890704-54-8, 896506-46-0, 906507-37-7

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

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## Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average  
 PC—STEL: Permissible Concentration-Short Term Exposure Limit  
 IARC: International Agency for Research on Cancer  
 ACGIH: American Conference of Governmental Industrial Hygienists  
 STEL: Short Term Exposure Limit  
 TEEL: Temporary Emergency Exposure Limit  
 IDLH: Immediately Dangerous to Life or Health Concentrations  
 OSF: Odour Safety Factor  
 NOAEL :No Observed Adverse Effect Level  
 LOAEL: Lowest Observed Adverse Effect Level  
 TLV: Threshold Limit Value  
 LOD: Limit Of Detection  
 OTV: Odour Threshold Value  
 BCF: BioConcentration Factors  
 BEI: Biological Exposure Index

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Continued...

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**Citric Acid Solution (50%)**

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TEL (+61 3) 9572 4700.

## 1 IDENTIFICATION

### IDENTIFICATION

Product Code:  
Product Name: EDTA Tetra sodium salt  
Product Use: Hardness control in Water Treatment  
Packaging Size: 25 kg Poly Woven Bags

### COMPANY DETAILS

Company: CHESSER CHEMICALS Pty Ltd  
ABN Number: 67 008 262 039  
Address: 124 Days Road  
FERRYDEN PARK SA 5010  
Telephone Number: (08) 8406 0000  
Facsimile Number: (08) 8406 0099  
Emergency Telephone Number: CHEMWATCH 1800 039 008

## 2 HAZARD IDENTIFICATION

Hazardous according to criteria of NOHSC/ASCC.

IRRITANT



### Risk Phrases

R36/37/38 Irritating to eyes, respiratory system and skin.

### Safety Phrases

S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

S36 Wear suitable protective clothing.

ERMA New Zealand Approval Code HSR006875

HSNO Hazard Classification 6.1D 6.4A 9.1C 9.3B

## 3 COMPOSITION

### Ingredients

Chemical Entity	CAS Number	Proportion	Risk Phrases
Ethylene Diamine Tetra Acetate			
Tetrasodium SALT, Tetrahydrate	[13235-36-4]	100%	

## 4 FIRST AID MEASURES

Description of necessary measures according to routes of exposure.

**Swallowed** Rinse mouth with water. Give plenty of water to drink provided victim is conscious. Do NOT induce vomiting. Seek medical attention immediately.

**Eye** Immediately flush eyes with plenty of water for at least 15 minutes while holding eyelids open. Seek immediate medical attention.

**Skin** Remove contaminated clothing. Wash affected area with plenty of Soap and water for at least 15 minutes. If irritation develops or persists, seek medical advice. Wash clothing before reuse.

**Inhaled** Remove victim from exposure to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Seek medical attention.

**Advice to Doctor** Treat symptomatically based on judgement of doctor and individual reactions of patient.

**Aggravated medical conditions caused by exposure** No information available on medical conditions aggravated from exposure to this product. There is insufficient data in the published literature to perform a complete hazard evaluation for this product. Special precautions must be used in storage, use and handling. Protective equipment should be chosen using professional judgement.

## 5 FIRE FIGHTING MEASURES

**Extinguishing Media** In case of fire, use appropriate extinguishing media most suitable for surrounding fire conditions.

**Hazards from Combustion Products** Non-combustible solid. This product is not considered to be a fire or explosion hazard. Incompatible with oxidising agents and sources of ignition. When involved in a fire, burning may produce carbon monoxide, carbon dioxide, and nitrogen oxides.

**Special Protective Precautions and Equipment for Fire Fighters** Fire fighters should wear a positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots and gloves). Clear fire area of all non-emergency personnel. Stay upwind. Keep out of low areas. Eliminate ignition sources. Move fire exposed containers from fire area if it can be done without risk. Do NOT allow fire fighting water to reach waterways, drains or sewers. Store fire fighting water for treatment.

**Flammability Conditions** Product is a non-flammable solid.

Additional Information

**Hazchem Code** N/A

## 6 ACCIDENTAL RELEASE MEASURES

**Emergency Procedures** Avoid accidents, clean up immediately. Slippery when spilt. Personnel involved in the clean up should wear full protective clothing as listed in section 8. Evacuate all unnecessary personnel. Eliminate all sources of ignition. Increase ventilation. Avoid generating dust. Stop leak if safe to do so. Isolate the danger area. Do NOT let product reach drains or waterways. If product does enter a waterway, advise the Environmental Protection Authority or your local Waste Management. Use clean, non-sparking tools and equipment.

**Methods and Materials for Containment and Clean Up** Contain and sweep/shovel up spills with dust binding material or use an industrial vacuum cleaner. Transfer to a suitable, labelled container and dispose of promptly..

## 7 HANDLING AND STORAGE

**Precautions for Safe Handling** Ensure an eye bath and safety shower are available and ready for use. Observe good personal hygiene practices and recommended procedures. Wash thoroughly after handling. Take precautionary measures against static discharges by bonding and grounding equipment. Avoid contact with eyes, skin and clothing. Do not inhale product dust/fumes. Containers of this material may be hazardous when empty since they retain product residues, (dust, solids); observe all warnings and precautions listed for the product.

**Conditions for Safe Storage (Including Any Incompatibles)** Store in a cool, dry, well-ventilated area. Keep containers tightly closed when not in use. Inspect regularly for deficiencies such as damage or leaks. Protect against physical damage. Store away from incompatible materials as listed in section 10. This product is not classified dangerous for transport according to The Australian Code for the Transport of Dangerous Goods By Road and Rail.

**Container Type** Packaging must comply with requirements of Hazardous Substances (Packaging) Regulations 2001. Store in original packaging as approved by manufacturer.

## 8 EXPOSURE CONTROL / PERSONAL PROTECTION

**National Exposure Standards** No exposure standard has been established for this product by the Australian Safety and Compensation Council (ASCC). However, the exposure standard for dust not otherwise specified is 10mg/m<sup>3</sup> (for inspirable dust) and 3mg/m<sup>3</sup> (for respirable dust).

**Biological Limit Values** No information available on biological limit values for this product.

**Engineering Controls** A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area.

### Personal Protection

**RESPIRATOR:** Wear a full-face piece particulate respirator (Type N100 filter) for up to 50 times the exposure limit, or the maximum use concentration specified consignments of instances where the exposure levels are not known, use a full-face piece positive pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in oxygen deficient atmospheres (AS1715/1716). **EYES:** Chemical safety goggles (AS1336/1337). **HANDS:** Wear protective gloves (AS2161). **CLOTHING:** Long-sleeved protective clothing and safety footwear (AS3765/2210).

## 9 PHYSICAL AND CHEMICAL PROPERTIES

<b>Appearance</b>	White Powder
<b>Formula</b>	C <sub>10</sub> H <sub>12</sub> N <sub>2</sub> O <sub>8</sub> .4Na.4H <sub>2</sub> O
<b>Odour</b>	Odourless
<b>Vapour Pressure</b>	Not applicable.
<b>Vapour Density</b>	Not applicable.
<b>Boiling Point</b>	Not applicable.

<b>Melting Point</b>	Not applicable.	
<b>Solubility in Water</b>	Soluble	
<b>Specific Gravity</b>	Not applicable.	
<b>Flash Point</b>	Not applicable.	
<b>pH</b>	11.3 (1% Solution)	
<b>Lower Explosion Limit</b>	Not applicable.	
<b>Upper Explosion Limit</b>	Not applicable.	
<b>Ignition Temperature</b>	Not applicable.	
<b>Specific Heat Value</b>	Not applicable.	
<b>Particle Size</b>	Not applicable.	
<b>Volatile Organic Compounds (VOC) Content</b>	Not applicable.	
<b>Evaporation Rate</b>	Not applicable.	
<b>Viscosity</b>	Not applicable.	
<b>Percent Volatile</b>	0% (21°C)	
<b>Octanol/Water partition coefficient</b>	Not applicable.	
<b>Saturated Vapour Concentration</b>	Not applicable.	
<b>Additional Characteristics</b>	Not applicable.	
<b>Flame Propagation/Burning Rate of Solid Materials</b>	Not applicable.	
<b>Properties of Materials That May Initiate or Contribute to Fire Intensity</b>		Not applicable.
<b>Potential for Dust Explosion</b>	Not applicable.	
<b>Reactions that Release Flammable Gases</b>	Not applicable.	
<b>Fast of Intensely Burning Characteristics</b>	Not applicable.	
<b>Non-flammables That Could Contribute Unusual Hazards to a Fire</b>		Not applicable.
<b>Release of Invisible Flammable Vapours and Gases</b>	Not applicable.	
<b>Decomposition Temperature</b>	Not applicable.	
<b>Additional Information</b>	Molecular Weight: 252.23g/mol	

## 10 STABILITY AND REACTIVITY

<b>Chemical Stability</b>	Product is stable under normal conditions of use, storage and temperature.
<b>Conditions to Avoid</b>	Avoid excessive heat, generating dust, direct sunlight, moisture and high temperatures.
<b>Incompatible Materials</b>	Incompatible with oxidizing agents and sources of ignition.
<b>Hazardous Decomposition Products</b>	When involved in a fire, burning may produce carbon monoxide, carbon dioxide, and nitrogen oxides
<b>Hazardous Reactions</b>	Hazardous Polymerisation will not occur..

## 11 TOXICOLOGICAL INFORMATION

<b>Toxicity Data</b>	No toxicological information available for this product.
<b>Health Effects - Acute</b>	
<b>Swallowed</b>	May be harmful if swallowed. Substance has low toxicity in ingestion. Large amounts may cause gastric upset due to osmotic imbalance through the sequestering of metal ions.
<b>Eye</b>	Irritating to eyes. Solutions are severe irritants to the eye and cause pain and blurred vision.
<b>Skin</b>	Irritating to skin. Symptoms may include reddening or inflammation on prolonged contact.
<b>Inhaled</b>	Irritating to respiratory system. May be harmful if inhaled. May be a mild irritant. Symptoms may include coughing and sneezing. May cause irritation to the respiratory tract.

## 12 ECOLOGICAL INFORMATION

<b>Ecotoxicity</b>	No ecological information available for this product.
<b>Persistence and Degradability</b>	No information available on persistence/degradability for this product.
<b>Mobility</b>	No information available on mobility for this product. Soluble in water
<b>Environmental Fate (Exposure)</b>	Avoid contaminating waterways, drains and sewers.
<b>Bioaccumulative Potential</b>	No information available on bioaccumulation for this product.

## 13 DISPOSAL CONSIDERATIONS

<b>Disposal</b>	Dispose of in accordance with all local, state and federal regulations. All empty packaging should be disposed of in accordance with Local, State, and Federal Regulations or recycled/reconditioned at an approved facility.
<b>Special Precautions for Land Fill or Incineration</b>	Contact a specialist disposal company or the local waste regulator for advice. This should be done in accordance with 'The Hazardous Waste Act'..

## 14 TRANSPORT INFORMATION

<b>Land and Sea Transport</b>	
<b>UN Number</b>	Not applicable
<b>Shipping Name</b>	ETHYLENEDIAMINE TETRAACETIC ACID TETRASODIUM SALT TETRAHYDRATE

<b>Dangerous Goods Class</b>	Not applicable
<b>Subsidiary Risk</b>	Not applicable.
<b>Pack Group</b>	Not applicable
<b>Precaution for User</b>	IRRITANT
<b>Hazchem Code</b>	Not applicable

**15 REGULATORY INFORMATION**

<b>Poisons Schedule</b>	N/A
<b>EPG</b>	N/A
<b>AICS Name</b>	GLYCINE,N,N'-1,2-ETHANEDIYLBIS[N-(CARBOXYMETHYL)-,TETRASODIUM SALT, TETRAHYDRATE
<b>NZ Toxic Substance</b>	N
<b>HSNO Hazard Classification</b>	6.1D 6.4A 9.1C 9.3B
<b>ERMA Approval Code</b>	HSR006875

**16 OTHER INFORMATION**

<b>Literature References</b>	No data available.		
<b>Sources for Data</b>	No data available.		
<b>Legend to Abbreviations and Acronyms</b>			
<	less than	<b>Ltr</b>	Litre
>	greater than	<b>m<sup>3</sup></b>	cubic metre
<b>AICS</b>	Australian Inventory of Chemical Substances	<b>mbar</b>	millibar
<b>CAS</b>	Chemical Abstracts Service (Registry Number)	<b>mg</b>	milligram
<b>cm<sup>2</sup></b>	square centimetres	<b>mg/24H</b>	milligrams per 24 hours
<b>CO<sub>2</sub></b>	Carbon Dioxide	<b>mg/kg</b>	milligrams per kilogram
<b>COD</b>	Chemical Oxygen Demand	<b>mg/m<sup>3</sup></b>	milligrams per cubic metre
<b>deg C (°C)</b>	degrees Celsius	<b>Misc</b>	miscible
<b>ERMA</b>	Environmental Risk Management Authority	<b>Miscible</b>	liquids form one homogeneous liquid phase regardless of the amount of either component present
<b>G</b>	gram	<b>mm</b>	millimetre
<b>g/cm<sup>3</sup></b>	grams per cubic centimetre	<b>mPa.s</b>	milli Pascal per second
<b>g/l</b>	grams per litre	<b>N/A</b>	Not Applicable
<b>HSNO</b>	Hazardous Substance and New Organism	<b>NOHSC</b>	National Occupational Health and Safety Commission
<b>IDLH</b>	Immediately Dangerous to Life and Health	<b>OECD</b>	Organization for Economic Co-operation and Development
<b>Immiscible</b>	liquids are insoluble in each other	<b>PEL</b>	Permissible Exposure Limit
<b>Kg</b>	kilogram	<b>ppb</b>	parts per billion
<b>kg/m<sup>3</sup></b>	kilograms per cubic metre	<b>ppm</b>	parts per million
<b>LC50</b>	LC stands for lethal concentration. LC50 is the concentration of a material in air which causes the death of 50% (one half) of a group of test animals. The material is inhaled over a set period of time, usually 1 or 4 hours.	<b>ppm/2h</b>	parts per million per 2 hours
		<b>ppm/6h</b>	parts per million per 6 hours
		<b>RCP</b>	Reciprocal Calculation Procedure
		<b>STEL</b>	Short Term Exposure Limit
		<b>TLV</b>	Threshold Limit Value
		<b>tne</b>	tonne
		<b>TWA</b>	Time Weighted Average
		<b>ug/24H</b>	micrograms per 24 hours
<b>LD50</b>	LD stands for Lethal Dose. LD50 is the amount of a material, given all at once,	<b>UN</b>	United Nations (number)
		<b>Wt</b>	weight



**CHESSER CHEMICALS Pty Ltd**  
 124 Days Road  
 FERRYDEN PARK SA 5010

Telephone: 08 8406 0000  
 Facsimile: 08 8406 0099  
 e-Mail: info@chesserchemicals.com.au

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# EnviroFloc 4017

**Ovivo Australia**

Chemwatch: **34-4761**

Version No: **2.1.1.1**

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: **0**

Issue Date: **16/02/2014**

Print Date: **25/02/2014**

Initial Date: **Not Available**

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

<b>Product name</b>	EnviroFloc 4017
<b>Chemical Name</b>	Not Applicable
<b>Synonyms</b>	polymer emulsion
<b>Proper shipping name</b>	Not Applicable
<b>Chemical formula</b>	Not Applicable
<b>Other means of identification</b>	Not Available
<b>CAS number</b>	Not Applicable

### Relevant identified uses of the substance or mixture and uses advised against

<b>Relevant identified uses</b>	Reverse demulsifier, water treatment flocculent.
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### Details of the supplier of the safety data sheet

<b>Registered company name</b>	Ovivo Australia		
<b>Address</b>	Building A 99-103 Cowpasture Road Wetherill Park 2164 NSW Australia		
<b>Telephone</b>	+61 2 9828 2900		
<b>Fax</b>	+61 2 9828 2988		
<b>Website</b>	Not Available		
<b>Email</b>	Not Available		

### Emergency telephone number

<b>Association / Organisation</b>	Not Available		
<b>Emergency telephone numbers</b>	1800 769 805		
<b>Other emergency telephone numbers</b>	1800 769 805		

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

NON-HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS. According to the Model WHS Regulations and the ADG Code.

#### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	0	
Body Contact	0	
Reactivity	0	
Chronic	0	

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

<b>Poisons Schedule</b>	
<b>GHS Classification</b>	Not Applicable



**Legend:** 1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

## Label elements

### GHS label elements

SIGNAL WORD **NOT APPLICABLE**

### Hazard statement(s)

Not Applicable

### Precautionary statement(s): Prevention

Not Applicable

### Precautionary statement(s): Response

Not Applicable

### Precautionary statement(s): Storage

Not Applicable

### Precautionary statement(s): Disposal

Not Applicable

## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

### Substances

See section below for composition of Mixtures

### Mixtures

CAS No	%[weight]	Name
9003-05-8	30-60	<a href="#">acrylamide homopolymer</a>
7732-18-5	30-60	<a href="#">water</a>

## SECTION 4 FIRST AID MEASURES

### Description of first aid measures

<b>Eye Contact</b>	If this product comes in contact with eyes: <ul style="list-style-type: none"><li>▶ Wash out immediately with water.</li><li>▶ If irritation continues, seek medical attention.</li><li>▶ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li></ul>
<b>Skin Contact</b>	If skin or hair contact occurs: <ul style="list-style-type: none"><li>▶ Flush skin and hair with running water (and soap if available).</li><li>▶ Seek medical attention in event of irritation.</li></ul>
<b>Inhalation</b>	<ul style="list-style-type: none"><li>▶ If fumes, aerosols or combustion products are inhaled remove from contaminated area.</li><li>▶ Other measures are usually unnecessary.</li></ul>
<b>Ingestion</b>	<ul style="list-style-type: none"><li>▶ Immediately give a glass of water.</li><li>▶ First aid is not generally required. If in doubt, contact a Poisons Information Centre or a doctor.</li></ul>

### Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

The product contains a substantial proportion of water, therefore there are no restrictions on the type of extinguishing media which may be used. Choice of extinguishing media should take into account surrounding areas.

Though the material is non-combustible, evaporation of water from the mixture, caused by the heat of nearby fire, may produce floating layers of combustible substances.

In such an event consider:



**Special hazards arising from the substrate or mixture**

<b>Fire Incompatibility</b>	None known.
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**Advice for firefighters**

<b>Fire Fighting</b>	<ul style="list-style-type: none"> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear full body protective clothing with breathing apparatus.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water course.</li> <li>▶ Use water delivered as a fine spray to control fire and cool adjacent area.</li> </ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>▶ The material is not readily combustible under normal conditions.</li> <li>▶ However, it will break down under fire conditions and the organic component may burn.</li> <li>▶ Not considered to be a significant fire risk.</li> <li>▶ Heat may cause expansion or decomposition with violent rupture of containers.</li> </ul>

**SECTION 6 ACCIDENTAL RELEASE MEASURES****Personal precautions, protective equipment and emergency procedures**

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>▶ Remove all ignition sources.</li> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid breathing vapours and contact with skin and eyes.</li> <li>▶ Control personal contact with the substance, by using protective equipment.</li> </ul>
<b>Major Spills</b>	<p>Moderate hazard.</p> <ul style="list-style-type: none"> <li>▶ Clear area of personnel and move upwind.</li> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear breathing apparatus plus protective gloves.</li> </ul>
	Personal Protective Equipment advice is contained in Section 8 of the MSDS.

**SECTION 7 HANDLING AND STORAGE****Precautions for safe handling**

<b>Safe handling</b>	<ul style="list-style-type: none"> <li>▶ Limit all unnecessary personal contact.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ <b>When handling</b></li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> </ul>

**Conditions for safe storage, including any incompatibilities**

<b>Suitable container</b>	<ul style="list-style-type: none"> <li>▶ Metal can or drum</li> <li>▶ Packaging as recommended by manufacturer.</li> <li>▶ Check all containers are clearly labelled and free from leaks.</li> </ul>
<b>Storage incompatibility</b>	<p>Avoid contamination of water, foodstuffs, feed or seed.</p> <ul style="list-style-type: none"> <li>▶ Avoid reaction with oxidising agents</li> </ul>

**PACKAGE MATERIAL INCOMPATIBILITIES****SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION****Control parameters****OCCUPATIONAL EXPOSURE LIMITS (OEL)****INGREDIENT DATA**

Not Available

**EMERGENCY LIMITS**

Ingredient	TEEL-0	TEEL-1	TEEL-2	TEEL-3
water	500(ppm)	500(ppm)	500(ppm)	500(ppm)

Ingredient	Original IDLH	Revised IDLH
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Continued...

EnviroFloc 4017

Not Available

Not Available

## Exposure controls

<b>Appropriate engineering controls</b>	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk.
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hand protection</b>	Wear general protective gloves, eg. light weight rubber gloves. The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application. The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	No special equipment needed when handling small quantities. <b>OTHERWISE:</b> <ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ Barrier cream.</li> </ul>
<b>Thermal hazards</b>	

## Recommended material(s)

## Respiratory protection

### GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

**"Forsberg Clothing Performance Index".**

The effect(s) of the following substance(s) are taken into account in the EnviroFloc 4017

Material	CPI
BUTYL	A
NEOPRENE	A
VITON	A

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

### Information on basic physical and chemical properties

<b>Appearance</b>	Milky white liquid with no odour; mixes with water.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.2
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Available
<b>pH (as supplied)</b>	5-6	<b>Decomposition temperature</b>	Not Available

## EnviroFloc 4017

<b>Melting point / freezing point (°C)</b>	Not Available	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	Not Available	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	>2000 (polymer)	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Available	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Available	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Available	<b>Volatile Component (%vol)</b>	Not Available
<b>Vapour pressure (kPa)</b>	Not Available	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution(1%)</b>	Not Available
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	The material is not thought to produce adverse health effects or irritation of the respiratory tract (as classified by EC Directives using animal models). Nevertheless, good hygiene practice requires that exposure be kept to a minimum and that suitable control measures be used in an occupational setting.
<b>Ingestion</b>	The material has <b>NOT</b> been classified by EC Directives or other classification systems as "harmful by ingestion". This is because of the lack of corroborating animal or human evidence.
<b>Skin Contact</b>	The material is not thought to produce adverse health effects or skin irritation following contact (as classified by EC Directives using animal models). Nevertheless, good hygiene practice requires that exposure be kept to a minimum and that suitable gloves be used in an occupational setting. Open cuts, abraded or irritated skin should not be exposed to this material Entry into the blood-stream through, for example, cuts, abrasions, puncture wounds or lesions, may produce systemic injury with harmful effects.
<b>Eye</b>	Although the liquid is not thought to be an irritant (as classified by EC Directives), direct contact with the eye may produce transient discomfort characterised by tearing or conjunctival redness (as with windburn).
<b>Chronic</b>	Long-term exposure to the product is not thought to produce chronic effects adverse to health (as classified by EC Directives using animal models); nevertheless exposure by all routes should be minimised as a matter of course.

<b>EnviroFloc 4017</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Not Available	Not Available
<b>acrylamide homopolymer</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (mouse) LD50: 12950 mg/kg	Eye: slight
	Oral (rabbit) LD50: 11250 mg/kg	
	Oral (rat) LD50: >2000 mg/kg	
	Not Available	Not Available

water	TOXICITY	IRRITATION
	Not Available	Not Available

\* Value obtained from manufacturer's msds  
unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances

<b>ACRYLAMIDE HOMOPOLYMER</b>	Sensitisation (guinea pig): 0% (0/20) OECD 406
<b>EnviroFloc 4017, WATER</b>	No significant acute toxicological data identified in literature search.

<b>Acute Toxicity</b>	Not Applicable	<b>Carcinogenicity</b>	Not Applicable
<b>Skin Irritation/Corrosion</b>	Not Applicable	<b>Reproductivity</b>	Not Applicable
<b>Serious Eye Damage/Irritation</b>	Not Applicable	<b>STOT - Single Exposure</b>	Not Applicable
<b>Respiratory or Skin sensitisation</b>	Not Applicable	<b>STOT - Repeated Exposure</b>	Not Applicable
<b>Mutagenicity</b>	Not Applicable	<b>Aspiration Hazard</b>	Not Applicable

## CMR STATUS

## SECTION 12 ECOLOGICAL INFORMATION

### Toxicity

### Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
Not Available	Not Available	Not Available

### Bioaccumulative potential

Ingredient	Bioaccumulation
Not Available	Not Available

### Mobility in soil

Ingredient	Mobility
Not Available	Not Available

## SECTION 13 DISPOSAL CONSIDERATIONS

### Waste treatment methods

<b>Product / Packaging disposal</b>	<ul style="list-style-type: none"> <li>▶ Recycle wherever possible or consult manufacturer for recycling options.</li> <li>▶ Consult State Land Waste Authority for disposal.</li> <li>▶ Bury or incinerate residue at an approved site.</li> <li>▶ Recycle containers if possible, or dispose of in an authorised landfill.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

### Labels Required

<b>Marine Pollutant</b>	NO
<b>HAZCHEM</b>	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

## SECTION 15 REGULATORY INFORMATION

**Safety, health and environmental regulations / legislation specific for the substance or mixture**

<b>acrylamide homopolymer(9003-05-8) is found on the following regulatory lists</b>	"Sigma-AldrichTransport Information","FisherTransport Information","Australia Inventory of Chemical Substances (AICS)","Australia National Pollutant Inventory"
<b>water(7732-18-5) is found on the following regulatory lists</b>	"IMO IBC Code Chapter 18: List of products to which the Code does not apply","OSPAR National List of Candidates for Substitution – Norway","Sigma-AldrichTransport Information","Australia Inventory of Chemical Substances (AICS)","International Fragrance Association (IFRA) Survey: Transparency List","OECD List of High Production Volume (HPV) Chemicals","Australia High Volume Industrial Chemical List (HVICL)"

**SECTION 16 OTHER INFORMATION****Other information**

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net/references](http://www.chemwatch.net/references)

The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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# HyBind 2002

Ovivo Australia

Chemwatch: 22-9555

Version No: 2.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 2

Issue Date: 01/01/2013

Print Date: 11/02/2014

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	HyBind 2002
Chemical Name	Not Applicable
Synonyms	P.A.C., poly aluminium chloride
Proper shipping name	Not Applicable
Chemical formula	Not Applicable
Other means of identification	Not Available
CAS number	Not Applicable

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Used for wastewater treatment.
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### Details of the supplier of the safety data sheet

Registered company name	Ovivo Australia		
Address	Building A 99-103 Cowpasture Road Wetherill Park 2164 NSW Australia		
Telephone	+61 2 9828 2900		
Fax	+61 2 9828 2988		
Website	Not Available		
Email	Not Available		

### Emergency telephone number

Association / Organisation	Not Available		
Emergency telephone numbers	1800 769 805		
Other emergency telephone numbers	1800 769 805		

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS. According to the Model WHS Regulations and the ADG Code.

#### CHEMWATCH HAZARD RATINGS


	Min	Max	
Flammability	0		
Toxicity	0		
Body Contact	2		
Reactivity	0		
Chronic	2		

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	None
GHS Classification <sup>[1]</sup>	Skin Corrosion/Irritation Category 2, Eye Irrit. 2, STOT - SE (Resp. Irr.) Category 3

**Legend:** 1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

## Label elements

GHS label elements	
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SIGNAL WORD	<b>WARNING</b>
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## Hazard statement(s)

H315	Causes skin irritation
H319	Causes serious eye irritation
H335	May cause respiratory irritation

## Precautionary statement(s): Prevention

P271	Use only outdoors or in a well-ventilated area.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

## Precautionary statement(s): Response

P321	Specific treatment (see advice on this label).
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312	Call a POISON CENTER/doctor/physician/first aider/if you feel unwell.
P337+P313	If eye irritation persists: Get medical advice/attention.
P302+P352	IF ON SKIN: Wash with plenty of water and soap
P304+P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P332+P313	If skin irritation occurs: Get medical advice/attention.
P362+P364	Take off contaminated clothing and wash it before reuse.

## Precautionary statement(s): Storage

P405	Store locked up.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.

## Precautionary statement(s): Disposal

P501	Dispose of contents/container to authorised chemical landfill or if organic to high temperature incineration
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

### Substances

See section below for composition of Mixtures

### Mixtures

CAS No	%[weight]	Name
12042-91-0	10-30	<a href="#">aluminium chlorohydrate</a>
7732-18-5	>60	<a href="#">water</a>

## SECTION 4 FIRST AID MEASURES

### Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>▶ Wash out immediately with fresh running water.</li> <li>▶ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> </ul>
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	<ul style="list-style-type: none"> <li>Seek medical attention without delay; if pain persists or recurs seek medical attention.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
<b>Skin Contact</b>	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
<b>Inhalation</b>	<ul style="list-style-type: none"> <li>If fumes or combustion products are inhaled remove from contaminated area.</li> <li>Lay patient down. Keep warm and rested.</li> <li>Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>Transport to hospital, or doctor, without delay.</li> </ul>
<b>Ingestion</b>	<ul style="list-style-type: none"> <li>Immediately give a glass of water.</li> <li>First aid is not generally required. If in doubt, contact a Poisons Information Centre or a doctor.</li> </ul>

### Indication of any immediate medical attention and special treatment needed

	<p>Treat symptomatically.</p> <ul style="list-style-type: none"> <li>Manifestation of aluminium toxicity include hypercalcaemia, anaemia, Vitamin D refractory osteodystrophy and a progressive encephalopathy (mixed dysarthria-apraxia of speech, asterixis, tremulousness, myoclonus, dementia, focal seizures). Bone pain, pathological fractures and proximal myopathy can occur.</li> <li>Symptoms usually develop insidiously over months to years (in chronic renal failure patients) unless dietary aluminium loads are excessive.</li> <li>Serum aluminium levels above 60 ug/ml indicate increased absorption. Potential toxicity occurs above 100 ug/ml and clinical symptoms are present when levels exceed 200 ug/ml.</li> <li>Deferoxamine has been used to treat dialysis encephalopathy and osteomalacia. CaNa2EDTA is less effective in chelating aluminium.</li> </ul> <p>[Ellenhorn and Barceloux: Medical Toxicology]</p>
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## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

	<p>The product contains a substantial proportion of water, therefore there are no restrictions on the type of extinguishing media which may be used. Choice of extinguishing media should take into account surrounding areas.</p> <p>Though the material is non-combustible, evaporation of water from the mixture, caused by the heat of nearby fire, may produce floating layers of combustible substances.</p> <p>In such an event consider:</p>
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### Special hazards arising from the substrate or mixture

<b>Fire Incompatibility</b>	None known.
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### Advice for firefighters

<b>Fire Fighting</b>	<ul style="list-style-type: none"> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear breathing apparatus plus protective gloves in the event of a fire.</li> <li>Prevent, by any means available, spillage from entering drains or water courses.</li> <li>Use fire fighting procedures suitable for surrounding area.</li> </ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>Non combustible.</li> <li>Not considered to be a significant fire risk.</li> <li>Expansion or decomposition on heating may lead to violent rupture of containers.</li> <li>Decomposes on heating and may produce toxic/ irritating fumes.</li> </ul>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>Clean up all spills immediately.</li> <li>Avoid breathing vapours and contact with skin and eyes.</li> <li>Control personal contact with the substance, by using protective equipment.</li> <li>Contain and absorb spill with sand, earth, inert material or vermiculite.</li> </ul>
<b>Major Spills</b>	<p>Minor hazard.</p> <ul style="list-style-type: none"> <li>Clear area of personnel.</li> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Control personal contact with the substance, by using protective equipment as required.</li> </ul>



Personal Protective Equipment advice is contained in Section 8 of the MSDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

<b>Safe handling</b>	<ul style="list-style-type: none"> <li>Limit all unnecessary personal contact.</li> <li>Wear protective clothing when risk of exposure occurs.</li> <li>Use in a well-ventilated area.</li> <li>Avoid contact with incompatible materials.</li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>Store below 38 deg. C.</li> <li>Store in original containers.</li> <li>Keep containers securely sealed.</li> </ul>

### Conditions for safe storage, including any incompatibilities

<b>Suitable container</b>	<ul style="list-style-type: none"> <li>Polyethylene or polypropylene container.</li> <li>Packing as recommended by manufacturer.</li> <li>Check all containers are clearly labelled and free from leaks.</li> </ul>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"> <li>Avoid strong acids, bases.</li> </ul>

### PACKAGE MATERIAL INCOMPATIBILITIES

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

### Control parameters

#### OCCUPATIONAL EXPOSURE LIMITS (OEL)

#### INGREDIENT DATA


Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	aluminium chlorohydrate	Aluminium, soluble salts (as Al)	2 (mg/m3)	Not Available	Not Available	Not Available

#### EMERGENCY LIMITS

Ingredient	TEEL-0	TEEL-1	TEEL-2	TEEL-3
water	500(ppm)	500(ppm)	500(ppm)	500(ppm)

Ingredient	Original IDLH	Revised IDLH
HyBind 2002	Not Available	Not Available

### Exposure controls

<b>Appropriate engineering controls</b>	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p>
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>Safety glasses with side shields.</li> <li>Chemical goggles.</li> <li>Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lens or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hand protection</b>	<ul style="list-style-type: none"> <li>Wear chemical protective gloves, e.g. PVC.</li> <li>Wear safety footwear or safety gumboots, e.g. Rubber</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p>

## HyBind 2002

<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>▸ Overalls.</li> <li>▸ P.V.C. apron.</li> <li>▸ Barrier cream.</li> </ul>
<b>Thermal hazards</b>	

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

**"Forsberg Clothing Performance Index".**

The effect(s) of the following substance(s) are taken into account in the HyBind 2002

Material	CPI
BUTYL	A
NEOPRENE	A
VITON	A

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

## Respiratory protection

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.

Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	-AUS P2	-	-PAPR-AUS / Class 1 P2
up to 50 x ES	-	-AUS / Class 1 P2	-
up to 100 x ES	-	-2 P2	-PAPR-2 P2 ^

^ - Full-face

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO<sub>2</sub>), G = Agricultural chemicals, K = Ammonia(NH<sub>3</sub>), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	Clear, water white/pale amber or slightly turbid odourless liquid; mixes with water.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.33
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Available
<b>pH (as supplied)</b>	Not Available	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	-12	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	104	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Available	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Available	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	Not Available
<b>Vapour pressure (kPa)</b>	Not Available	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution(1%)</b>	Not Available
<b>Vapour density (Air = 1)</b>	9.2 @ >180 deg.	<b>VOC g/L</b>	

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
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<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▸ Presence of incompatible materials.</li> <li>▸ Product is considered stable.</li> <li>▸ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

### Information on toxicological effects

<b>Inhaled</b>	Evidence shows, or practical experience predicts, that the material produces irritation of the respiratory system, in a substantial number of individuals, following inhalation. In contrast to most organs, the lung is able to respond to a chemical insult by first removing or neutralising the irritant and then repairing the damage. The repair process, which initially evolved to protect mammalian lungs from foreign matter and antigens, may however, produce further lung damage resulting in the impairment of gas exchange, the primary function of the lungs. Respiratory tract irritation often results in an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system.
<b>Ingestion</b>	Overexposure is unlikely in this form. The material has <b>NOT</b> been classified by EC Directives or other classification systems as "harmful by ingestion".
<b>Skin Contact</b>	The material produces mild skin irritation; evidence exists, or practical experience predicts, that the material either <ul style="list-style-type: none"> <li>▸ produces mild inflammation of the skin in a substantial number of individuals following direct contact, and/or</li> <li>▸ produces significant, but mild, inflammation when applied to the healthy intact skin of animals (for up to four hours), such inflammation being present twenty-four hours or more after the end of the exposure period.</li> </ul> Skin irritation may also be present after prolonged or repeated exposure; this may result in a form of contact dermatitis (nonallergic).
<b>Eye</b>	Evidence exists, or practical experience predicts, that the material may cause eye irritation in a substantial number of individuals and/or may produce significant ocular lesions which are present twenty-four hours or more after instillation into the eye(s) of experimental animals. Repeated or prolonged eye contact may cause inflammation characterised by temporary redness (similar to windburn) of the conjunctiva (conjunctivitis); temporary impairment of vision and/or other transient eye damage/ulceration may occur.
<b>Chronic</b>	Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems. Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems. Occupational exposure to aluminium compounds may produce asthma, chronic obstructive lung disease and pulmonary fibrosis. Long-term overexposure may produce dyspnoea, cough, pneumothorax, variable sputum production and nodular interstitial fibrosis; death has been reported.

<b>HyBind 2002</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Not Available	Not Available
<b>aluminium chlorohydrate</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (rat) LD50: 3730 mg/kg	Skin (human): 150 mg/30 s - mild
	Not Available	Not Available
<b>water</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Not Available	Not Available

Not available. Refer to individual constituents.

<b>ALUMINIUM CHLOROHYDRATE</b>	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow
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Continued...

	pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. for aluminium chloride: Reproductive effector in rats
<b>WATER</b>	No significant acute toxicological data identified in literature search.

<b>Acute Toxicity</b>	Not Applicable	<b>Carcinogenicity</b>	Not Applicable
<b>Skin Irritation/Corrosion</b>	Skin Corrosion/Irritation Category 2	<b>Reproductivity</b>	Not Applicable
<b>Serious Eye Damage/Irritation</b>	Eye Irrit. 2	<b>STOT - Single Exposure</b>	STOT - SE (Resp. Irr.) Category 3
<b>Respiratory or Skin sensitisation</b>	Not Applicable	<b>STOT - Repeated Exposure</b>	Not Applicable
<b>Mutagenicity</b>	Not Applicable	<b>Aspiration Hazard</b>	Not Applicable

**CMR STATUS****SECTION 12 ECOLOGICAL INFORMATION****Toxicity**

**DO NOT** discharge into sewer or waterways.

**Persistence and degradability**

Ingredient	Persistence: Water/Soil	Persistence: Air
Not Available	Not Available	Not Available

**Bioaccumulative potential**

Ingredient	Bioaccumulation
Not Available	Not Available

**Mobility in soil**

Ingredient	Mobility
Not Available	Not Available

**SECTION 13 DISPOSAL CONSIDERATIONS****Waste treatment methods**

<b>Product / Packaging disposal</b>	<ul style="list-style-type: none"> <li>Recycle wherever possible.</li> <li>Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>Dispose of by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or incineration in a licenced apparatus (after admixture with suitable combustible material).</li> <li>Decontaminate empty containers.</li> </ul>
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**SECTION 14 TRANSPORT INFORMATION****Labels Required**

<b>Marine Pollutant</b>	NO
<b>HAZCHEM</b>	Not Applicable

**Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS**

**Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS**

**Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS**

**Transport in bulk according to Annex II of MARPOL 73 / 78 and the IBC code**

Source	Ingredient	Pollution Category	Residual Concentration - Outside Special Area (% w/w)	Residual Concentration
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## HyBind 2002

IMO MARPOL 73/78 (Annex II) - List of Other Liquid Substances	aluminium chlorohydrate	Not Available	Not Available	Not Available
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## SECTION 15 REGULATORY INFORMATION

## Safety, health and environmental regulations / legislation specific for the substance or mixture

aluminium chlorohydrate(12042-91-0) is found on the following regulatory lists	"International Council of Chemical Associations (ICCA) - High Production Volume List", "IMO MARPOL 73/78 (Annex II) - List of Other Liquid Substances", "OECD List of High Production Volume (HPV) Chemicals", "IMO IBC Code Chapter 18: List of products to which the Code does not apply", "Australia High Volume Industrial Chemical List (HVICL)", "GESAMP/EHS Composite List - GESAMP Hazard Profiles", "Australia Hazardous Substances Information System - Consolidated Lists"
water(7732-18-5) is found on the following regulatory lists	"OSPAR National List of Candidates for Substitution – Norway", "OECD List of High Production Volume (HPV) Chemicals", "IMO IBC Code Chapter 18: List of products to which the Code does not apply", "Sigma-AldrichTransport Information", "Australia High Volume Industrial Chemical List (HVICL)"

## SECTION 16 OTHER INFORMATION

## Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net/references](http://www.chemwatch.net/references)

The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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# HYDROCHLORIC ACID

Osmoflo Water Management Pty Ltd

Chemwatch: 1789

Version No: 7.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 3

Issue Date: 01/01/2013

Print Date: 07/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	HYDROCHLORIC ACID
Chemical Name	hydrochloric acid
Synonyms	6195P, 66572, 66575, 76573, Convol analytical reagent, Elite 10745000 Astral E569 Depurination solution, HCl, Merck Hydrochloric acid sp.gr. 1.16 AnalaR 10307, Sigma-Aldrich Hydrochloric acid, 30721, chlorohydric acid gas, hydrochloric acid 28-37%, hydrochloride, hydrogen chloride aqueous solution, muriatic acid, spirits of salt, spirits of salts
Proper shipping name	HYDROCHLORIC ACID
Chemical formula	HCl Cl-D
Other means of identification	Not Available
CAS number	7647-01-0

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation. For pickling and heavy duty cleaning of metal parts; rust and scale removal. The production of chlorides; neutralising bases; a laboratory reagent. For hydrolyzing starch and proteins in preparations for food. As a catalyst and solvent in organic synthesis.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.

### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	3	
Body Contact	3	
Reactivity	1	
Chronic	1	

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme



Poisons Schedule	S6 (S3)
Classification [2]	Metal Corrosion Category 1, Acute Toxicity (Inhalation) Category 2, Skin Corrosion/Irritation Category 1A, Specific target organ toxicity - single exposure Category 3 (respiratory tract irritation)

Continued...

## HYDROCHLORIC ACID

**Legend:** 1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

GHS label elements	 
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**SIGNAL WORD** DANGER

### Hazard statement(s)

H290	May be corrosive to metals
H330	Fatal if inhaled
H314	Causes severe skin burns and eye damage
H335	May cause respiratory irritation

### Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P234	Keep only in original container.

### Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

### Precautionary statement(s) Storage

P403+P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

### Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

### Substances

CAS No	%[weight]	Name
7647-01-0.	30-35	hydrogen chloride
7732-18-5	65-70	water

### Mixtures

See section above for composition of Substances

## SECTION 4 FIRST AID MEASURES

### Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>Transport to hospital or doctor without delay.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes or combustion products are inhaled remove from contaminated area.</li> <li>Lay patient down. Keep warm and rested.</li> <li>Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>Transport to hospital, or doctor, without delay.</li> <li>Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.</li> <li>Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).</li> <li>As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.</li> </ul>

Continued...

## HYDROCHLORIC ACID

	<ul style="list-style-type: none"> <li>Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. <b>This must definitely be left to a doctor or person authorised by him/her.</b> (ICSC13719)</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li><b>IF SWALLOWED, REFER FOR MEDICAL ATTENTION, WHERE POSSIBLE, WITHOUT DELAY.</b></li> <li>For advice, contact a Poisons Information Centre or a doctor.</li> <li>Urgent hospital treatment is likely to be needed.</li> <li>In the mean time, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition.</li> <li>If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the SDS should be provided. Further action will be the responsibility of the medical specialist.</li> <li>If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the SDS.</li> </ul> <p><b>Where medical attention is not immediately available or where the patient is more than 15 minutes from a hospital or unless instructed otherwise:</b></p> <ul style="list-style-type: none"> <li><b>INDUCE</b> vomiting with fingers down the back of the throat, <b>ONLY IF CONSCIOUS</b>. Lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> </ul> <p><b>NOTE:</b> Wear a protective glove when inducing vomiting by mechanical means.</p>

### Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

For acute or short term repeated exposures to strong acids:

- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.
- Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
- Strong acids produce a coagulation necrosis characterised by formation of a coagulum (eschar) as a result of the desiccating action of the acid on proteins in specific tissues.

INGESTION:

- Immediate dilution (milk or water) within 30 minutes post ingestion is recommended.
- DO NOT attempt to neutralise the acid since exothermic reaction may extend the corrosive injury.**
- Be careful to avoid further vomit since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
- Charcoal has no place in acid management.
- Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:

- Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
- Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:

- Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjunctival cul-de-sacs. Irrigation should last at least 20-30 minutes. **DO NOT use neutralising agents or any other additives.** Several litres of saline are required.
- Cycloplegic drops, (1% cyclopentolate for short-term use or 5% homatropine for longer term use) antibiotic drops, vasoconstrictive agents or artificial tears may be indicated dependent on the severity of the injury.
- Steroid eye drops should only be administered with the approval of a consulting ophthalmologist).

[Ellenhorn and Barceloux: Medical Toxicology]

If exposure has been severe and/or symptoms marked, observation in hospital for 48 hours should be considered due to possibility of delayed pulmonary oedema.

## SECTION 5 FIREFIGHTING MEASURES

### Extinguishing media

- Water spray or fog.
- Foam.
- Dry chemical powder.
- BCF (where regulations permit).

### Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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### Advice for firefighters

Fire Fighting	<ul style="list-style-type: none"> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear full body protective clothing with breathing apparatus.</li> <li>Prevent, by any means available, spillage from entering drains or water course.</li> <li>Use fire fighting procedures suitable for surrounding area.</li> </ul>
Fire/Explosion Hazard	<ul style="list-style-type: none"> <li>Non combustible.</li> <li>Not considered to be a significant fire risk.</li> <li>Acids may react with metals to produce hydrogen, a highly flammable and explosive gas.</li> <li>Heating may cause expansion or decomposition leading to violent rupture of containers.</li> </ul> <p>Decomposition may produce toxic fumes of; hydrogen chloride <b>Contains low boiling substance:</b> Closed containers may rupture due to pressure buildup under fire conditions.</p>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

Minor Spills	<ul style="list-style-type: none"> <li>Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.</li> <li>Check regularly for spills and leaks.</li> <li>Clean up all spills immediately.</li> <li>Avoid breathing vapours and contact with skin and eyes.</li> <li>Control personal contact with the substance, by using protective equipment.</li> <li>Contain and absorb spill with sand, earth, inert material or vermiculite.</li> </ul>
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## HYDROCHLORIC ACID

### Major Spills

- ▶ Clear area of personnel and move upwind.
- ▶ Alert Fire Brigade and tell them location and nature of hazard.
- ▶ Wear full body protective clothing with breathing apparatus.
- ▶ Prevent, by any means available, spillage from entering drains or water course.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

Safe handling	<p><b>Contains low boiling substance:</b> Storage in sealed containers may result in pressure buildup causing violent rupture of containers not rated appropriately.</p> <ul style="list-style-type: none"> <li>▶ Check for bulging containers.</li> <li>▶ Vent periodically</li> <li>▶ Always release caps or seals slowly to ensure slow dissipation of vapours</li> <li>▶ <b>DO NOT allow clothing wet with material to stay in contact with skin</b></li> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ <b>WARNING: To avoid violent reaction, ALWAYS add material to water and NEVER water to material.</b></li> </ul>
Other information	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> </ul>

### Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> <li>▶ <b>DO NOT use aluminium or galvanised containers</b></li> <li>▶ Check regularly for spills and leaks</li> <li>▶ Lined metal can, lined metal pail/ can.</li> <li>▶ Plastic pail.</li> <li>▶ Polyliner drum.</li> <li>▶ Packing as recommended by manufacturer.</li> </ul> <p>For low viscosity materials</p> <ul style="list-style-type: none"> <li>▶ Drums and jerricans must be of the non-removable head type.</li> <li>▶ Where a can is to be used as an inner package, the can must have a screwed enclosure.</li> </ul> <p>For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):</p> <ul style="list-style-type: none"> <li>▶ Removable head packaging;</li> <li>▶ Cans with friction closures and</li> <li>▶ low pressure tubes and cartridges</li> </ul> <p>may be used.</p>
Storage incompatibility	<ul style="list-style-type: none"> <li>▶ Inorganic acids are generally soluble in water with the release of hydrogen ions. The resulting solutions have pH's of less than 7.0.</li> <li>▶ Inorganic acids neutralise chemical bases (for example: amines and inorganic hydroxides) to form salts - neutralisation can generate dangerously large amounts of heat in small spaces.</li> <li>▶ The dissolution of inorganic acids in water or the dilution of their concentrated solutions with additional water may generate significant heat.</li> <li>▶ Reacts vigorously with alkalis</li> <li>▶ Reacts with mild steel, galvanised steel / zinc producing hydrogen gas which may form an explosive mixture with air.</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

### Control parameters

#### OCCUPATIONAL EXPOSURE LIMITS (OEL)

#### INGREDIENT DATA


Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	hydrogen chloride	Hydrogen chloride	Not Available	Not Available	7.5 mg/m3 / 5 ppm	Not Available

#### EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
hydrogen chloride	Hydrogen chloride; (Hydrochloric acid)	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
hydrogen chloride	100 ppm	50 ppm
water	Not Available	Not Available

### Exposure controls

Appropriate engineering controls	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p> <p>[Hydrogen chloride vapours will not be adequately absorbed by organic vapour respirators. [NSW D.I.R.]</p>
Personal protection	

## HYDROCHLORIC ACID

<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>Safety glasses with side shields.</li> <li>Chemical goggles.</li> <li>Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<ul style="list-style-type: none"> <li>Wear chemical protective gloves, e.g. PVC.</li> <li>Wear safety footwear or safety gumboots, e.g. Rubber</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>Overalls.</li> <li>PVC Apron.</li> <li>PVC protective suit may be required if exposure severe.</li> <li>Eyewash unit.</li> </ul>
<b>Thermal hazards</b>	Not Available

### Recommended material(s)

#### GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

**"Forsberg Clothing Performance Index".**

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

HYDROCHLORIC ACID

Material	CPI
BUTYL	A
BUTYL/NEOPRENE	A
HYPALON	A
NEOPRENE	A
NEOPRENE/NATURAL	A
NITRILE	A
NITRILE+PVC	A
PE/EVAL/PE	A
PVC	A
SARANEX-23	A
VITON/NEOPRENE	A
NATURAL RUBBER	B
NATURAL+NEOPRENE	B
NAT+NEOPR+NITRILE	C

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

### Respiratory protection

Type B-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.

Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	B-AUS P2	-	B-PAPR-AUS / Class 1 P2
up to 50 x ES	-	B-AUS / Class 1 P2	-
up to 100 x ES	-	B-2 P2	B-PAPR-2 P2 ^

^ - Full-face

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

### Information on basic physical and chemical properties

<b>Appearance</b>	Clear to light yellow (orange tint for inhibited grades) fuming corrosive liquid with sharp, suffocating odour. [CARE: mixes with water but generates heat, may cause dangerous boiling. Concentrate and solutions are acidic and strongly corrosive. Material is a solution of corrosive hydrogen chloride gas in water. Commercial grades contain 28-37% hydrogen chloride HCl and at room temperature slowly gives off significant levels of acidic HCl gas.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.14-1.19
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not available.
<b>pH (as supplied)</b>	0.9	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	> -74	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	> 50	<b>Molecular weight (g/mol)</b>	Not Applicable

Continued...

## HYDROCHLORIC ACID

Flash point (°C)	Not Applicable	Taste	Not Available
Evaporation rate	Slow	Explosive properties	Not Available
Flammability	Not Applicable	Oxidising properties	Not Available
Upper Explosive Limit (%)	Not Applicable	Surface Tension (dyn/cm or mN/m)	Not Available
Lower Explosive Limit (%)	Not Applicable	Volatile Component (%vol)	approx. 100
Vapour pressure (kPa)	< 25 @ 25 C	Gas group	Not Available
Solubility in water (g/L)	Miscible	pH as a solution (1%)	1.2
Vapour density (Air = 1)	1.3	VOC g/L	Not Available

### SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	► Contact with alkaline material liberates heat
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

### SECTION 11 TOXICOLOGICAL INFORMATION

#### Information on toxicological effects

Inhaled	<p>The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Corrosive acids can cause irritation of the respiratory tract, with coughing, choking and mucous membrane damage. There may be dizziness, headache, nausea and weakness.</p> <p>Inhalation of quantities of liquid mist may be extremely hazardous, even lethal due to spasm, extreme irritation of larynx and bronchi, chemical pneumonitis and pulmonary oedema.</p> <p>Hydrogen chloride (HCl) vapour or fumes present a hazard from a single acute exposure. Exposures of 1300 to 2000 ppm have been lethal to humans in a few minutes.</p> <p>Inhalation of HCl may cause choking, coughing, burning sensation and may cause ulceration of the nose, throat and larynx. Fluid on the lungs followed by generalised lung damage may follow.</p> <p>Inhalation of the vapour is hazardous and may even be fatal</p> <p>Inhalation of aerosols (mists, fumes), generated by the material during the course of normal handling, may produce toxic effects; these may be fatal.</p> <p>Inhalation of toxic gases may cause:</p> <ul style="list-style-type: none"> <li>► Central Nervous System effects including depression, headache, confusion, dizziness, stupor, coma and seizures;</li> <li>► respiratory: acute lung swellings, shortness of breath, wheezing, rapid breathing, other symptoms and respiratory arrest;</li> <li>► heart: collapse, irregular heartbeats and cardiac arrest;</li> <li>► gastrointestinal: irritation, ulcers, nausea and vomiting (may be bloody), and abdominal pain.</li> </ul>
Ingestion	<p>Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual.</p> <p>Ingestion of acidic corrosives may produce burns around and in the mouth, the throat and oesophagus. Immediate pain and difficulties in swallowing and speaking may also be evident.</p> <p>Not normally a hazard due to physical form of product.</p> <p>Considered an unlikely route of entry in commercial/industrial environments</p>
Skin Contact	<p>The material is not thought to be a skin irritant (as classified by EC Directives using animal models). Temporary discomfort, however, may result from prolonged dermal exposures.</p> <p>Skin contact with the material may damage the health of the individual; systemic effects may result following absorption.</p> <p>Skin contact with acidic corrosives may result in pain and burns; these may be deep with distinct edges and may heal slowly with the formation of scar tissue.</p> <p>Open cuts, abraded or irritated skin should not be exposed to this material</p> <p>Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.</p>
Eye	<p>Although the liquid is not thought to be an irritant (as classified by EC Directives), direct contact with the eye may produce transient discomfort characterised by tearing or conjunctival redness (as with windburn).</p> <p>Direct eye contact with acid corrosives may produce pain, tears, sensitivity to light and burns. Mild burns of the epithelia generally recover rapidly and completely.</p>
Chronic	<p>Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.</p> <p>There has been some concern that this material can cause cancer or mutations but there is not enough data to make an assessment.</p> <p>Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.</p> <p>Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and/or ulceration of mouth lining. Irritation of airways to lung, with cough, and inflammation of lung tissue often occurs.</p> <p>Chronic minor exposure to hydrogen chloride (HCl) vapour or fume may cause discolouration or erosion of the teeth, bleeding of the nose and gums; and ulceration of the nasal mucous membranes.</p> <p>Repeated exposures of animals to concentrations of about 34 ppm HCl produced no immediate toxic effects.</p> <p>Workers exposed to hydrochloric acid suffered from gastritis and a number of cases of chronic bronchitis have also been reported.</p> <p>Repeated or prolonged exposure to dilute solutions of HCl may cause dermatitis.</p>

HYDROCHLORIC ACID	TOXICITY		IRRITATION	
	Inhalation (rat) LC50: 3124 ppm/1h <sup>[2]</sup>		Eye (rabbit): 5mg/30s - mild	
	Oral (rat) LD50: 900 mg/kg <sup>[2]</sup>			
hydrogen chloride	TOXICITY		IRRITATION	

## HYDROCHLORIC ACID

	Inhalation (rat) LC50: 3124 ppm/1h <sup>[2]</sup>	Eye (rabbit): 5 mg/30s - mild
	Oral (rat) LD50: 900 mg/kg <sup>[2]</sup>	
water	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	Not Available

**Legend:** 1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. \* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances

<b>HYDROCHLORIC ACID</b>	<p>Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.</p> <p>No significant acute toxicological data identified in literature search.</p> <p>for acid mists, aerosols, vapours</p> <p>Data from assays for genotoxic activity in vitro suggest that eukaryotic cells are susceptible to genetic damage when the pH falls to about 6.5. Cells from the respiratory tract have not been examined in this respect. Mucous secretion may protect the cells of the airways from direct exposure to inhaled acidic mists, just as mucous plays an important role in protecting the gastric epithelium from its auto-secreted hydrochloric acid. In considering whether pH itself induces genotoxic events in vivo in the respiratory system, comparison should be made with the human stomach, in which gastric juice may be at pH 1-2 under fasting or nocturnal conditions, and with the human urinary bladder, in which the pH of urine can range from &lt;5 to &gt; 7 and normally averages 6.2.</p> <p>The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. The substance is classified by IARC as Group 3:</p> <p><b>NOT</b> classifiable as to its carcinogenicity to humans.</p> <p>Evidence of carcinogenicity may be inadequate or limited in animal testing.</p>
<b>HYDROGEN CHLORIDE</b>	<p>Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.</p> <p>The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.</p> <p>4701 ppm/30m</p>
<b>WATER</b>	No significant acute toxicological data identified in literature search.

<b>Acute Toxicity</b>	✓	<b>Carcinogenicity</b>	⊘
<b>Skin Irritation/Corrosion</b>	✓	<b>Reproductivity</b>	⊘
<b>Serious Eye Damage/Irritation</b>	⊘	<b>STOT - Single Exposure</b>	⊘
<b>Respiratory or Skin sensitisation</b>	⊘	<b>STOT - Repeated Exposure</b>	⊘
<b>Mutagenicity</b>	⊘	<b>Aspiration Hazard</b>	⊘

**Legend:** ✗ – Data available but does not fill the criteria for classification  
✓ – Data required to make classification available  
⊘ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

### Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
hydrogen chloride	EC50	96	Algae or other aquatic plants	344.947mg/L	3
hydrogen chloride	LC50	96	Fish	70.057mg/L	3
hydrogen chloride	EC50	9.33	Fish	0.014000mg/L	4
hydrogen chloride	NOEC	0.08	Fish	10mg/L	4
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3

**Legend:** Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

### Ecotoxicity:

The tolerance of water organisms towards pH margin and variation is diverse. Recommended pH values for test species listed in OECD guidelines are between 6.0 and almost 9. Acute testing with fish showed 96h-LC50 at about pH 3.5

For Chloride: Although inorganic chloride ions are not normally considered toxic they can exist in effluents at acutely toxic levels. Incidental exposure to inorganic chloride may occur in occupational settings where chemicals management policies are improperly applied. The toxicity of chloride salts depends on the counter-ion (cation) present; that of chloride itself is unknown. Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure.

Prevent, by any means available, spillage from entering drains or water courses.

**DO NOT discharge into sewer or waterways.**

|Ecotoxicity|Fish LC100 (24 h): trout 10 mg/l|Tlm (96 h): mosquito fish 282 ppm (fresh water)|LC50 : goldfish 178 mg/l|Shrimp LC50 (48 h): 100 - 330 ppm (salt water)|Starfish LC50 (48 h): 100 - 330 mg/l|Cockle LC50 (48 h): 330 - 1000 mg/l|[Hach]|Hydrogen chloride in water dissociates almost completely, releasing hydrogen and chloride ions; the hydrogen ions are captured by water

## HYDROCHLORIC ACID

to produce hydronium ions. Hydrochloric acid infiltrates soil, the rate dependent on moisture content. During soil transport, hydrochloric acid dissolves soil components. Drinking water standard: chloride: 400 mg/l (UK max.) 250 mg/l (WHO guideline)

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
hydrogen chloride	LOW	LOW
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
hydrogen chloride	LOW (LogKOW = 0.5392)
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
hydrogen chloride	LOW (KOC = 14.3)
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"><li>Containers may still present a chemical hazard/ danger when empty.</li><li>Return to supplier for reuse/ recycling if possible.</li></ul> Otherwise: <ul style="list-style-type: none"><li>If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill.</li><li>Where possible retain label warnings and SDS and observe all notices pertaining to the product.</li></ul> Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked. A Hierarchy of Controls seems to be common - the user should investigate: <ul style="list-style-type: none"><li>Reduction</li><li>Reuse</li><li>Recycling</li><li>Disposal (if all else fails)</li></ul> This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. <ul style="list-style-type: none"><li><b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li><li>It may be necessary to collect all wash water for treatment before disposal.</li><li>In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li><li>Where in doubt contact the responsible authority.</li><li>Recycle wherever possible.</li><li>Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li><li>Treat and neutralise at an approved treatment plant. Treatment should involve: Neutralisation with soda-ash or soda-lime followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material).</li></ul>
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## SECTION 14 TRANSPORT INFORMATION

## Labels Required

	
Marine Pollutant	NO
HAZCHEM	2R

## Land transport (ADG)

UN number	1789
Packing group	II
UN proper shipping name	HYDROCHLORIC ACID
Environmental hazard	Not Applicable
Transport hazard class(es)	Class 8 Subrisk Not Applicable
Special precautions for user	Special provisions Not Applicable Limited quantity 1 L

## Air transport (ICAO-IATA / DGR)

## HYDROCHLORIC ACID

UN number	1789		
Packing group	II		
UN proper shipping name	Hydrochloric acid		
Environmental hazard	Not Applicable		
Transport hazard class(es)	ICAO/IATA Class	8	
	ICAO / IATA Subrisk	Not Applicable	
	ERG Code	8L	
Special precautions for user	Special provisions	A3A803	
	Cargo Only Packing Instructions	855	
	Cargo Only Maximum Qty / Pack	30 L	
	Passenger and Cargo Packing Instructions	851	
	Passenger and Cargo Maximum Qty / Pack	1 L	
	Passenger and Cargo Limited Quantity Packing Instructions	Y840	
	Passenger and Cargo Limited Maximum Qty / Pack	0.5 L	

### Sea transport (IMDG-Code / GGVSee)

UN number	1789		
Packing group	II		
UN proper shipping name	HYDROCHLORIC ACID		
Environmental hazard	Not Applicable		
Transport hazard class(es)	IMDG Class	8	
	IMDG Subrisk	Not Applicable	
Special precautions for user	EMS Number	F-A, S-B	
	Special provisions	Not Applicable	
	Limited Quantities	1 L	

### Transport in bulk according to Annex II of MARPOL and the IBC code

Source	Product name	Pollution Category	Ship Type
IMO MARPOL (Annex II) - List of Noxious Liquid Substances Carried in Bulk	Hydrochloric acid	Z	3

## SECTION 15 REGULATORY INFORMATION

### Safety, health and environmental regulations / legislation specific for the substance or mixture

#### HYDROGEN CHLORIDE(7647-01-0.) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards	International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs
Australia Hazardous Substances Information System - Consolidated Lists	International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List
Australia Inventory of Chemical Substances (AICS)	Passenger and Cargo Aircraft

#### WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water; hydrogen chloride)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## HYDROCHLORIC ACID

### Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:  
[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

### Definitions and abbreviations

PC – TWA: Permissible Concentration-Time Weighted Average  
PC – STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer  
ACGIH: American Conference of Governmental Industrial Hygienists  
STEL: Short Term Exposure Limit  
TEEL: Temporary Emergency Exposure Limit.  
IDLH: Immediately Dangerous to Life or Health Concentrations  
OSF: Odour Safety Factor  
NOAEL :No Observed Adverse Effect Level  
LOAEL: Lowest Observed Adverse Effect Level  
TLV: Threshold Limit Value  
LOD: Limit Of Detection  
OTV: Odour Threshold Value  
BCF: BioConcentration Factors  
BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.



## Wildcat Kuriverter IK-110

### Wildcat

Chemwatch: 5215-25

Version No: 3.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 4

Issue Date: 06/30/2016

Print Date: 09/28/2016

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Wildcat Kuriverter IK-110
Synonyms	Not Available
Proper shipping name	SODIUM HYDROXIDE SOLUTION
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Use according to manufacturer's directions. Reverse Osmosis Chemical.
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### Details of the supplier of the safety data sheet

Registered company name	Wildcat
Address	15 Magnesium Street Narangba QLD 4504 Australia
Telephone	+61 7 3204 8577
Fax	+61 7 3204 8588
Website	Not Available
Email	Wildcat@imdexlimited.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	+61 2 9186 1132
Other emergency telephone numbers	Not Available

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	1800 039 008	+612 9186 1132

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION


### Classification of the substance or mixture



Wildcat Kuriverter IK-110

<b>Poisons Schedule</b>	S6
<b>Classification</b> <sup>[1]</sup>	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1A, Serious Eye Damage Category 1
<b>Legend:</b>	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

Label elements

<b>GHS label elements</b>	
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<b>SIGNAL WORD</b>	<b>DANGER</b>
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Hazard statement(s)

<b>H290</b>	May be corrosive to metals.
<b>H314</b>	Causes severe skin burns and eye damage.
<b>H318</b>	Causes serious eye damage.

Precautionary statement(s) Prevention

<b>P260</b>	Do not breathe dust/fume/gas/mist/vapours/spray.
<b>P280</b>	Wear protective gloves/protective clothing/eye protection/face protection.
<b>P234</b>	Keep only in original container.

Precautionary statement(s) Response

<b>P301+P330+P331</b>	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
<b>P303+P361+P353</b>	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
<b>P305+P351+P338</b>	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Precautionary statement(s) Storage

<b>P405</b>	Store locked up.
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Precautionary statement(s) Disposal

<b>P501</b>	Dispose of contents/container in accordance with local regulations.
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SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
1310-73-2	10-30	<u>sodium hydroxide</u>
	balance	Ingredients determined not to be hazardous

SECTION 4 FIRST AID MEASURES

Description of first aid measures

<b>Eye Contact</b>	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>▶ Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>▶ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>▶ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>▶ Transport to hospital or doctor without delay.</li> <li>▶ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
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## Wildcat Kuriverter IK-110

<b>Skin Contact</b>	<p>If skin or hair contact occurs:</p> <ul style="list-style-type: none"> <li>▶ Immediately flush body and clothes with large amounts of water, using safety shower if available.</li> <li>▶ Quickly remove all contaminated clothing, including footwear.</li> <li>▶ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.</li> <li>▶ Transport to hospital, or doctor.</li> </ul>
<b>Inhalation</b>	<ul style="list-style-type: none"> <li>▶ If fumes or combustion products are inhaled remove from contaminated area.</li> <li>▶ Lay patient down. Keep warm and rested.</li> <li>▶ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>▶ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>▶ Transport to hospital, or doctor, without delay.</li> <li>▶ Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.</li> <li>▶ Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).</li> <li>▶ As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.</li> <li>▶ Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.</li> </ul> <p><b>This must definitely be left to a doctor or person authorised by him/her.</b> (ICSC13719)</p>
<b>Ingestion</b>	<ul style="list-style-type: none"> <li>▶ For advice, contact a Poisons Information Centre or a doctor at once.</li> <li>▶ Urgent hospital treatment is likely to be needed.</li> <li>▶ <b>If swallowed do NOT induce vomiting.</b></li> <li>▶ If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> <li>▶ Observe the patient carefully.</li> <li>▶ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.</li> <li>▶ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink.</li> <li>▶ Transport to hospital or doctor without delay.</li> </ul>

**Indication of any immediate medical attention and special treatment needed**

For acute or short-term repeated exposures to highly alkaline materials:

- ▶ Respiratory stress is uncommon but present occasionally because of soft tissue edema.
- ▶ Unless endotracheal intubation can be accomplished under direct vision, cricothyroidotomy or tracheotomy may be necessary.
- ▶ Oxygen is given as indicated.
- ▶ The presence of shock suggests perforation and mandates an intravenous line and fluid administration.
- ▶ Damage due to alkaline corrosives occurs by liquefaction necrosis whereby the saponification of fats and solubilisation of proteins allow deep penetration into the tissue.

Alkalis continue to cause damage after exposure.

**INGESTION:**

- ▶ Milk and water are the preferred diluents

No more than 2 glasses of water should be given to an adult.

- ▶ Neutralising agents should never be given since exothermic heat reaction may compound injury.

\* Catharsis and emesis are absolutely contra-indicated.

\* Activated charcoal does not absorb alkali.

\* Gastric lavage should not be used.

Supportive care involves the following:

- ▶ Withhold oral feedings initially.
- ▶ If endoscopy confirms transmucosal injury start steroids only within the first 48 hours.
- ▶ Carefully evaluate the amount of tissue necrosis before assessing the need for surgical intervention.
- ▶ Patients should be instructed to seek medical attention whenever they develop difficulty in swallowing (dysphagia).

**SKIN AND EYE:**

- ▶ Injury should be irrigated for 20-30 minutes.

Eye injuries require saline. [Ellenhorn & Barceloux: Medical Toxicology]

**SECTION 5 FIREFIGHTING MEASURES****Extinguishing media**

- ▶ Water spray or fog.
- ▶ Foam.
- ▶ Dry chemical powder.

**Special hazards arising from the substrate or mixture**

<b>Fire Incompatibility</b>	None known.
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**Advice for firefighters**

<b>Fire Fighting</b>	▶ Alert Fire Brigade and tell them location and nature of hazard.
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## Wildcat Kuriverter IK-110

	<ul style="list-style-type: none"> <li>▶ Wear full body protective clothing with breathing apparatus.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water course.</li> </ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>▶ Non combustible.</li> <li>▶ Not considered a significant fire risk, however containers may burn.</li> </ul> <p>Decomposition may produce toxic fumes of; metal oxides May emit corrosive fumes.</p>
<b>HAZCHEM</b>	2R

## SECTION 6 ACCIDENTAL RELEASE MEASURES

## Personal precautions, protective equipment and emergency procedures

See section 8

## Environmental precautions

See section 12

## Methods and material for containment and cleaning up

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>▶ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.</li> <li>▶ Check regularly for spills and leaks.</li> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid breathing vapours and contact with skin and eyes.</li> <li>▶ Control personal contact with the substance, by using protective equipment.</li> </ul>
<b>Major Spills</b>	<ul style="list-style-type: none"> <li>▶ Clear area of personnel and move upwind.</li> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear full body protective clothing with breathing apparatus.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

## Precautions for safe handling

<b>Safe handling</b>	<ul style="list-style-type: none"> <li>▶ <b>DO NOT allow clothing wet with material to stay in contact with skin</b></li> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ <b>DO NOT store near acids, or oxidising agents</b></li> <li>▶ No smoking, naked lights, heat or ignition sources.</li> </ul>

## Conditions for safe storage, including any incompatibilities

<b>Suitable container</b>	<ul style="list-style-type: none"> <li>▶ Lined metal can, lined metal pail/ can.</li> <li>▶ Plastic pail.</li> <li>▶ Polyliner drum.</li> </ul> <p>For low viscosity materials</p> <ul style="list-style-type: none"> <li>▶ Drums and jerricans must be of the non-removable head type.</li> <li>▶ Where a can is to be used as an inner package, the can must have a screwed enclosure.</li> </ul> <p>For materials with a viscosity of at least 2680 cSt.</p>
<b>Storage incompatibility</b>	<p>Sodium hydroxide/ potassium hydroxide:</p> <ul style="list-style-type: none"> <li>▶ reacts with water evolving heat and corrosive fumes</li> <li>▶ reacts violently with acids, trans-acetylene dichloride, aminotetrazole, p-bis(1,3-dibromoethyl), benzene, bromoform, halogenated compounds, nitrogen-containing compounds, organic halogens, chlorine dioxide ((explodes), chloroform, cresols, cyclopentadiene, 4-chloro-2-methylphenol, cis-dichloroethylene, 2,2-dichloro-3,3-dimethylbutane, ethylene chlorohydrin, germanium, iodine pentafluoride, maleic anhydride, p-nitrotoluene, nitrogen trichloride, o-nitrophenol, phosphonium iodide, potassium peroxodisulfate, propylene oxide, 1,2,4,5-tetrachlorobenzene (highly toxic substance is forme), 2,2,3,3-tetrafluoro-1-propanol, tetrahydrofuran, thorium dicarbide, trichloroethanol, 2,4,6-trinitrotoluene, vinyl acetate</li> <li>▶ reacts with fluorine, nitroalkanes, (forming explosive compounds)</li> <li>▶ incompatible with acetic acid, acetaldehyde, acetic anhydride, acrolein, acrylonitrile, allyl chloride, organic anhydride, acrylates, alcohols, aldehydes, alkylene oxides, substituted allyls, ammonium chloroplatinate, benzanthrone, bromine, benzene-1,4-diol, carbon dioxide, cellulose nitrate, chlorine trifluoride, 4-chlorobutyronitrile, chlorohydrin, chloronitrotoluenes, chlorosulfonic acid, cinnamaldehyde, caprolactam solution, chlorocresols, 1,2-dichloroethylene, epichlorohydrin, ethylene cyanohydrin, formaldehyde (forms formic acid and flammable hydrogen gas), glycols, glyoxal, hexachloroplatinate, hydrogen sulfide, hydroquinone, iron-silicon, isocyanates, ketones, methyl azide, 4-methyl-2-nitrophenol, mineral acids (forming corresponding salt), nitrobenzene, N-nitrosohydroxylamine, nitrates pentol, phenols, phosphorus, phosphorus</li> </ul>

## Wildcat Kuriverter IK-110

- ▶ pentaoxide, beta-propiolactone, sodium, sulfur dioxide, tetrahydroborate, 1,1,1,2-tetrachloroethane, 2,2,2-trichloroethanol, trichloronitromethane, zirconium
- ▶ ignites on contact with cinnamaldehyde or zinc and reacts explosively with a mixture of chloroform and methane
- ▶ forms heat-, friction-, and/ or shock-sensitive- explosive salts with nitro-compounds, cyanogen azide, 3-ethyl-4-hydroxy-1,2,5-oxadiazole, 3-methyl-2-penten-4-yn-1-ol, N,N'-bis(2,2,2-trinitroethyl)urea, trichloroethylene (forms dichloroacetylene)
- ▶ increase the explosive sensitivity of nitromethane
- ▶ attacks some plastics, rubber, coatings and metals: aluminium, tin, zinc, etc, and their alloys, producing flammable hydrogen gas
- ▶ In presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas.
- ▶ Avoid strong acids, acid chlorides, acid anhydrides and chloroformates.
- ▶ Avoid contact with copper, aluminium and their alloys.

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

### Control parameters

#### OCCUPATIONAL EXPOSURE LIMITS (OEL)

#### INGREDIENT DATA


Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sodium hydroxide	Sodium hydroxide	Not Available	Not Available	2 mg/m3	Not Available

#### EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sodium hydroxide	Sodium hydroxide	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sodium hydroxide	250 mg/m3	10 mg/m3

### Exposure controls

<b>Appropriate engineering controls</b>	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p>
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>▶ Safety glasses with unperforated side shields may be used where continuous eye protection is desirable, as in laboratories; spectacles are not sufficient where complete eye protection is needed such as when handling bulk-quantities, where there is a danger of splashing, or if the material may be under pressure.</li> <li>▶ Chemical goggles whenever there is a danger of the material coming in contact with the eyes; goggles must be properly fitted.</li> <li>▶ Full face shield (20 cm, 8 in minimum) may be required for supplementary but never for primary protection of eyes; these afford face protection.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<ul style="list-style-type: none"> <li>▶ Elbow length PVC gloves</li> </ul> <p>Wear safety footwear.</p> <ul style="list-style-type: none"> <li>▶ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ PVC Apron.</li> <li>▶ PVC protective suit may be required if exposure severe.</li> </ul>
<b>Thermal hazards</b>	Not Available

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

### Information on basic physical and chemical properties

<b>Appearance</b>	Light yellow to brown liquid with a mild odour; mixes with water.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.20-1.40
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Applicable
<b>pH (as supplied)</b>	>13	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	Not Available	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	Not Available	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Applicable	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	Not Available
<b>Vapour pressure (kPa)</b>	Not Available	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	Not Available
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Unstable in the presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

### Information on toxicological effects

<b>Inhaled</b>	<p>The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage.</p> <p>Inhaling corrosive bases may irritate the respiratory tract. Symptoms include cough, choking, pain and damage to the mucous membrane.</p> <p>Sudden inhalation of sodium hydroxide dust may produce fatal outcome such as spasm, inflammation of the throat and airway, burns, severe lung inflammation and fluid accumulated in the lungs. These manifest as coughing, wheezing, shortness of breath, headache, nausea and vomiting.</p>
<b>Ingestion</b>	<p>Ingestion of alkaline corrosives may produce burns around the mouth, ulcerations and swellings of the mucous membranes, profuse saliva production, with an inability to speak or swallow. Both the oesophagus and stomach may experience burning pain; vomiting and diarrhoea may follow.</p> <p>Accidental ingestion of the material may be damaging to the health of the individual.</p> <p>Ingestion of sodium hydroxide may result in severe pain, burns to the mouth, throat, stomach, nausea and vomiting, swelling of the throat and subsequent perforation of the gastro-intestinal tract and suffocation but a 1% solution (pH 13.4) of sodium</p>

## Wildcat Kuriverter IK-110

	hydroxide in water failed to cause any damage of the stomach or gullet in rabbits.
<b>Skin Contact</b>	<p>The material can produce severe chemical burns following direct contact with the skin.</p> <p>Sodium hydroxide causes burns which may take time to manifest and cause pain, thus care should be taken to avoid contamination of gloves and boots.</p> <p>A 5% aqueous solution of it produces tissue death on rabbit skin while 1% solution caused no effect on irrigated rabbit eye.</p> <p>Open cuts, abraded or irritated skin should not be exposed to this material</p> <p>Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.</p> <p>Skin contact with alkaline corrosives may produce severe pain and burns; brownish stains may develop. The corroded area may be soft, gelatinous and necrotic; tissue destruction may be deep.</p>
<b>Eye</b>	<p>If applied to the eyes, this material causes severe eye damage.</p> <p>Direct eye contact with corrosive bases can cause pain and burns. There may be swelling, epithelium destruction, clouding of the cornea and inflammation of the iris. Mild cases often resolve; severe cases can be prolonged with complications such as persistent swelling, scarring, permanent cloudiness, bulging of the eye, cataracts, eyelids glued to the eyeball and blindness.</p>
<b>Chronic</b>	<p>Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue.</p> <p>Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.</p> <p>Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.</p>

<b>Wildcat Kuriverter IK-110</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Not Available	Not Available
<b>sodium hydroxide</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (rabbit) LD50: 325 mg/kg <sup>[1]</sup>	Eye (rabbit): 0.05 mg/24h SEVERE
		Eye (rabbit): 1 mg/24h SEVERE
		Eye (rabbit): 1 mg/30s rinsed-SEVERE
		Skin (rabbit): 500 mg/24h SEVERE
<b>Legend:</b>	<p>1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS.</p> <p>Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances</p>	

<b>SODIUM HYDROXIDE</b>	<p>The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.</p> <p>The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.</p> <p>Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant.</p>
-------------------------	--

<b>Acute Toxicity</b>	⊘	<b>Carcinogenicity</b>	⊘
<b>Skin Irritation/Corrosion</b>	✓	<b>Reproductivity</b>	⊘
<b>Serious Eye Damage/Irritation</b>	✓	<b>STOT - Single Exposure</b>	⊘
<b>Respiratory or Skin sensitisation</b>	⊘	<b>STOT - Repeated Exposure</b>	⊘
<b>Mutagenicity</b>	⊘	<b>Aspiration Hazard</b>	⊘

**Legend:** ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊘ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
sodium hydroxide	LC50	96	Fish	4.16158mg/L	3

## Wildcat Kuriverter IK-110

sodium hydroxide	EC50	48	Crustacea	40.4mg/L	2
sodium hydroxide	EC50	96	Algae or other aquatic plants	1034.10043mg/L	3
sodium hydroxide	EC50	384	Crustacea	27901.643mg/L	3
sodium hydroxide	NOEC	96	Fish	56mg/L	4

**Legend:**

Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

For Metal:

Atmospheric Fate - Metal-containing inorganic substances generally have negligible vapour pressure and are not expected to partition to air.

Environmental Fate: Environmental processes, such as oxidation, the presence of acids or bases and microbiological processes, may transform insoluble metals to more soluble ionic forms. Environmental processes may enhance bioavailability and may also be important in changing solubilities.

Prevent, by any means available, spillage from entering drains or water courses.

**DO NOT** discharge into sewer or waterways.

**Persistence and degradability**

Ingredient	Persistence: Water/Soil	Persistence: Air
sodium hydroxide	LOW	LOW

**Bioaccumulative potential**

Ingredient	Bioaccumulation
sodium hydroxide	LOW (LogKOW = -3.8796)


**Mobility in soil**

Ingredient	Mobility
sodium hydroxide	LOW (KOC = 14.3)

**SECTION 13 DISPOSAL CONSIDERATIONS****Waste treatment methods**

<b>Product / Packaging disposal</b>	<p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <ul style="list-style-type: none"> <li>▶ <b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Treat and neutralise at an approved treatment plant.</li> </ul>
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**SECTION 14 TRANSPORT INFORMATION****Labels Required**

	
<b>Marine Pollutant</b>	NO
<b>HAZCHEM</b>	2R

**Land transport (ADG)**

<b>UN number</b>	1824				
<b>UN proper shipping name</b>	SODIUM HYDROXIDE SOLUTION				
<b>Transport hazard class(es)</b>	<table> <tr> <td>Class</td><td>8</td></tr> <tr> <td>Subrisk</td><td>Not Applicable</td></tr> </table>	Class	8	Subrisk	Not Applicable
Class	8				
Subrisk	Not Applicable				

<b>Packing group</b>	II	
<b>Environmental hazard</b>	Not Applicable	
<b>Special precautions for user</b>	Special provisions	Not Applicable
	Limited quantity	1 L

**Air transport (ICAO-IATA / DGR)**

<b>UN number</b>	1824	
<b>UN proper shipping name</b>	Sodium hydroxide solution	
<b>Transport hazard class(es)</b>	ICAO/IATA Class	8
	ICAO / IATA Subrisk	Not Applicable
	ERG Code	8L
<b>Packing group</b>	II	
<b>Environmental hazard</b>	Not Applicable	
<b>Special precautions for user</b>	Special provisions	A3A803
	Cargo Only Packing Instructions	855
	Cargo Only Maximum Qty / Pack	30 L
	Passenger and Cargo Packing Instructions	851
	Passenger and Cargo Maximum Qty / Pack	1 L
	Passenger and Cargo Limited Quantity Packing Instructions	Y840
	Passenger and Cargo Limited Maximum Qty / Pack	0.5 L

**Sea transport (IMDG-Code / GGVSee)**

<b>UN number</b>	1824	
<b>UN proper shipping name</b>	SODIUM HYDROXIDE SOLUTION	
<b>Transport hazard class(es)</b>	IMDG Class	8
	IMDG Subrisk	Not Applicable
<b>Packing group</b>	II	
<b>Environmental hazard</b>	Not Applicable	
<b>Special precautions for user</b>	EMS Number	F-A, S-B
	Special provisions	Not Applicable
	Limited Quantities	1 L

**Transport in bulk according to Annex II of MARPOL and the IBC code**

Not Applicable

**SECTION 15 REGULATORY INFORMATION****Safety, health and environmental regulations / legislation specific for the substance or mixture****SODIUM HYDROXIDE(1310-73-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Exposure Standards

Australia Inventory of Chemical Substances (AICS)

Australia Hazardous Substances Information System - Consolidated Lists

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (sodium hydroxide)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y



Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	<i>Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)</i>

## SECTION 16 OTHER INFORMATION

### Other information

#### Ingredients with multiple cas numbers

Name	CAS No
sodium hydroxide	1310-73-2, 12200-64-5

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios.

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TEL (+61 3) 9572 4700.

# MATERIAL SAFETY DATA SHEET

**Product : OSMOCIDE 20%**

**Classified as a hazardous according to  
criteria of NOHSC/ASCC**

**Classified as a Dangerous Good  
according to the Australian Dangerous  
Goods Code**

**Emergency Response No:1800 039 008**

## 1 IDENTIFICATION

### IDENTIFICATION

Product Code: P00227; P00350; P01092  
 Product Name: OSMOCIDE 20%  
 Product use: Microbiocide for Water systems  
 Packaging Size: 15 Kg Drum, 200 kg Plastic Drums; 400 Kg IBC

### COMPANY DETAILS

Company: OSMOFLO Pty Ltd  
 ACN Number: 050 952 175  
 Address: 382 Diment Road  
 BURTON SA 5110  
 Telephone Number: (08) 8282 9700  
 Facsimile Number: (08) 8280 3015  
 Emergency Telephone Number: 1800 039 008

Other Information: This information summarises our best knowledge on the health and safety hazard information of the product and how to safely handle and use the product in the workplace. Each user should read this MSDS and consider the information in the context of how the product will be handled and used in the workplace including in conjunction with other products.

## 2 HAZARD IDENTIFICATION

**Hazard Classification: Hazardous according to the criteria of NOHSC Australia.**

**C, Corrosive.**



**T, Toxic.**



### Risk Phrases:

**R23/24/25** Toxic by inhalation, in contact with skin and if swallowed.  
**R34** Causes burns.  
**R36/37/38** Irritating to eyes, respiratory system and skin.  
**R41** Risk of serious eye damage.  
**R42/43** May cause sensitization by inhalation and skin contact.  
**R51** Toxic to aquatic organisms.  
**R53** May cause long term effects in the aquatic environment.

### Safety Phrases:

**S3/9/14** Keep in a cool, well ventilated place away from strong alkalis and oxidizing agents.  
**S24/25** Avoid contact with skin and eyes.  
**S29** Do Not empty into drains.  
**S36/37/39** Wear suitable protective clothing, gloves and eye/face protection.  
**S45** In case of accident or if you feel unwell, seek medical advice immediately (show label where possible)  
**S46** If swallowed, seek medical advice immediately and show this container or label.

**Poisons Schedule: S6.**

## 3 COMPOSITION

### Ingredients

Chemical Entity	CAS Number	Proportion	Risk Phrases
2,2 Di Bromo 3 Nitrilopropionamide		10222-01-2	20%
Poly Ethylene Glycol	25322-68-3	30-60%	
Water	7732-18-5	10-30%	

#### 4 FIRST AID MEASURES

**Eyes:** Any contamination of eyes should be washed away with copious quantities of clean water. Eyelids to be held open. Seek urgent medical advice. Irritating to eyes. Will cause pain and visual problems.

Particularly, if left untreated, may cause permanent damage to the eye.

**Skin:** Any contamination of the skin should be immediately washed away with copious quantities of water. Remove any contaminated clothing (including footwear). If irritation occurs, seek medical advice. DO NOT reuse clothing. Discard clothing.

**Inhalation:** Remove victim to fresh air. Remove any contaminated clothing. Do not use mouth-to-mouth method. Induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Seek immediate medical attention. May Cause chemical burns to the respiratory tract.

**Ingestion:** Do Not induce vomiting. If victim conscious give 2-4 cups of milk or water to dilute stomach contents. Never give anything orally to an unconscious person. Wash mouth with water and seek medical advice urgently. May Cause gastrointestinal tract burns

#### 5 FIRE FIGHTING MEASURES

**Suitable Extinguishing Media:** CO<sub>2</sub>, Foam, Dry Powder, Water Fog.

**Hazards from combustion:** When heated to decomposition (above 70 Deg C), may release poisonous and corrosive fumes of bromine gas, hydrogen bromide, and nitrogen oxides.

**Special Fire Fighting Procedures:** Fire fighters should wear self-contained breathing apparatus and protective fire-fighting clothing. Keep away from drains and stormwater.

**Hazchem Code:** •2Z

#### 6 ACCIDENTAL RELEASE MEASURES

**Emergency Procedures:** Keep non-essential personnel away from the spill. Isolate hazard area and restrict entry. Stay upwind. Wear appropriate eye, skin and respiratory protection as outlined in this MSDS. Keep spills and cleaning runoff out of municipal sewers and streams, lakes or ponds.

**Clean Up Procedures:** Contain spills immediately with sand or vermiculite and place in closed container for disposal. Decontaminate spill area with a solution of 10% sodium bicarbonate in water. Absorb decontaminated solution with sand or vermiculite. Sweep up and place in a suitable container and hold for waste disposal. Ventilate area and wash spill site after material pickup is complete.

**LARGE SPILLS:** Notify Emergency Services (Police/ Fire Brigade/ Ambulance). Inform them of the exact location and quantity of the release. Be prepared to answer any other questions they may have. Block access to drains, particularly storm water drains. Trained personnel should wear personal protective equipment as indicated in this MSDS.

#### 7 HANDLING AND STORAGE

**Precautions for safe handling:** Keep containers tightly closed. Avoid bodily contact. Wear correct PPE. Handle in accordance with good industrial hygiene practice and any legal requirements.

**Conditions for safe storage:** Store in a dry, cool, well-ventilated and shaded area away from heat source and strong alkalis and oxidizing agents. Check containers for leaks regularly. Store in original packages as approved by manufacturer. Suitable materials for product handling are glass, PVC, polypropylene, polyethylene and glass reinforced plastic. Do NOT store in steel, aluminium or other metals.

#### 8 EXPOSURE CONTROL / PERSONAL PROTECTION

**National exposure standards:** TLV-TWA Not established.

**Biological limit values:** BEI's Not established.

**Engineering controls:** Local exhaust or natural ventilation should be adequate under normal use conditions. Normal safety showers and eyewash facilities should be nearby.

**Personal protective equipment:**

**RESPIRATORY PROTECTION:** A respiratory protection program meeting OSHA 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Not required under normal operating conditions. Where misting may occur, wear a MSHA/NIOSH approved (or equivalent) full-face, dust/mist air-purifying respirator. Air-purifying respirators should be equipped with MSHA/NIOSH approved (or equivalent) filters for protection against dusts and mists.

**EYE PROTECTION:** Use chemical splash goggles or face shield with safety glasses (ANSI Z87.1 or approved equivalent). Eye protection worn must be compatible with respiratory protection system employed.

**HAND PROTECTION:** Material is a possible skin sensitizer. Use rubber gloves to protect against permeation. Gloves should be removed or replaced immediately if there is any indication of degradation or chemical breakthrough. Rinse and remove gloves immediately after use. Wash hands with soap and water.

**OTHER PROTECTION:** Use chemically resistant apron or other impervious clothing to avoid prolonged or repeated skin contact. If entering spaces where the airborne concentration of a contaminant is unknown then the use of a Selfcontained breathing apparatus (SCBA) with positive pressure air supply complying with AS/NZS 1715 / 1716, or any other acceptable International Standard is recommended. In these circumstances, the use of a fully encapsulating gas-tight suit is also recommended.

## 9 PHYSICAL AND CHEMICAL PROPERTIES

<b>Appearance:</b>	Clear yellow solution.
<b>Odour:</b>	No Odour
<b>pH (25°C):</b>	3.0 – 5.50.
<b>Vapour Density:</b>	No data
<b>Boiling Point/Range:</b>	No data.
<b>Freezing/Melting Point:</b>	No data.
<b>Solubility in Water:</b>	Soluble in water.
<b>Specific Gravity @25°C:</b>	1.22 – 1.26.
<b>Flash Point:</b>	Not applicable.

## 10 STABILITY AND REACTIVITY

**Chemical Stability:** Stable under normal conditions of use.

**Conditions to avoid:** Heat and incompatibilities.

**Incompatible materials:** Corrosive to aluminium, tin, zinc in the presence of moisture. Reacts with ammonium Salts to evolve ammonia gas. Can react violently if in contact with alkalis acids and Chlorinated hydrocarbons. HIGHLY reactive with aluminium, zinc, lead, tin, and alloys of these metals producing flammable hydrogen gas.

**Hazardous decomposition products:** Poisonous and corrosive fumes of bromine gas, hydrogen bromide, and nitrogen oxides.

**Hazardous reactions:** Polymerization will not occur.

## 11 TOXICOLOGICAL INFORMATION

### Acute and chronic health effects:

ORAL LD50	308 mg/kg (rat)
INHALATION LD50	0.32 mg/1/4hr (rat)
EYE IRRITATION	Corrosive (rabbit)
DERMAL IRRITATION	Moderate irritant (rabbit)
DERMAL SENSITIZATION	Weak sensitizer (guinea pig)
SUB-CHRONIC TOXICI	NOEL: 5 mg/kg/day (13 weeks oral, rat)

**Possible routes of exposure:** Eyes, skin, inhalation, ingestion.

**Range of effects following exposure:** May cause severe irritation to eyes, skin, respiratory and digestive tracts.

### Dose, concentration or conditions of exposure likely to cause injury:

ORAL LD50	308 mg/kg (rat)
INHALATION LD50	0.32 mg/1/4hr (rat)
EYE IRRITATION	Corrosive (rabbit)
DERMAL IRRITATION	Moderate irritant (rabbit)
DERMAL SENSITIZATION	Weak sensitizer (guinea pig)
SUB-CHRONIC TOXICITY	NOEL: 5 mg/kg/day (13 weeks oral, rat)

**Delayed effects:** No data.

**Relevant negative data:** Not a likely carcinogen

## 12 ECOLOGICAL INFORMATION

### Ecotoxicity:

#### AQUATIC TOXICITY

Rainbow trout (96-hour LC50)	2.3 mg/l
Sheepshead minnow (96-hour LC50)	3.4 mg/l

Bluegill sunfish (96-hour LC50)	2.3 mg/l
Mysid shrimp (96-hour LC50)	0.72 mg/l
Eastern oyster (96-hour LC50)	0.37 mg/l
Daphnia magna (48-hour EC50)	0.86 mg/l

#### AVIAN TOXICITY

Bobwhite quail (acute oral LD50)	354 mg/kg
Mallard duck (dietary LC50)	5620 ppm
Bobwhite quail (dietary LC50)	>5620 ppm

The environmental toxicity data mentioned are from studies conducted on active ingredient 2,2-Dibromo-3-nitrilopropionamide.

**Persistence and degradability:** No data.

**Mobility:** Avoid contaminating waterways.

#### 13 DISPOSAL CONSIDERATIONS

**Disposal Methods:** Dispose of in accordance with local, state and federal regulations utilizing a licensed contactor.

#### 14 TRANSPORT INFORMATION

##### Land Transport

<b>UN Number</b>	2922
<b>Shipping Name</b>	Corrosive Liquid, Toxic, N.O.S.
<b>Dangerous Goods Class</b>	8 Corrosive Substance
<b>Subsidiary Risk</b>	6.1 Toxic
<b>Pack Group</b>	III
<b>Precaution for User</b>	CORROSIVE and TOXIC
<b>Hazchem Code</b>	2Z



##### Sea Transport

<b>UN Number</b>	2922
<b>Shipping Name</b>	Corrosive Liquid, Toxic, N.O.S.
<b>Dangerous Goods Class</b>	8 Corrosive Substance
<b>Subsidiary Risk</b>	6.1 Toxic
<b>Pack Group</b>	III
<b>Precaution for User</b>	CORROSIVE and TOXIC
<b>Hazchem Code</b>	2Z

#### 15 REGULATORY INFORMATION

<b>Poisons Schedule</b>	6
<b>EPG</b>	37
<b>AICS Name</b>	2,2 Di Bromo 3 Nitrilopropionamide

#### 16 OTHER INFORMATION

**Literature References** No data available.

**Sources for Data** No data available.

##### Legend to Abbreviations and Acronyms

<	less than
>	greater than
<b>AICS</b>	Australian Inventory of Chemical Substances
<b>CAS</b>	Chemical Abstracts Service (Registry Number)
<b>cm<sup>2</sup></b>	square centimetres
<b>CO<sub>2</sub></b>	Carbon Dioxide
<b>COD</b>	Chemical Oxygen Demand
<b>deg C (°C)</b>	degrees Celsius
<b>ERMA</b>	Environmental Risk Management Authority
<b>G</b>	gram
<b>g/cm<sup>3</sup></b>	grams per cubic centimetre
<b>g/l</b>	grams per litre

<b>HSNO</b>	Hazardous Substance and New Organism
<b>IDLH</b>	Immediately Dangerous to Life and Health
<b>Immiscible</b>	liquids are insoluble in each other
<b>Kg</b>	kilogram
<b>kg/m<sup>3</sup></b>	kilograms per cubic metre
<b>LC50</b>	LC stands for lethal concentration. LC50 is the concentration of a material in air which causes the death of 50% (one half) of a group of test animals. The material is inhaled over a set period of time, usually 1 or 4 hours.

<b>LD50</b>	LD stands for Lethal Dose. LD50 is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals
<b>Ltr</b>	Litre
<b>m<sup>3</sup></b>	cubic metre
<b>mbar</b>	millibar
<b>mg</b>	milligram
<b>mg/24H</b>	milligrams per 24 hours
<b>mg/kg</b>	milligrams per kilogram
<b>mg/m<sup>3</sup></b>	milligrams per cubic metre
<b>Misc</b>	miscible
<b>Miscible</b>	liquids form one homogeneous liquid phase regardless of the amount of either component present
<b>mm</b>	millimetre
<b>mPa.s</b>	milli Pascal per second
<b>N/A</b>	Not Applicable

<b>NOHSC</b>	National Occupational Health and Safety Commission
<b>OECD</b>	Organization for Economic Co-operation and Development
<b>PEL</b>	Permissible Exposure Limit
<b>ppb</b>	parts per billion
<b>ppm</b>	parts per million
<b>ppm/2h</b>	parts per million per 2 hours
<b>ppm/6h</b>	parts per million per 6 hours
<b>RCP</b>	Reciprocal Calculation Procedure
<b>STEL</b>	Short Term Exposure Limit
<b>TLV</b>	Threshold Limit Value
<b>tne</b>	tonne
<b>TWA</b>	Time Weighted Average
<b>ug/24H</b>	micrograms per 24 hours
<b>UN</b>	United Nations (number)
<b>Wt</b>	weight



Quality  
ISO 9001



Health & Safety  
AS 4801

*OSMOFLO Pty Ltd*  
382 Diment Road  
BURTON SA 5110

Telephone: (08) 8282 9700  
Facsimile: (08) 8280 3015  
e-Mail: [mail@osmoflo.com.au](mailto:mail@osmoflo.com.au)

Veolia Water Solutions & Technologies Australia  
72 – 74 Ordish Road  
Dandenong South VIC 3175  
Ph: +61 3 9554 5048  
Fax: +61 3 9554 5090  
www.veoliawaterst.com.au

# Material Safety Data Sheet

# HYDREX 9209

## Water Treatment Chemical

### SECTION 1 - IDENTIFICATION OF THE MATERIAL AND SUPPLIER

**Product (material) name:** Hydrex 9209  
**Other names:** None allocated  
**Recommended use:** Scale inhibitor for thermal desalination.  
**Supplier name:** Veolia Water Solutions & Technologies Australia P/L  
**Address:** 72 – 74 Ordish Rd., Dandenong South, Vic 3175, Australia  
**Telephone number:** (03) 9554 5048  
**Australian emergency contact number:** (03) 9554 5048 (Office hours)

### SECTION 2 - HAZARDS IDENTIFICATION

**Hazard Classification:** Not classified as hazardous according to the criteria of NOHSC.  
**Risk Phrase(s):** None Allocated  
**Safety Phrase(s):** None allocated

### SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Identity	Common Name	CAS No.	Proportion of Ingredients
Polyacrylate		9003-04-7	30 – 60%
Homopolymer of maleic acid		26009-09-2	10 – 30%
Sodium Hydroxide		1310-73-2	10 – 30%
Water		7732-18-5	Balance

### SECTION 4 - FIRST AID MEASURES

#### Description of Necessary First Aid Measures:

**If in eyes:** Immediately flush eyes with water for 15 minutes. Obtain medical attention.  
**If on skin:** Immediately wash with soap and water for 15 minutes. Obtain medical advice if there are persistent symptoms.  
**If inhaled:** Remove to fresh air, loosen tight clothing and rest until recovered. If symptoms persist, obtain medical advice.  
**If swallowed:** Immediately rinse mouth with water, then drink plenty of water. Do not induce vomiting. Obtain medical attention.

#### Medical Attention and Special Treatment:

Treat symptomatically.

#### ADDITIONAL INFORMATION

#### Aggravated Medical Conditions Caused by Exposure:

No data



Veolia Water Solutions & Technologies Australia  
72 – 74 Ordish Road  
Dandenong South VIC 3175  
Ph: +61 3 9554 5048  
Fax: +61 3 9554 5090  
www.veoliawaterst.com.au

# Material Safety Data Sheet

# HYDREX 9209

## Water Treatment Chemical

### SECTION 5 - FIRE FIGHTING MEASURES

**Suitable Extinguishing Media:** Not flammable. Use media appropriate to the surrounding fire.

**Hazards From Combustion Products:** Thermal decomposition may generate carbon monoxide and carbon dioxide .

**Precautions For Fire Fighters and Special Protective Equipment:**

Wear self-contained breathing apparatus and full protective clothing. Avoid breathing fumes. Keep containers cool with water spray.

**ADDITIONAL INFORMATION**

**Hazchem Code:** None allocated.

### SECTION 6 - ACCIDENTAL RELEASE MEASURES

**Emergency Procedures:**

Keep spills from entering sewers and open bodies of water.

**Methods and Materials for Containment and Clean Up Procedures:**

Wear protective clothing (see section 8). Contain spills with inert material (e.g. earth or sand). Transfer liquids and containment material to separate suitable containers for recovery or disposal.

### SECTION 7 - HANDLING AND STORAGE

**Precautions for Safe Handling:** Avoid skin and eye contact

**Conditions for Safe Storage:** Keep containers closed when not in use. Store between 0°C and 55°C. Store in a well ventilated area.

### SECTION 8 - EXPOSURE CONTROLS/PERSONAL PROTECTION

**National Exposure Standards:** None allocated for this product.

**Biological Limit Values:** No biological limit allocated.

**Engineering Controls:** Avoid generation of sprays or mists.

**Personal Protective Equipment (PPE):** Wear chemical splash goggles and face-shield, butyl rubber or nitrile gloves and chemical resistant apron or other impervious clothing to avoid prolonged or repeated skin contact.

### SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

**Appearance:** Clear orange liquid

**Boiling Point:** Approx.100°C

**Vapour Pressure:** Not available

**pH:** 6.5 – 7.5

**Specific Gravity:** 1.25 – 1.30

**Solubility in Water:** Soluble in all proportions

**Flammability Limits:** Not flammable

**Flash Point:** None

Veolia Water Solutions & Technologies Australia  
72 – 74 Ordish Road  
Dandenong South VIC 3175  
Ph: +61 3 9554 5048  
Fax: +61 3 9554 5090  
www.veoliawaterst.com.au

# Material Safety Data Sheet

# HYDREX 9209

## Water Treatment Chemical

### SECTION 10 - STABILITY AND REACTIVITY

<b>Chemical Stability:</b>	Stable under normal conditions of storage and use.
<b>Conditions to Avoid:</b>	Store away from freezing conditions.
<b>Incompatible Materials:</b>	Avoid contact with oxidising or reducing agents and strong alkalis.
<b>Hazardous Decomposition Products:</b>	Thermal decomposition may yield oxides of carbon.
<b>Hazardous Reactions:</b>	Product will not undergo polymerisation.

### SECTION 11 - TOXICOLOGICAL INFORMATION

<b>Eye:</b>	May be irritating to eyes.
<b>Skin:</b>	May be irritating.
<b>Inhaled:</b>	Sprays or mists may be irritating to the nose and throat.
<b>Swallowed:</b>	No data.

### SECTION 12 - ECOLOGICAL INFORMATION

<b>Ecotoxicity:</b>	No data.
<b>Persistence/Degradability:</b>	No data for this product.
<b>Mobility:</b>	Not expected to bio-accumulate.

### SECTION 13 - DISPOSAL CONSIDERATIONS

<b>Disposal Methods:</b>	Recycle or incinerate.
<b>Special Precautions for Landfill or Incineration:</b>	This product should not be allowed to enter sewers or waterways.

### SECTION 14 - TRANSPORT INFORMATION

<b>UN Number:</b>	None allocated.
<b>Proper Shipping Name:</b>	None allocated.
<b>Class and Subsidiary Risk(s):</b>	None allocated.
<b>Packing Group:</b>	None allocated.
<b>Special Precautions for User:</b>	Avoid contact with eyes.
<b>Hazchem Code:</b>	None allocated.
<b>Material for export :</b>	No data

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# Material Safety Data Sheet

# HYDREX 9209

## Water Treatment Chemical

### SECTION 15 - REGULATORY INFORMATION

**Classification:** Not hazardous according to the criteria of NOHSC.

**Hazard Category:** none allocated.

**Poisons Schedule:** Not Scheduled.

All components are included in the Australian AICS inventory.

### SECTION 16 - OTHER INFORMATION

No other information.

This Material Safety Data Sheet (MSDS) summarises our best knowledge at the date of issue of the health and safety hazard information of the product and how to safely handle and use the product in the workplace. Each user should read the MSDS and consider the information in the context of how the product will be handled and used in the workplace including in conjunction with other products.

If clarification or further information is needed to ensure that an appropriate risk assessment can be made, the user should contact their Veolia Water Solutions & Technologies representative or the office listed on Page 1.

Our responsibility for products sold is subject to our standard terms and conditions, a copy of which is sent to our customers and is also available upon request.



# Safety Data Sheet

acc. to OSHA HCS



Printing date 06/26/2015

Reviewed on 06/17/2015

## 1 Identification

- **Product identifier**
- **Trade name:** SDS (sodium dodecylsulfate)
- **Catalog or product number:** 1610327, 1610301, 1610302, 9700037, 1610302EDU, 1610301XTU, 1610301EDU
- **CAS Number:**  
151-21-3
- **EC number:**  
205-788-1
- **Relevant identified uses of the substance or mixture and uses advised against**  
No further relevant information available.
- **Application of the substance / the mixture** Laboratory chemicals
- **Details of the supplier of the safety data sheet**
- **Manufacturer/Supplier:**  
Bio-Rad Laboratories, Life Science Group  
2000 Alfred Nobel Drive  
Hercules, California 94547  
(510)741-1000
- **Information department:**  
Technical services, customer support  
lsg\_techserv\_us@bio-rad.com
- **Emergency telephone number:**  
1(800)424-9300 Use only in the event of a CHEMICAL EMERGENCY involving a SPILL, LEAK, FIRE, EXPLOSION or ACCIDENT.  
510-741-1000

## 2 Hazard(s) identification

- **Classification of the substance or mixture**  
Acute Tox. 4 H302 Harmful if swallowed.  
Acute Tox. 3 H311 Toxic in contact with skin.  
Skin Irrit. 2 H315 Causes skin irritation.  
Eye Irrit. 2A H319 Causes serious eye irritation.
- **Label elements**
- **GHS label elements** The substance is classified and labeled according to the Globally Harmonized System (GHS).
- **Hazard pictograms**  
  
GHS06 GHS07
- **Signal word** Danger
- **Hazard-determining components of labeling:**  
sodium dodecyl sulphate
- **Hazard statements**  
H302 Harmful if swallowed.  
H311 Toxic in contact with skin.  
H315 Causes skin irritation.  
H319 Causes serious eye irritation.

(Contd. on page 2)

# Safety Data Sheet

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Trade name: SDS (sodium dodecylsulfate)

(Contd. of page 1)

## Precautionary statements

P280 Wear protective gloves.

P280 Wear protective gloves / protective clothing.

P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P361 Remove/Take off immediately all contaminated clothing.

P405 Store locked up.

P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Additional information: Contact with acids may cause release of toxic gases

## Other hazards

## Results of PBT and vPvB assessment

PBT: Not applicable.

vPvB: Not applicable.

## 3 Composition/information on ingredients

### Chemical characterization: Substances

### CAS No. Description:

151-21-3 sodium dodecyl sulphate

### Identification number(s):

EC number: 205-788-1

Additional information: For the wording of the listed risk phrases refer to section 15.

## 4 First-aid measures

### Description of first aid measures

After inhalation Supply fresh air; consult doctor in case of complaints.

After eye contact Rinse opened eye for several minutes under running water.

After swallowing Induce vomiting and call for medical help.

### Information for doctor

Most important symptoms and effects, both acute and delayed No further relevant information available.

Indication of any immediate medical attention and special treatment needed No further relevant information available.

## 5 Fire-fighting measures

### Extinguishing media

### Suitable extinguishing agents

CO2, extinguishing powder or water spray. Fight larger fires with water spray or alcohol resistant foam.

Special hazards arising from the substance or mixture No further relevant information available.

### Advice for firefighters

Protective equipment: No special measures required.

## 6 Accidental release measures

Personal precautions, protective equipment and emergency procedures Wear protective clothing.

Environmental precautions: Do not allow to enter sewers/ surface or ground water.

Methods and material for containment and cleaning up: Pick up mechanically.

(Contd. on page 3)

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Trade name: SDS (sodium dodecylsulfate)

(Contd. of page 2)

- **Reference to other sections**

See Section 7 for information on safe handling  
 See Section 8 for information on personal protection equipment.  
 See Section 13 for disposal information.

## 7 Handling and storage

- **Handling**

- **Precautions for safe handling** No special precautions are necessary if used correctly.
- **Information about protection against explosions and fires:** No special measures required.

- **Conditions for safe storage, including any incompatibilities**

- **Storage**

- **Requirements to be met by storerooms and receptacles:** According to product specification
- **Information about storage in one common storage facility:** Not required.
- **Further information about storage conditions:** None.
- **Specific end use(s)** No further relevant information available.

## 8 Exposure controls/personal protection

- **Additional information about design of technical systems:** No further data; see item 7.

- **Control parameters**

- **Components with limit values that require monitoring at the workplace:** Not required.
- **Additional information:** The lists that were valid during the creation were used as basis.

- **Exposure controls**

- **Personal protective equipment**

- **General protective and hygienic measures** Wash hands before breaks and at the end of work.

- **Protection of hands:** Protective gloves.

- **Material of gloves** Synthetic gloves

- **Penetration time of glove material**

The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

- **Eye protection:** Safety glasses

## 9 Physical and chemical properties

- **Information on basic physical and chemical properties**

- **General Information**

- **Appearance:**

Form: Solid

Color: White

- **Odor:** Odorless

- **Odour threshold:** Not determined.

- **pH-value:** Not applicable.

- **Change in condition**

Melting point/Melting range: undetermined

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Trade name: SDS (sodium dodecylsulfate)

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<b>Boiling point/Boiling range:</b>	undetermined
· <b>Flash point:</b>	Not applicable
· <b>Flammability (solid, gaseous)</b>	Product is not flammable.
· <b>Ignition temperature:</b>	
<b>Decomposition temperature:</b>	Not determined.
· <b>Auto igniting:</b>	Not determined.
· <b>Danger of explosion:</b>	Product does not present an explosion hazard.
· <b>Explosion limits:</b>	
<b>Lower:</b>	Not determined.
<b>Upper:</b>	Not determined.
· <b>Vapor pressure:</b>	Not applicable.
· <b>Density at 20 °C:</b>	0.67 g/cm <sup>3</sup>
· <b>Relative density</b>	Not determined.
· <b>Vapour density</b>	Not applicable.
· <b>Evaporation rate</b>	Not applicable.
· <b>Solubility in / Miscibility with Water at 20 °C:</b>	100 g/l Fully miscible
· <b>Partition coefficient (n-octanol/water):</b>	Not determined.
· <b>Viscosity:</b>	
<b>dynamic:</b>	Not applicable.
<b>kinematic:</b>	Not applicable.
<b>Organic solvents:</b>	0.0 %
<b>Solids content:</b>	100.0 %
· <b>Other information</b>	No further relevant information available.

## 10 Stability and reactivity

- **Reactivity**
- **Chemical stability**
- **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.
- **Possibility of hazardous reactions** No dangerous reactions known
- **Conditions to avoid** No further relevant information available.
- **Incompatible materials:** No further relevant information available.
- **Hazardous decomposition products:** No dangerous decomposition products known

US

(Contd. on page 5)



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Trade name: SDS (sodium dodecylsulfate)

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## 11 Toxicological information

- Information on toxicological effects

- Acute toxicity:

- LD/LC50 values for hazardous components per OSHA criteria:

### 151-21-3 sodium dodecyl sulphate

Oral	LD50	1288 mg/kg (rat)
Dermal	LD50	580 mg/kg (rab)

- Primary irritant effect:

- on the skin: Irritant to skin and mucous membranes.

- on the eye: Irritant effect.

- Sensitization: No sensitizing effects known.

- Additional toxicological information:

- Carcinogenic categories

- IARC (International Agency for Research on Cancer)

Substance is not listed.

- NTP (National Toxicology Program)

Substance is not listed.

- OSHA-Ca (Occupational Safety & Health Administration)

Substance is not listed.

## 12 Ecological information

- Toxicity

- Aquatic toxicity: No further relevant information available.

- Persistence and degradability: No further relevant information available.

- Behavior in environmental systems:

- Bioaccumulative potential: No further relevant information available.

- Mobility in soil: No further relevant information available.

- Additional ecological information:

- General notes:

Water hazard class 2 (Assessment by list): hazardous for water.

Do not allow product to reach ground water, water course or sewage system.

Danger to drinking water if even small quantities leak into the ground.

- Results of PBT and vPvB assessment

- PBT: Not applicable.

- vPvB: Not applicable.

- Other adverse effects: No further relevant information available.

## 13 Disposal considerations

- Waste treatment methods

- Recommendation

Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

(Contd. on page 6)



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Trade name: SDS (sodium dodecylsulfate)

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- **Uncleaned packagings:**
- **Recommendation:** Disposal must be made according to official regulations.
- **Recommended cleansing agent:** Water, if necessary with cleansing agents.

## 14 Transport information

· <b>UN-Number</b>	
· <b>DOT, ADR, IMDG, IATA</b>	UN2811
· <b>UN proper shipping name</b>	
· <b>DOT, IMDG, IATA</b>	TOXIC SOLID, ORGANIC, N.O.S. (sodium dodecyl sulphate)
· <b>ADR</b>	2811 TOXIC SOLID, ORGANIC, N.O.S. (sodium dodecyl sulphate)
· <b>Transport hazard class(es)</b>	
· <b>DOT, ADR, IMDG, IATA</b>	
· <b>Class</b>	6.1 Toxic substances
· <b>Label</b>	6.1
· <b>Packing group</b>	
· <b>DOT, ADR, IMDG, IATA</b>	III
· <b>Environmental hazards:</b>	
· <b>Marine pollutant:</b>	No
· <b>Special precautions for user</b>	Warning: Toxic substances
· <b>Danger code (Kemler):</b>	60
· <b>EMS Number:</b>	F-A, S-A
· <b>Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code</b>	Not applicable.
· <b>UN "Model Regulation":</b>	UN2811, TOXIC SOLID, ORGANIC, N.O.S. (sodium dodecyl sulphate), 6.1, III

## 15 Regulatory information

- **Safety, health and environmental regulations/legislation specific for the substance or mixture**
- **SARA (Superfund Amendments and Reauthorization Act of 1986 - USA)**

- **Section 302/304 (40CFR355.30 / 40CFR355.40):**

Substance not listed.

- **Section 313 (40CFR372.65):**

Substance is not listed.

- **TSCA (Toxic Substances Control Act):**

Substance is listed.

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Trade name: SDS (sodium dodecylsulfate)

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- **Carcinogenic categories**

- **EPA (Environmental Protection Agency)**

Substance is not listed.

- **TLV (Threshold Limit Value established by ACGIH)**

Substance is not listed.

- **MAK (German Maximum Workplace Concentration)**

Substance is not listed.

- **NIOSH-Ca (National Institute for Occupational Safety and Health)**

Substance is not listed.

- **National regulations**

- **Water hazard class:** Water hazard class 2 (Assessment by list): hazardous for water.

- **Chemical safety assessment:** A Chemical Safety Assessment has not been carried out.

## 16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

- **Department issuing SDS:** Environmental Health and Safety.

- **Contact:**

Life Science Group, Environmental Health and Safety, 2000 Alfred Nobel Drive, Hercules, California, 94547: 1(510) 741-1000

Diagnostic Group, Environmental Health and Safety, 4000 Alfred Nobel Drive, Hercules, California, 94547: 1(510) 724-7000

- **Date of preparation / last revision** 06/26/2015 / -

- **Abbreviations and acronyms:**

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)

IMDG: International Maritime Code for Dangerous Goods

DOT: US Department of Transportation

IATA: International Air Transport Association

ACGIH: American Conference of Governmental Industrial Hygienists

EINECS: European Inventory of Existing Commercial Chemical Substances

CAS: Chemical Abstracts Service (division of the American Chemical Society)

LC50: Lethal concentration, 50 percent

LD50: Lethal dose, 50 percent

Acute Tox. 4: Acute toxicity, Hazard Category 4

Acute Tox. 3: Acute toxicity, Hazard Category 3

Skin Irrit. 2: Skin corrosion/irritation, Hazard Category 2

Eye Irrit. 2A: Serious eye damage/eye irritation, Hazard Category 2A

- **\* Data compared to the previous version altered.**



## SAFETY DATA SHEET

PRODUCT

**NALCO® 7330**

EMERGENCY TELEPHONE NUMBER(S)

(800) 424-9300 (24 Hours) CHEMTREC

### 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : **NALCO® 7330**

APPLICATION : **BIOCIDE**

COMPANY IDENTIFICATION :  
Nalco Company  
1601 W. Diehl Road  
Naperville, Illinois  
60563-1198

EMERGENCY TELEPHONE NUMBER(S) : (800) 424-9300 (24 Hours) CHEMTREC

NFPA 704M/HMIS RATING

HEALTH : 3 / 3\* FLAMMABILITY : 0 / 0 INSTABILITY : 0 / 0 OTHER :  
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme \* = Chronic Health Hazard

### 2. COMPOSITION/INFORMATION ON INGREDIENTS

Our hazard evaluation has identified the following chemical substance(s) as hazardous. Consult Section 15 for the nature of the hazard(s).

Hazardous Substance(s)	CAS NO	% (w/w)
Magnesium Nitrate	10377-60-3	1.0 - 5.0
5-Chloro-2-Methyl-4-Isothiazolin-3-one	26172-55-4	1.0 - 5.0
2-Methyl-4-Isothiazolin-3-one	2682-20-4	0.1 - 1.0

### 3. HAZARDS IDENTIFICATION

#### **\*\*EMERGENCY OVERVIEW\*\***

#### **DANGER**

**CORROSIVE.** CAUSES IRREVERSIBLE EYE DAMAGE OR SKIN BURNS. HARMFUL IF INHALED, SWALLOWED OR ABSORBED THROUGH SKIN. Do not get in eyes, on skin or on clothing. Prolonged or frequently repeated skin contact may cause allergic reaction in some individuals.

Mixers, loaders, and others exposed to this product must wear: long-sleeved shirt and long pants; chemical resistant gloves such as nitrile or butyl rubber; shoes plus socks; goggles and face shield; and chemical resistant apron.

Discard clothing or other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Users should wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Users should remove PPE immediately after handling the product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly. Do not apply this product in a way that will contact workers or other persons.

May evolve oxides of carbon (COx) under fire conditions. May evolve HCl under fire conditions. May evolve oxides of nitrogen (NOx) and sulfur (SOx) under fire conditions.

**Nalco Company** 1601 W. Diehl Road • Naperville, Illinois 60563-1198 • (630)305-1000

For additional copies of an MSDS visit [www.nalco.com](http://www.nalco.com) and request access.



## SAFETY DATA SHEET

PRODUCT

**NALCO® 7330**

EMERGENCY TELEPHONE NUMBER(S)

(800) 424-9300 (24 Hours) CHEMTREC

PRIMARY ROUTES OF EXPOSURE :

Eye, Skin

HUMAN HEALTH HAZARDS - ACUTE :

EYE CONTACT :

Corrosive. Will cause eye burns and permanent tissue damage.

SKIN CONTACT :

Corrosive; causes permanent skin damage. May cause sensitization by skin contact. Skin irritation effects can be delayed for hours. Harmful if absorbed through skin.

INGESTION :

Not a likely route of exposure. Corrosive; causes chemical burns to the mouth, throat and stomach. Harmful if swallowed.

INHALATION :

Elevated temperatures or mechanical action may form vapors, mists or fumes which may be irritating to the eyes, nose, throat and lungs. Harmful by inhalation.

AGGRAVATION OF EXISTING CONDITIONS :

A review of available data does not identify any worsening of existing conditions.

HUMAN HEALTH HAZARDS - CHRONIC :

No adverse effects expected other than those mentioned above.

## 4. FIRST AID MEASURES

IF IN EYES: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice.

If Swallowed: Call a poison control center or a doctor immediately for treatment advice. DO NOT INDUCE VOMITING. Do not give anything to drink.

IF ON SKIN: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

IF INHALED: Move person to fresh air. If person is not breathing, call 911 or ambulances, then give artificial respiration, preferably mouth-to-mouth, if possible. Call a poison control center or doctor for treatment advice.

NOTE TO PHYSICIAN :

Probable mucosal damage may contraindicate the use of gastric lavage. Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

## 5. FIRE FIGHTING MEASURES

FLASH POINT : None



## SAFETY DATA SHEET

PRODUCT

**NALCO® 7330**

EMERGENCY TELEPHONE NUMBER(S)

(800) 424-9300 (24 Hours) CHEMTREC

### EXTINGUISHING MEDIA :

Not expected to burn. Use extinguishing media appropriate for surrounding fire.

### FIRE AND EXPLOSION HAZARD :

May evolve oxides of carbon (COx) under fire conditions. May evolve HCl under fire conditions. May evolve oxides of nitrogen (NOx) and sulfur (SOx) under fire conditions.

### SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :

In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

## 6. ACCIDENTAL RELEASE MEASURES

### PERSONAL PRECAUTIONS :

Restrict access to area as appropriate until clean-up operations are complete. Ensure clean-up is conducted by trained personnel only. Ventilate spill area if possible. Do not touch spilled material. Stop or reduce any leaks if it is safe to do so. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection). Notify appropriate government, occupational health and safety and environmental authorities.

### METHODS FOR CLEANING UP :

**SMALL SPILLS:** Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. **LARGE SPILLS:** Soak up with inert absorbent material. Transfer contaminated material to suitable containers for disposal. Contaminated surfaces should be swabbed with deactivation solution, let stand for 30 minutes and rinse thoroughly with clean water. **DO NOT** add deactivation solution to the waste container to deactivate the absorbed material.

**\*DEACTIVATION SOLUTION** - prepare fresh a solution of 5% Sodium bicarbonate and 5% Sodium hypochlorite in water. Use a ratio of 10 volumes decontamination solution per estimated volume of residual spill. Wash site of spillage thoroughly with water. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

### ENVIRONMENTAL PRECAUTIONS :

This pesticide is toxic to fish and wildlife. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters, unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA. Do not contaminate water by cleaning of equipment or disposal of waste. Apply this pesticide only as specified on this label. Do not contaminate surface water.

## 7. HANDLING AND STORAGE

### HANDLING :

Do not get in eyes, on skin, on clothing. Do not take internally. Use with adequate ventilation. Avoid generating aerosols and mists. Keep the containers closed when not in use. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Ensure all containers are labeled.

### STORAGE CONDITIONS :

Store the containers tightly closed. Store separately from oxidizers. Store in suitable labeled containers.



## SAFETY DATA SHEET

### PRODUCT

**NALCO® 7330**

### EMERGENCY TELEPHONE NUMBER(S)

**(800) 424-9300 (24 Hours) CHEMTREC**

#### SUITABLE CONSTRUCTION MATERIAL :

Hastelloy C-276, Polyethylene, HDPE (high density polyethylene), EPDM, Plexiglass, Stainless Steel 316L, Nylon, PTFE, Perfluoroelastomer, Polytetrafluoroethylene/polypropylene copolymer

#### UNSUITABLE CONSTRUCTION MATERIAL :

Mild steel, Carbon Steel C1018, Stainless Steel 304, Copper, Aluminum, Brass, Buna-N, Polypropylene, PVC, Ethylene propylene, Neoprene, Polyurethane, Fluoroelastomer, Chlorosulfonated polyethylene rubber Shipping and long term storage compatibility with construction materials can vary; we therefore recommend that compatibility is tested prior to use.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

#### OCCUPATIONAL EXPOSURE LIMITS :

This product contains the following component(s) with a recognised or recommended OEL value:

Substance(s)	Category:	ppm	mg/m3	Non-Standard Unit
5-Chloro-2-Methyl-4-Isothiazolin-3-one	Manufacturer's Recommendation/TWA		0.076	
	Manufacturer's Recommendation/STEL		0.23	
2-Methyl-4-Isothiazolin-3-one	Manufacturer's Recommendation/TWA		1.5	
	Manufacturer's Recommendation/STEL		4.5	

#### ENGINEERING MEASURES :

General ventilation is recommended. Use local exhaust ventilation if necessary to control airborne mist and vapor.

#### RESPIRATORY PROTECTION :

If significant mists, vapors or aerosols are generated an approved respirator is recommended. A suitable filter material depends on the amount and type of chemicals being handled. Consider the use of filter type: Multi-contaminant cartridge. with a Particulate pre-filter. In event of emergency or planned entry into unknown concentrations a positive pressure, full-facepiece SCBA should be used. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance and inspection.

#### HAND PROTECTION :

When handling this product, the use of chemical gloves is recommended. The choice of work glove depends on work conditions and what chemicals are handled. Please contact the PPE manufacturer for advice on what type of glove material may be suitable. Gloves should be replaced immediately if signs of degradation are observed.

#### SKIN PROTECTION :

Wear chemical resistant apron, chemical splash goggles, impervious gloves and boots. A full slicker suit is recommended if gross exposure is possible.

#### EYE PROTECTION :

Wear a face shield with chemical splash goggles.



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### HYGIENE RECOMMENDATIONS :

Use good work and personal hygiene practices to avoid exposure. Eye wash station and safety shower are necessary. If clothing is contaminated, remove clothing and thoroughly wash the affected area. Launder contaminated clothing before reuse. Always wash thoroughly after handling chemicals. When handling this product never eat, drink or smoke.

### HUMAN EXPOSURE CHARACTERIZATION :

Based on our recommended product application and personal protective equipment, the potential human exposure is: Moderate

## 9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE	Liquid
APPEARANCE	Light green Light yellow
ODOR	Mild
SPECIFIC GRAVITY	1.026
DENSITY	8.5 lb/gal
SOLUBILITY IN WATER	Complete
pH (100 %)	3.0 - 5.0
FREEZING POINT	25 °F / -4 °C
BOILING POINT	/ 100 °C
VOC CONTENT	0.80 % EPA Method 24

Note: These physical properties are typical values for this product and are subject to change.

## 10. STABILITY AND REACTIVITY

### STABILITY :

Stable under normal conditions.

### HAZARDOUS POLYMERIZATION :

Hazardous polymerization will not occur.

### CONDITIONS TO AVOID :

Freezing temperatures.

### MATERIALS TO AVOID :

Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.

### HAZARDOUS DECOMPOSITION PRODUCTS :

Under fire conditions: Oxides of carbon, Oxides of nitrogen, Oxides of sulfur, HCl



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### 11. TOXICOLOGICAL INFORMATION

The following results are for the product along with results on the active substances.

#### ACUTE ORAL TOXICITY :

Species: Rat  
LD50: 3,810 mg/kg  
Test Descriptor: Product

#### ACUTE DERMAL TOXICITY :

Species: Rabbit  
LD50: > 5,000 mg/kg  
Test Descriptor: Product

#### ACUTE INHALATION TOXICITY :

Species: Rat  
LC50: 13.7 mg/l (4 hrs)  
Test Descriptor: Product

#### PRIMARY SKIN IRRITATION :

Remarks: A 1.5% active solution is corrosive to skin, a 0.6% active solution is a severe skin irritant, a 0.3% active solution is a moderate skin irritant and a 0.06% active solution is a non-irritant.

#### PRIMARY EYE IRRITATION :

Remarks: A 1.5% active solution is corrosive to the eyes, a 0.3% active solution is an eye irritant and 0.06% active solution is a non-irritant.

#### SENSITIZATION :

Repeated or prolonged contact may cause sensitization in some individuals. A Guinea pig (Buehler Technique) sensitization study with an induction dosage of 90 ppm of active ingredients followed by an insult of 429 ppm of active ingredients was positive. A human repeated insult patch study of 28 ppm active ingredients followed by an insult of 56 ppm of active ingredients resulted in no effect to the subjects tested.

#### CHRONIC TOXICITY DATA :

A 90-day dietary study in dogs of 840 ppm of isothiazolinone resulted in no mortalities or pathological findings. A 90-day dermal study in rabbits of 0.4 mg/kg/day of isothiazolinone resulted in irritation but no pathological effects. A 30-month skin painting study with mice using 400 ppm isothiazolinone three times per week showed no increased tumor frequency over control. A teratology study with rabbits and rats was negative using dosages of 1.5 to 15 mg/kg isothiazolinone. Mutagenicity results have been equivocal.

#### CARCINOGENICITY :

None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).



**SAFETY DATA SHEET****PRODUCT****NALCO® 7330****EMERGENCY TELEPHONE NUMBER(S)****(800) 424-9300 (24 Hours) CHEMTREC****HUMAN HAZARD CHARACTERIZATION :**

Based on our hazard characterization, the potential human hazard is: High

**12. ECOLOGICAL INFORMATION****ECOTOXICOLOGICAL EFFECTS :**

The following results are for the product along with results on the active substances.

**ACUTE FISH RESULTS :**

Species	Exposure	LC50	Test Descriptor
Sheepshead Minnow	96.00 hrs	32.000 mg/l	Product
Bluegill Sunfish	96 hrs	18.67 mg/l	Product
Fathead Minnow	144 hrs	8 mg/l	Product (estimated)
Rainbow Trout	96 hrs	12.67 mg/l	Product
Inland Silverside	96 hrs	16.62 mg/l	Product

**ACUTE INVERTEBRATE RESULTS :**

Species	Exposure	LC50	EC50	Test Descriptor
Ceriodaphnia dubia	48 hrs	15 mg/l		Product (estimated)
Mysid Shrimp (Mysidopsis bahia)	96.00 hrs	18.000 mg/l		Product
Daphnia magna	48 hrs	8.7 - 12 mg/l		Product (estimated)
Blue Mussel	48 hrs	865 mg/l		Product (estimated)
American Oyster	48 hrs	1,730 mg/l		Product (estimated)

**AVIAN RESULTS :**

Species	Exposure	LC50	Test Descriptor
Bobwhite Quail	8 Days	> 60 mg/kg > 560 ppm	Active Substance

**PERSISTENCY AND DEGRADATION :**

Total Organic Carbon (TOC) : 7,850 mg/l

Chemical Oxygen Demand (COD) : 20,000 mg/l

The degradation of the major active substance begins with ring opening and elimination of chloride ion. Degradation leads to the formation of a variety of small organic acids, methylamine, carbon dioxide and elemental sulfur. The half life of each active substance is dependent upon the initial concentration.

**MOBILITY :**

The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is



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intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.

If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	Water	Soil/Sediment
<5%	30 - 50%	50 - 70%

The portion in water is expected to be soluble or dispersible.

### BIOACCUMULATION POTENTIAL

This preparation or material is not expected to bioaccumulate.

### ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION

Based on our hazard characterization, the potential environmental hazard is: Moderate

Based on our recommended product application and the product's characteristics, the potential environmental exposure is: Moderate

If released into the environment, see CERCLA/SUPERFUND in Section 15.

## 13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it could meet the criteria of a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Before disposal, it should be determined if the waste meets the criteria of a hazardous waste.

Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

## 14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

The presence of an RQ component (Reportable Quantity for U.S. EPA and DOT) in this product causes it to be regulated with an additional description of RQ for road, or as a class 9 for road and air, ONLY when the net weight in the package exceeds the calculated RQ for the product.

### LAND TRANSPORT :

Proper Shipping Name :	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
Technical Name(s) :	ISOTHIAZOLINONE MICROBIOCID
UN/ID No :	UN 3265
Hazard Class - Primary :	8
Packing Group :	II



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Flash Point :	None
Reportable Quantity (per package) :	132,270 lbs
RQ Component :	CUPRIC NITRATE

### AIR TRANSPORT (ICAO/IATA) :

The presence of an RQ component (Reportable Quantity for U.S. EPA and DOT) in this product causes it to be regulated with an additional description of RQ for road, or as a class 9 for road and air, ONLY when the net weight in the package exceeds the calculated RQ for the product.

Proper Shipping Name :	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
Technical Name(s) :	ISOTHIAZOLINONE MICROBIOCIDE
UN/ID No :	UN 3265
Hazard Class - Primary :	8
Packing Group :	II
Reportable Quantity (per package) :	132,270 lbs
RQ Component :	CUPRIC NITRATE

### MARINE TRANSPORT (IMDG/IMO) :

Proper Shipping Name :	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S.
Technical Name(s) :	ISOTHIAZOLINONE MICROBIOCIDE
UN/ID No :	UN 3265
Hazard Class - Primary :	8
Packing Group :	II

## 15. REGULATORY INFORMATION

This section contains additional information that may have relevance to regulatory compliance. The information in this section is for reference only. It is not exhaustive, and should not be relied upon to take the place of an individualized compliance or hazard assessment. Nalco accepts no liability for the use of this information.

### NATIONAL REGULATIONS, USA :

#### OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200 :

Based on our hazard evaluation, the following substance(s) in this product is/are hazardous and the reason(s) is/are shown below.

Magnesium Nitrate : Oxidizer  
5-Chloro-2-Methyl-4-Isothiazolin-3-one : Corrosive, Sensitizer  
2-Methyl-4-Isothiazolin-3-one : Corrosive, Sensitizer

#### CERCLA/SUPERFUND, 40 CFR 302 :

This product contains the following Reportable Quantity (RQ) Substance. Also listed is the RQ for the product.

<u>RQ Substance</u>	<u>RQ</u>
Cupric Nitrate	132,270 lbs



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SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313 :

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355) :

This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370) :

Our hazard evaluation has found this product to be hazardous. The product should be reported under the following indicated EPA hazard categories:

X	Immediate (Acute) Health Hazard
-	Delayed (Chronic) Health Hazard
-	Fire Hazard
-	Sudden Release of Pressure Hazard
-	Reactive Hazard

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372) :

This product contains the following substance(s), (with CAS # and % range) which appear(s) on the List of Toxic Chemicals

<u>Hazardous Substance(s)</u>	<u>CAS NO</u>	<u>% (w/w)</u>
Magnesium Nitrate	10377-60-3	1.0 - 5.0

TOXIC SUBSTANCES CONTROL ACT (TSCA) :

This product is exempted under TSCA and regulated under FIFRA. The inerts are on the Inventory List.

FOOD AND DRUG ADMINISTRATION (FDA) Federal Food, Drug and Cosmetic Act :

When use situations necessitate compliance with FDA regulations, this product is acceptable under : 21 CFR 176.300 Slimicides 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods. 21 CFR 176.170 Components of paper and paperboard in contact with aqueous and fatty foods and 21 CFR 176.180 Components of paper and paperboard in contact with dry foods.

The following limitations apply:

<u>Maximum dosage</u>	<u>Limitation</u>
FOR 176.300: 0.125% (ACTIVES)	of dry weight fiber
FOR 176.170/180: 1675 PPM	as an antimicrobial agent for finished coating formulations and for additives used in the manufacture of paper and paperboard, including fillers, binders, pigment slurries and sizing solutions
FOR 176.170/180: 3350 PPM	as an antimicrobial agent for polymer latex emulsions in paper coatings

NSF NON-FOOD COMPOUNDS REGISTRATION PROGRAM (former USDA List of Proprietary Substances & Non-Food Compounds) :

NSF Registration number for this product is : 062419

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This product is acceptable for treating boilers, steam lines, and/or cooling systems where neither the treated water nor the steam produced may contact edible products in and around food processing areas, excluding such use in areas where meat and poultry are processed (G10).

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (FIFRA) :  
EPA Reg. No. 1706-153

In all cases follow instructions on the product label.

This product has been certified as KOSHER/PAREVE for year-round use INCLUDING THE PASSOVER SEASON by the CHICAGO RABBINICAL COUNCIL.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR 116.4 / formerly Sec. 311 :

This product may contain trace levels (<0.1% for carcinogens, <1% all other substances) of the following substance(s) listed under the regulation. Additional components may be unintentionally present at trace levels.

Substance(s)	Citations
• Cupric Nitrate	Sec. 307, Sec. 311
• Nitric Acid	Sec. 311

CLEAN AIR ACT, Sec. 112 (Hazardous Air Pollutants, as amended by 40 CFR 63), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances) :

Substances listed under this regulation are not intentionally added or expected to be present in this product. Listed components may be present at trace levels.

CALIFORNIA PROPOSITION 65 :

Substances listed under California Proposition 65 are not intentionally added or expected to be present in this product.

MICHIGAN CRITICAL MATERIALS :

This product contains the following substances listed in the regulation. Additional components may be unintentionally present at trace levels.

Copper

STATE RIGHT TO KNOW LAWS :

The following substances are disclosed for compliance with State Right to Know Laws:

Copper	7440-50-8
Magnesium Nitrate	10377-60-3

INTERNATIONAL CHEMICAL CONTROL LAWS :



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### CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) :

Substances regulated under the Pest Control Products Act are exempt from CEPA New Substance Notification requirements.

### AUSTRALIA

All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

### CHINA

All substances in this product comply with the Provisions on the Environmental Administration of New Chemical Substances and are listed on the Inventory of Existing Chemical Substances China (IECSC).

### EUROPE

The substances in this preparation have been reviewed for compliance with the EINECS or ELINCS inventories.

### JAPAN

All substances in this product comply with the Law Regulating the Manufacture and Importation Of Chemical Substances and are listed on the Existing and New Chemical Substances list (ENCS).

### KOREA

All substances in this product comply with the Toxic Chemical Control Law (TCCL) and are listed on the Existing Chemicals List (ECL)

### NEW ZEALAND

All substances in this product comply with the Hazardous Substances and New Organisms (HSNO) Act 1996, and are listed on or are exempt from the New Zealand Inventory of Chemicals.

### PHILIPPINES

All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

## 16. OTHER INFORMATION

Due to our commitment to Product Stewardship, we have evaluated the human and environmental hazards and exposures of this product. Based on our recommended use of this product, we have characterized the product's general risk. This information should provide assistance for your own risk management practices. We have evaluated our product's risk as follows:

\* The human risk is: Moderate

\* The environmental risk is: Moderate

Any use inconsistent with our recommendations may affect the risk characterization. Our sales representative will assist you to determine if your product application is consistent with our recommendations. Together we can implement an appropriate risk management process.

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should



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be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

### REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH, (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Ariel Insight™ (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight™ CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS™ CD-ROM Version), Micromedex, Inc., Englewood, CO.

Prepared By : Product Safety Department  
Date issued : 02/14/2011  
Version Number : 2.0

# Safety Data Sheet



## 1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

**Product Name:** **CAUSTIC SODA - LIQUID (46%-50%)**

**Other name(s):** Sodium hydroxide - liquid (46%-50%), Soda lye solution (46%-50%), Caustic soda solution (46%-50%), Sodium hydroxide solution (46%-50%), Liquid caustic soda (46%-50%), LCS 46%, Rezolv 46, Algane C46, Rezolv 50.

**Recommended use of the chemical and restrictions on use:** Chemical manufacture; neutralising agent; pulp and paper, aluminium, detergent, and textile processing; vegetable oil refining; reclaiming rubber; etching and electroplating; food additive.

**Supplier:** Ixom Operations Pty Ltd  
**ABN:** 51 600 546 512  
**Street Address:** Level 8, 1 Nicholson Street  
Melbourne 3000  
Australia

**Telephone Number:** +61 3 9665 7111  
**Facsimile:** +61 3 9665 7937  
**Emergency Telephone:** **1 800 033 111 (ALL HOURS)**

Please ensure you refer to the limitations of this Safety Data Sheet as set out in the "Other Information" section at the end of this Data Sheet.

## 2. HAZARDS IDENTIFICATION

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

**Classification of the substance or mixture:**

Corrosive to Metals - Category 1  
Skin Corrosion - Sub-category 1A  
Eye Damage - Category 1

**SIGNAL WORD:** DANGER



**Hazard Statement(s):**

H290 May be corrosive to metals.  
H314 Causes severe skin burns and eye damage.

**Precautionary Statement(s):**

**Prevention:**

P234 Keep only in original container.  
P260 Do not breathe dust / fume / gas / mist / vapours / spray.  
P264 Wash hands thoroughly after handling.  
P280 Wear protective gloves / protective clothing / eye protection / face protection.



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**Response:**

P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.  
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.  
P363 Wash contaminated clothing before re-use.  
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.  
P310 Immediately call a POISON CENTER or doctor/physician.  
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).  
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.  
P390 Absorb spillage to prevent material damage.

**Storage:**

P405 Store locked up.  
P406 Store in corrosive resistant container with a resistant inner liner.

**Disposal:**

P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

**Poisons Schedule (SUSMP):** S6 Poison.

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS Number	Proportion	Hazard Codes
Sodium hydroxide	1310-73-2	46-50%	H290 H314 H318
Water	7732-18-5	50-54%	-

## 4. FIRST AID MEASURES

For advice, contact a Poisons Information Centre (e.g. phone Australia 131 126; New Zealand 0800 764 766) or a doctor.

**Inhalation:**

Remove victim from area of exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. For all but the most minor symptoms arrange for patient to be seen by a doctor as soon as possible, either on site or at the nearest hospital.

**Skin Contact:**

If spilt on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin and hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.

**Eye Contact:**

If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre or a doctor, or for at least 15 minutes.

**Ingestion:**

Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

**Indication of immediate medical attention and special treatment needed:**

Treat symptomatically. Can cause corneal burns.

## 5. FIRE FIGHTING MEASURES

Product Name: CAUSTIC SODA - LIQUID (46%-50%)  
Substance No: 000031006701

Issued: 11/05/2015  
Version: 6

# Safety Data Sheet

**Suitable Extinguishing Media:**

Not combustible, however, if material is involved in a fire use: Fine water spray, normal foam, dry agent (carbon dioxide, dry chemical powder).

**Hazchem or Emergency Action Code:** 2R

**Specific hazards arising from the substance or mixture:**

Non-combustible material.

**Special protective equipment and precautions for fire-fighters:**

Not combustible, however following evaporation of aqueous component residual material can decompose if involved in a fire, emitting toxic fumes. Contact with metals may liberate hydrogen gas which is extremely flammable. Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

## 6. ACCIDENTAL RELEASE MEASURES

**Emergency procedures/Environmental precautions:**

Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

**Personal precautions/Protective equipment/Methods and materials for containment and cleaning up:**

Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal. Caution - heat may be evolved on contact with water.

## 7. HANDLING AND STORAGE

This material is a Scheduled Poison S6 and must be stored, maintained and used in accordance with the relevant regulations.

**Precautions for safe handling:**

Avoid skin and eye contact and breathing in vapour, mists and aerosols.

**Conditions for safe storage, including any incompatibilities:**

Store in cool place and out of direct sunlight. Store away from incompatible materials described in Section 10. Store away from foodstuffs. Do not store in aluminium or galvanised containers nor use die-cast zinc or aluminium bungs; plastic bungs should be used. At temperatures greater than 40°C, tanks must be stress relieved. Keep containers closed when not in use - check regularly for leaks.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Control Parameters:** No value assigned for this specific material by Safe Work Australia. However, Workplace Exposure Standard(s) for constituent(s):

Sodium hydroxide: Peak Limitation = 2 mg/m<sup>3</sup>

# Safety Data Sheet



As published by Safe Work Australia Workplace Exposure Standards for Airborne Contaminants.

Peak Limitation - a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

These Workplace Exposure Standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These workplace exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.

## Appropriate engineering controls:

Ensure ventilation is adequate to maintain air concentrations below Workplace Exposure Standards. Keep containers closed when not in use.

If in the handling and application of this material, safe exposure levels could be exceeded, the use of engineering controls such as local exhaust ventilation must be considered and the results documented. If achieving safe exposure levels does not require engineering controls, then a detailed and documented risk assessment using the relevant Personal Protective Equipment (PPE) (refer to PPE section below) as a basis must be carried out to determine the minimum PPE requirements.

## Individual protection measures, such as Personal Protective Equipment (PPE):

The selection of PPE is dependent on a detailed risk assessment. The risk assessment should consider the work situation, the physical form of the chemical, the handling methods, and environmental factors.

OVERALLS, CHEMICAL GOGGLES, FACE SHIELD, GLOVES (Long), APRON, RUBBER BOOTS.



Wear overalls, chemical goggles, face shield, elbow-length impervious gloves, splash apron or equivalent chemical impervious outer garment, and rubber boots. Always wash hands before smoking, eating, drinking or using the toilet. Wash contaminated clothing and other protective equipment before storage or re-use.

If determined by a risk assessment an inhalation risk exists, wear a suitable mist respirator meeting the requirements of AS/NZS 1715 and AS/NZS 1716.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

<b>Physical state:</b>	Liquid
<b>Colour:</b>	Colourless to Slightly Coloured
<b>Solubility:</b>	Miscible with water.
<b>Specific Gravity:</b>	1.48-1.52 @20°C
<b>Relative Vapour Density (air=1):</b>	Not available
<b>Vapour Pressure (20 °C):</b>	1.34 mm Hg (calculated)
<b>Flash Point (°C):</b>	Not applicable
<b>Flammability Limits (%):</b>	Not applicable
<b>Autoignition Temperature (°C):</b>	Not applicable
<b>Boiling Point/Range (°C):</b>	ca. 145 (literature)
<b>pH:</b>	14 (literature)
<b>Freezing Point/Range (°C):</b>	ca. 12 (calculated)

Product Name: CAUSTIC SODA - LIQUID (46%-50%)  
Substance No: 000031006701

Issued: 11/05/2015  
Version: 6

## 10. STABILITY AND REACTIVITY

<b>Reactivity:</b>	Reacts violently with acids. Reacts exothermically on dilution with water.
<b>Chemical stability:</b>	Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Absorbs carbon dioxide from the air.
<b>Possibility of hazardous reactions:</b>	Reacts with ammonium salts, evolving ammonia gas. Reacts readily with various reducing sugars (i.e. fructose, galactose, maltose, dry whey solids) to produce carbon monoxide. Take precautions including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.
<b>Conditions to avoid:</b>	Avoid exposure to moisture.
<b>Incompatible materials:</b>	Incompatible with ammonium salts , aluminium , tin , and zinc .
<b>Hazardous decomposition products:</b>	None known.

## 11. TOXICOLOGICAL INFORMATION

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms or effects that may arise if the product is mishandled and overexposure occurs are:

<b>Ingestion:</b>	Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.
<b>Eye contact:</b>	A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.
<b>Skin contact:</b>	Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.
<b>Inhalation:</b>	Breathing in mists or aerosols may produce respiratory irritation.
<b>Acute toxicity:</b>	No LD50 data available for the product. For the constituent Sodium hydroxide :
<b>Skin corrosion/irritation:</b>	Severe irritant (rabbit).
<b>Chronic effects:</b>	No information available for the product.

## 12. ECOLOGICAL INFORMATION

<b>Ecotoxicity</b>	Avoid contaminating waterways.
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## 13. DISPOSAL CONSIDERATIONS

**Disposal methods:**  
Refer to Waste Management Authority. Dispose of contents/container in accordance with local/regional/national/international regulations.

## 14. TRANSPORT INFORMATION

# Safety Data Sheet



## Road and Rail Transport

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.



**UN No:** 1824  
**Transport Hazard Class:** 8 Corrosive  
**Packing Group:** II  
**Proper Shipping Name or Technical Name:** SODIUM HYDROXIDE SOLUTION  
**Hazchem or Emergency Action Code:** 2R

## Marine Transport

Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.

**UN No:** 1824  
**Transport Hazard Class:** 8 Corrosive  
**Packing Group:** II  
**Proper Shipping Name or Technical Name:** SODIUM HYDROXIDE SOLUTION

**IMDG EMS Fire:** F-A  
**IMDG EMS Spill:** S-B

## Air Transport

Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air; DANGEROUS GOODS.

**UN No:** 1824  
**Transport Hazard Class:** 8 Corrosive  
**Packing Group:** II  
**Proper Shipping Name or Technical Name:** SODIUM HYDROXIDE SOLUTION

## 15. REGULATORY INFORMATION

### **Classification:**

This material is hazardous according to Safe Work Australia; HAZARDOUS SUBSTANCE.

### **Classification of the substance or mixture:**

Corrosive to Metals - Category 1  
Skin Corrosion - Sub-category 1A  
Eye Damage - Category 1

### **Hazard Statement(s):**

H290 May be corrosive to metals.  
H314 Causes severe skin burns and eye damage.

**Poisons Schedule (SUSMP):** S6 Poison.

# Safety Data Sheet



All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

## 16. OTHER INFORMATION

'Registry of Toxic Effects of Chemical Substances'. Ed. D. Sweet, US Dept. of Health & Human Services: Cincinnati, 2014.

This safety data sheet has been prepared by Ixom Operations Pty Ltd Toxicology & SDS Services.

### **Reason(s) for Issue:**

Change in company details

This SDS summarises to our best knowledge at the date of issue, the chemical health and safety hazards of the material and general guidance on how to safely handle the material in the workplace. Since Ixom Operations Pty Ltd cannot anticipate or control the conditions under which the product may be used, each user must, prior to usage, assess and control the risks arising from its use of the material.

If clarification or further information is needed, the user should contact their Ixom representative or Ixom Operations Pty Ltd at the contact details on page 1.

Ixom Operations Pty Ltd's responsibility for the material as sold is subject to the terms and conditions of sale, a copy of which is available upon request.

# Osmoclean CD

Osmoflo Water Management Pty Ltd

Chemwatch: 6533-76

Version No: 4.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 2

Issue Date: 01/01/2013

Print Date: 07/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Osmoclean CD
Synonyms	Osmoclean CD
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Reverse osmosis membrane cleaner.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.


### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	1	2
Toxicity	0	1
Body Contact	2	3
Reactivity	1	2
Chronic	2	3

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	Not Applicable
Classification <sup>[1]</sup>	Skin Corrosion/Irritation Category 2, Eye Irritation Category 2A, Specific target organ toxicity - single exposure Category 3 (respiratory tract irritation)
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

GHS label elements	
SIGNAL WORD	WARNING

Continued...

## Osmoclean CD

## Hazard statement(s)

H315	Causes skin irritation
H319	Causes serious eye irritation
H335	May cause respiratory irritation

## Precautionary statement(s) Prevention

P271	Use only outdoors or in a well-ventilated area.
P261	Avoid breathing dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

## Precautionary statement(s) Response

P362	Take off contaminated clothing and wash before reuse.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312	Call a POISON CENTER or doctor/physician if you feel unwell.
P337+P313	If eye irritation persists: Get medical advice/attention.

## Precautionary statement(s) Storage

P405	Store locked up.
P403+P233	Store in a well-ventilated place. Keep container tightly closed.

## Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
5949-29-1	NotSpec.	<u>citric acid, monohydrate</u>
Not Available	NotSpec.	additives nonhazardous
7732-18-5	NotSpec.	<u>water</u>

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Wash out immediately with fresh running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Seek medical attention without delay; if pain persists or recurs seek medical attention.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes or combustion products are inhaled remove from contaminated area.</li> <li>Lay patient down. Keep warm and rested.</li> <li>Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>Transport to hospital, or doctor, without delay.</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Immediately give a glass of water.</li> <li>First aid is not generally required. If in doubt, contact a Poisons Information Centre or a doctor.</li> </ul>

## Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

## SECTION 5 FIREFIGHTING MEASURES

## Extinguishing media

- There is no restriction on the type of extinguisher which may be used.
- Use extinguishing media suitable for surrounding area.

## Special hazards arising from the substrate or mixture

Fire Incompatibility	<ul style="list-style-type: none"> <li>Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result</li> </ul>
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## Advice for firefighters

Continued...



## Osmoclean CD

<b>Fire Fighting</b>	<ul style="list-style-type: none"> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear breathing apparatus plus protective gloves in the event of a fire.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water courses.</li> <li>▶ Use fire fighting procedures suitable for surrounding area.</li> </ul>
<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>▶ Solid which exhibits difficult combustion or is difficult to ignite.</li> <li>▶ Avoid generating dust, particularly clouds of dust in a confined or unventilated space as dusts may form an explosive mixture with air, and any source of ignition, i.e. flame or spark, will cause fire or explosion.</li> <li>▶ Dust clouds generated by the fine grinding of the solid are a particular hazard; accumulations of fine dust (420 micron or less) may burn rapidly and fiercely if ignited; once initiated larger particles up to 1400 microns diameter will contribute to the propagation of an explosion.</li> <li>▶ A dust explosion may release large quantities of gaseous products; this in turn creates a subsequent pressure rise of explosive force capable of damaging plant and buildings and injuring people.</li> </ul> <p>Combustion products include; carbon monoxide (CO) carbon dioxide (CO<sub>2</sub>) other pyrolysis products typical of burning organic material May emit poisonous fumes. May emit corrosive fumes.</p>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

## Personal precautions, protective equipment and emergency procedures

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid breathing dust and contact with skin and eyes.</li> <li>▶ Wear protective clothing, gloves, safety glasses and dust respirator.</li> <li>▶ Use dry clean up procedures and avoid generating dust.</li> </ul>
<b>Major Spills</b>	<p>Moderate hazard.</p> <ul style="list-style-type: none"> <li>▶ <b>CAUTION:</b> Advise personnel in area.</li> <li>▶ Alert Emergency Services and tell them location and nature of hazard.</li> <li>▶ Control personal contact by wearing protective clothing.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

## Precautions for safe handling

<b>Safe handling</b>	<ul style="list-style-type: none"> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ Prevent concentration in hollows and sumps.</li> <li>▶ Organic powders when finely divided over a range of concentrations regardless of particulate size or shape and suspended in air or some other oxidizing medium may form explosive dust-air mixtures and result in a fire or dust explosion (including secondary explosions)</li> <li>▶ Minimise airborne dust and eliminate all ignition sources. Keep away from heat, hot surfaces, sparks, and flame.</li> <li>▶ Establish good housekeeping practices.</li> <li>▶ Remove dust accumulations on a regular basis by vacuuming or gentle sweeping to avoid creating dust clouds.</li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> </ul>

## Conditions for safe storage, including any incompatibilities

<b>Suitable container</b>	<ul style="list-style-type: none"> <li>▶ Polyethylene or polypropylene container.</li> <li>▶ Check all containers are clearly labelled and free from leaks.</li> </ul>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"> <li>▶ Avoid reaction with oxidising agents</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA

Not Available

## EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
citric acid, monohydrate	Citric acid monohydrate	2.3 mg/m <sup>3</sup>	25 mg/m <sup>3</sup>	150 mg/m <sup>3</sup>
citric acid, monohydrate	Citric acid	0.37 mg/m <sup>3</sup>	4 mg/m <sup>3</sup>	590 mg/m <sup>3</sup>






Ingredient	Original IDLH	Revised IDLH
citric acid, monohydrate	Not Available	Not Available
additives nonhazardous	Not Available	Not Available
water	Not Available	Not Available

## Exposure controls

<b>Appropriate engineering controls</b>	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
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Continued...

## Osmoclean CD

<b>Personal protection</b>	    
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields.</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p> <p>Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present.</p> <ul style="list-style-type: none"> <li>▶ polychloroprene.</li> <li>▶ nitrile rubber.</li> <li>▶ butyl rubber.</li> </ul>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ P.V.C. apron.</li> <li>▶ Barrier cream.</li> </ul>
<b>Thermal hazards</b>	Not Available

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

"Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

Osmoclean CD

Material	CPI
BUTYL	A
NEOPRENE	A
VITON	A
NATURAL RUBBER	C
PVA	C

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

## Respiratory protection

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	P1 Air-line*	-	PAPR-P1
up to 50 x ES	Air-line**	P2	PAPR-P2
up to 100 x ES	-	P3	-
		Air-line*	-
100+ x ES	-	Air-line**	PAPR-P3

\* - Negative pressure demand \*\* - Continuous flow

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO<sub>2</sub>), G = Agricultural chemicals, K = Ammonia(NH<sub>3</sub>), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	Colourless or white crystals with no odour; miscible with water.		
<b>Physical state</b>	Divided Solid	<b>Relative density (Water = 1)</b>	1.665 @ 18 degC
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Available
<b>pH (as supplied)</b>	Not Available	<b>Decomposition temperature</b>	>153
<b>Melting point / freezing point (°C)</b>	153	<b>Viscosity (cSt)</b>	5-7 @20C
<b>Initial boiling point and boiling range (°C)</b>	Not Available	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Available	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Available	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Available	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Applicable

Continued...

Lower Explosive Limit (%)	Not Available	Volatile Component (%vol)	Not Available
Vapour pressure (kPa)	Not Available	Gas group	Not Available
Solubility in water (g/L)	Miscible	pH as a solution (1%)	2.2 (0.1N)
Vapour density (Air = 1)	Not Available	VOC g/L	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	<ul style="list-style-type: none"><li>Unstable in the presence of incompatible materials.</li><li>Product is considered stable.</li><li>Hazardous polymerisation will not occur.</li></ul>
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled. If prior damage to the circulatory or nervous systems has occurred or if kidney damage has been sustained, proper screenings should be conducted on individuals who may be exposed to further risk if handling and use of the material result in excessive exposures.
Ingestion	The material has <b>NOT</b> been classified by EC Directives or other classification systems as "harmful by ingestion". This is because of the lack of corroborating animal or human evidence.
Skin Contact	This material can cause inflammation of the skin on contact in some persons. The material may accentuate any pre-existing dermatitis condition Open cuts, abraded or irritated skin should not be exposed to this material Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
Eye	This material can cause eye irritation and damage in some persons.
Chronic	Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems. Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure. Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis, caused by particles less than 0.5 micron penetrating and remaining in the lung.

Osmoclean CD	TOXICITY	IRRITATION
	Not Available	Not Available
citric acid, monohydrate	TOXICITY	IRRITATION
	dermal (rat) LD50: >2000 mg/kg <sup>[1]</sup>	Eye (rabbit): 5 mg/30s mild
	Oral (rat) LD50: 3000 mg/kg <sup>[2]</sup>	
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

Osmoclean CD	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.		
CITRIC ACID, MONOHYDRATE	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.		
WATER	No significant acute toxicological data identified in literature search.		
Acute Toxicity	☹	Carcinogenicity	☹

## Osmoclean CD

Skin Irritation/Corrosion	✓	Reproductivity	⊘
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	⊘
Respiratory or Skin sensitisation	⊘	STOT - Repeated Exposure	⊘
Mutagenicity	⊘	Aspiration Hazard	⊘

Legend:   
 ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊘ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
citric acid, monohydrate	EC10	24	Algae or other aquatic plants	>1000mg/L	4
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3
Legend:	Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data				

**DO NOT** discharge into sewer or waterways.

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
citric acid, monohydrate	LOW	LOW
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
citric acid, monohydrate	LOW (LogKOW = -1.64)
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
citric acid, monohydrate	LOW (KOC = 10)
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>▶ Reduction</li> <li>▶ Reuse</li> <li>▶ Recycling</li> <li>▶ Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li>▶ <b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Where in doubt contact the responsible authority.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Dispose of by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material)</li> <li>▶ Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

## Labels Required

Marine Pollutant	NO
HAZCHEM	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Continued...

**Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS**

**Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS**

**Transport in bulk according to Annex II of MARPOL and the IBC code**

Not Applicable

## SECTION 15 REGULATORY INFORMATION

**Safety, health and environmental regulations / legislation specific for the substance or mixture**

**CITRIC ACID, MONOHYDRATE(5949-29-1) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Hazardous Substances Information System - Consolidated Lists

Australia Inventory of Chemical Substances (AICS)

**WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Inventory of Chemical Substances (AICS)

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (citric acid, monohydrate; water)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

### Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

### Definitions and abbreviations

PC — TWA: Permissible Concentration-Time Weighted Average  
PC — STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer  
ACGIH: American Conference of Governmental Industrial Hygienists  
STEL: Short Term Exposure Limit  
TEEL: Temporary Emergency Exposure Limit,  
IDLH: Immediately Dangerous to Life or Health Concentrations  
OSF: Odour Safety Factor  
NOAEL :No Observed Adverse Effect Level  
LOAEL: Lowest Observed Adverse Effect Level  
TLV: Threshold Limit Value  
LOD: Limit Of Detection  
OTV: Odour Threshold Value  
BCF: BioConcentration Factors  
BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.

# Osmoclean DW

Osmoflo Water Management Pty Ltd

Chemwatch: 6534-89

Version No: 4.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 2

Issue Date: 01/01/2013

Print Date: 08/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Osmoclean DW
Synonyms	Osmoclean DW
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Reverse osmosis membrane cleaner.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.


### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	1	2
Toxicity	0	1
Body Contact	2	3
Reactivity	1	2
Chronic	0	1

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	Not Applicable
Classification <sup>[1]</sup>	Skin Corrosion/Irritation Category 2, Eye Irritation Category 2A
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

GHS label elements	
SIGNAL WORD	<b>WARNING</b>

Continued...

## Osmoclean DW

## Hazard statement(s)

H315	Causes skin irritation
H319	Causes serious eye irritation

## Precautionary statement(s) Prevention

P280	Wear protective gloves/protective clothing/eye protection/face protection.
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## Precautionary statement(s) Response

P362	Take off contaminated clothing and wash before reuse.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313	If eye irritation persists: Get medical advice/attention.
P302+P352	IF ON SKIN: Wash with plenty of soap and water.

## Precautionary statement(s) Storage

Not Applicable

## Precautionary statement(s) Disposal

Not Applicable

## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
64-02-8	}	<u>EDTA tetrasodium salt</u>
Not Available	}100	additives nonhazardous

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Wash out immediately with fresh running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Seek medical attention without delay; if pain persists or recurs seek medical attention.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes, aerosols or combustion products are inhaled remove from contaminated area.</li> <li>Other measures are usually unnecessary.</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Immediately give a glass of water.</li> <li>First aid is not generally required. If in doubt, contact a Poisons Information Centre or a doctor.</li> </ul>

## Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

## SECTION 5 FIREFIGHTING MEASURES

## Extinguishing media

- There is no restriction on the type of extinguisher which may be used.
- Use extinguishing media suitable for surrounding area.

## Special hazards arising from the substrate or mixture

Fire Incompatibility	Avoid contamination with oxidising agents i.e. nitrates, oxidising acids, chlorine bleaches, pool chlorine etc. as ignition may result
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## Advice for firefighters

Fire Fighting	<ul style="list-style-type: none"> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear breathing apparatus plus protective gloves in the event of a fire.</li> <li>Prevent, by any means available, spillage from entering drains or water courses.</li> <li>Use fire fighting procedures suitable for surrounding area.</li> </ul>
Fire/Explosion Hazard	<ul style="list-style-type: none"> <li>Solid which exhibits difficult combustion or is difficult to ignite.</li> <li>Avoid generating dust, particularly clouds of dust in a confined or unventilated space as dusts may form an explosive mixture with air, and any source of ignition, i.e. flame or spark, will cause fire or explosion.</li> <li>Dust clouds generated by the fine grinding of the solid are a particular hazard; accumulations of fine dust (420 micron or less) may burn rapidly and fiercely if ignited; once initiated larger particles up to 1400 microns diameter will contribute to the propagation of an explosion.</li> <li>A dust explosion may release large quantities of gaseous products; this in turn creates a subsequent pressure rise of explosive force capable of damaging plant and buildings and injuring people.</li> </ul> <p>Combustion products include; carbon monoxide (CO) carbon dioxide (CO2) other pyrolysis products typical of burning organic material</p>

Continued...

## SECTION 6 ACCIDENTAL RELEASE MEASURES

### Personal precautions, protective equipment and emergency procedures

Minor Spills	<ul style="list-style-type: none"> <li>▶ Clean up all spills immediately.</li> <li>▶ Avoid breathing dust and contact with skin and eyes.</li> <li>▶ Wear protective clothing, gloves, safety glasses and dust respirator.</li> <li>▶ Use dry clean up procedures and avoid generating dust.</li> </ul>
Major Spills	<p>Moderate hazard.</p> <ul style="list-style-type: none"> <li>▶ <b>CAUTION:</b> Advise personnel in area.</li> <li>▶ Alert Emergency Services and tell them location and nature of hazard.</li> <li>▶ Control personal contact by wearing protective clothing.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

### Precautions for safe handling

Safe handling	<ul style="list-style-type: none"> <li>▶ Avoid all personal contact, including inhalation.</li> <li>▶ Wear protective clothing when risk of exposure occurs.</li> <li>▶ Use in a well-ventilated area.</li> <li>▶ Prevent concentration in hollows and sumps.</li> <li>▶ Organic powders when finely divided over a range of concentrations regardless of particulate size or shape and suspended in air or some other oxidizing medium may form explosive dust-air mixtures and result in a fire or dust explosion (including secondary explosions)</li> <li>▶ Minimise airborne dust and eliminate all ignition sources. Keep away from heat, hot surfaces, sparks, and flame.</li> <li>▶ Establish good housekeeping practices.</li> <li>▶ Remove dust accumulations on a regular basis by vacuuming or gentle sweeping to avoid creating dust clouds.</li> </ul>
Other information	<ul style="list-style-type: none"> <li>▶ Store in original containers.</li> <li>▶ Keep containers securely sealed.</li> <li>▶ Store in a cool, dry, well-ventilated area.</li> <li>▶ Store away from incompatible materials and foodstuff containers.</li> </ul>

### Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> <li>▶ Lined metal can, lined metal pail/ can.</li> <li>▶ Plastic pail.</li> <li>▶ Polyliner drum.</li> <li>▶ Packing as recommended by manufacturer.</li> </ul>
Storage incompatibility	<ul style="list-style-type: none"> <li>▶ Avoid reaction with oxidising agents</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

### Control parameters

#### OCCUPATIONAL EXPOSURE LIMITS (OEL)

#### INGREDIENT DATA


Not Available

#### EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
EDTA tetrasodium salt	Ethylenediaminetetraacetic acid, tetrasodium salt, dihydrate	6 mg/m3	66 mg/m3	400 mg/m3
EDTA tetrasodium salt	Ethylenediaminetetraacetic acid, tetrasodium salt; (Tetrasodium EDTA)	30 mg/m3	330 mg/m3	2000 mg/m3

Ingredient	Original IDLH	Revised IDLH
EDTA tetrasodium salt	Not Available	Not Available
additives nonhazardous	Not Available	Not Available

### Exposure controls

Appropriate engineering controls	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
Personal protection	
Eye and face protection	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields.</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
Skin protection	See Hand protection below



## Osmoclean DW

<b>Hands/feet protection</b>	<p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p> <p>Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present.</p> <ul style="list-style-type: none"> <li>▶ polychloroprene.</li> <li>▶ nitrile rubber.</li> <li>▶ butyl rubber.</li> </ul>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ P.V.C. apron.</li> <li>▶ Barrier cream.</li> </ul>
<b>Thermal hazards</b>	Not Available

## Respiratory protection

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	P1 Air-line*	- -	PAPR-P1 -
up to 50 x ES	Air-line**	P2	PAPR-P2
up to 100 x ES	-	P3	-
		Air-line*	-
100+ x ES	-	Air-line**	PAPR-P3

\* - Negative pressure demand \*\* - Continuous flow

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	White powder with slight odour; miscible with water.		
<b>Physical state</b>	Divided Solid	<b>Relative density (Water = 1)</b>	1.67
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Available
<b>pH (as supplied)</b>	Not Available	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	150	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	Not Available	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Available	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Available	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Available	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Applicable
<b>Lower Explosive Limit (%)</b>	Not Available	<b>Volatile Component (%vol)</b>	negligible
<b>Vapour pressure (kPa)</b>	Not Available	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	Not Available
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	Product is considered stable and hazardous polymerisation will not occur.
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Osmoclean DW

## Information on toxicological effects

Inhaled	The material is not thought to produce adverse health effects or irritation of the respiratory tract (as classified by EC Directives using animal models). Nevertheless, good hygiene practice requires that exposure be kept to a minimum and that suitable control measures be used in an occupational setting. Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled. If prior damage to the circulatory or nervous systems has occurred or if kidney damage has been sustained, proper screenings should be conducted on individuals who may be exposed to further risk if handling and use of the material result in excessive exposures.
Ingestion	The material has <b>NOT</b> been classified by EC Directives or other classification systems as "harmful by ingestion". This is because of the lack of corroborating animal or human evidence.
Skin Contact	This material can cause inflammation of the skin on contact in some persons. The material may accentuate any pre-existing dermatitis condition
Eye	This material can cause eye irritation and damage in some persons.
Chronic	Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis, caused by particles less than 0.5 micron penetrating and remaining in the lung.

Osmoclean DW	TOXICITY	IRRITATION
	Not Available	Not Available
EDTA tetrasodium salt	TOXICITY	IRRITATION
	Oral (rat) LD50: 630 mg/kg <sup>[2]</sup>	*[BASF]
		Eyes (rabbit): 1.9 mg
		Eyes (rabbit): 100 mg/24h-moderate
		Skin (rabbit): 500 mg/24h-moderate
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

Acute Toxicity	☐	Carcinogenicity	☐
Skin Irritation/Corrosion	✓	Reproductivity	☐
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	☐
Respiratory or Skin sensitisation	☐	STOT - Repeated Exposure	☐
Mutagenicity	☐	Aspiration Hazard	☐

Legend: ✗ – Data available but does not fill the criteria for classification  
✓ – Data required to make classification available  
☐ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
EDTA tetrasodium salt	NOEC	71	Algae or other aquatic plants	0.0003802mg/L	4
EDTA tetrasodium salt	EC10	72	Algae or other aquatic plants	=0.48mg/L	1
EDTA tetrasodium salt	EC50	72	Algae or other aquatic plants	=1.01mg/L	1
EDTA tetrasodium salt	LC50	96	Fish	41mg/L	2
EDTA tetrasodium salt	EC50	48	Crustacea	140mg/L	2
Legend:	Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data				

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
	No Data available for all ingredients	No Data available for all ingredients

## Bioaccumulative potential

Ingredient	Bioaccumulation
	No Data available for all ingredients

## Mobility in soil

Ingredient	Mobility
	No Data available for all ingredients

## SECTION 13 DISPOSAL CONSIDERATIONS

### Waste treatment methods

Product / Packaging disposal	<p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>▶ Reduction</li> <li>▶ Reuse</li> <li>▶ Recycling</li> <li>▶ Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li>▶ <b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Where in doubt contact the responsible authority.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Dispose of by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material)</li> <li>▶ Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

### Labels Required

Marine Pollutant	NO
HAZCHEM	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

## SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

EDTA TETRASODIUM SALT(64-02-8) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Hazardous Substances Information System - Consolidated Lists	Australia Inventory of Chemical Substances (AICS)
National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (EDTA tetrasodium salt)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	<p>Y = All ingredients are on the inventory</p> <p>N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)</p>

## SECTION 16 OTHER INFORMATION

### Other information

#### Ingredients with multiple cas numbers

Name	CAS No
EDTA tetrasodium salt	10378-23-1, 13235-36-4, 194491-31-1, 64-02-8

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other

Continued...

settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

#### Definitions and abbreviations

PC — TWA: Permissible Concentration-Time Weighted Average  
PC — STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer  
ACGIH: American Conference of Governmental Industrial Hygienists  
STEL: Short Term Exposure Limit  
TEEL: Temporary Emergency Exposure Limit,  
IDLH: Immediately Dangerous to Life or Health Concentrations  
OSF: Odour Safety Factor  
NOAEL :No Observed Adverse Effect Level  
LOAEL: Lowest Observed Adverse Effect Level  
TLV: Threshold Limit Value  
LOD: Limit Of Detection  
OTV: Odour Threshold Value  
BCF: BioConcentration Factors  
BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.

# Osmoflo Osmotreat Si P01077, P01078, P01079

Osmoflo Water Management Pty Ltd

Chemwatch: 25-8130

Version No: 2.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 3

Issue Date: 01/01/2013

Print Date: 11/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	Osmoflo Osmotreat Si P01077, P01078, P01079
Synonyms	Osmotreat Si P01077, P01078, P01079, scale inhibitor
Proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains polycarboxylic acids & phosphonic acid)
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Reverse osmosis scale inhibitor.
--------------------------	----------------------------------

### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.


### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	1	2
Toxicity	2	3
Body Contact	3	4
Reactivity	1	2
Chronic	2	3

0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	Not Applicable
Classification <sup>[1]</sup>	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 2, Eye Irritation Category 2A, Chronic Aquatic Hazard Category 3
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

GHS label elements	
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Continued...

## Osmoflo Osmotreat Si P01077, P01078, P01079

## SIGNAL WORD

WARNING

## Hazard statement(s)

H290	May be corrosive to metals.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H412	Toxic to aquatic life with long lasting effects.

## Precautionary statement(s) Prevention

P234	Keep only in original container.
P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

## Precautionary statement(s) Response

P362	Take off contaminated clothing and wash before reuse.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313	If eye irritation persists: Get medical advice/attention.
P390	Absorb spillage to prevent material damage.

## Precautionary statement(s) Storage

Not Applicable

## Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
Not Available	40-90	polycarboxylic acids
Not Available	5-10	phosphonic acid derivative.
7732-18-5	0-55	water

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Wash out immediately with fresh running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Seek medical attention without delay; if pain persists or recurs seek medical attention.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>If fumes, aerosols or combustion products are inhaled remove from contaminated area.</li> <li>Other measures are usually unnecessary.</li> <li>Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.</li> <li>Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).</li> <li>As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.</li> <li>Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.</li> </ul> <p><b>This must definitely be left to a doctor or person authorised by him/her.</b> (ICSC13719)</p>
Ingestion	<ul style="list-style-type: none"> <li>Immediately give a glass of water.</li> <li>First aid is not generally required. If in doubt, contact a Poisons Information Centre or a doctor.</li> </ul>

## Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

For acute or short term repeated exposures to strong acids:

- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.
- Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
- Strong acids produce a coagulation necrosis characterised by formation of a coagulum (eschar) as a result of the desiccating action of the acid on proteins in specific tissues.

## INGESTION:

- Immediate dilution (milk or water) within 30 minutes post ingestion is recommended.
- DO NOT attempt to neutralise the acid since exothermic reaction may extend the corrosive injury.**
- Be careful to avoid further vomit since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
- Charcoal has no place in acid management.

Continued...

## Osmoflo Osmotreat Si P01077, P01078, P01079

- Some authors suggest the use of lavage within 1 hour of ingestion.

## SKIN:

- Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
- Deep second-degree burns may benefit from topical silver sulfadiazine.

## EYE:

- Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjunctival cul-de-sacs. Irrigation should last at least 20-30 minutes. **DO NOT use neutralising agents or any other additives.** Several litres of saline are required.
- Cycloplegic drops, (1% cyclopentolate for short-term use or 5% homatropine for longer term use) antibiotic drops, vasoconstrictive agents or artificial tears may be indicated dependent on the severity of the injury.
- Steroid eye drops should only be administered with the approval of a consulting ophthalmologist).

[Ellenhorn and Barceloux: Medical Toxicology]

## SECTION 5 FIREFIGHTING MEASURES

## Extinguishing media

The product contains a substantial proportion of water, therefore there are no restrictions on the type of extinguishing media which may be used. Choice of extinguishing media should take into account surrounding areas.

Though the material is non-combustible, evaporation of water from the mixture, caused by the heat of nearby fire, may produce floating layers of combustible substances.

In such an event consider:

- foam.

## Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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## Advice for firefighters

Fire Fighting	<ul style="list-style-type: none"> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear full body protective clothing with breathing apparatus.</li> <li>Prevent, by any means available, spillage from entering drains or water course.</li> <li>Use fire fighting procedures suitable for surrounding area.</li> </ul>
Fire/Explosion Hazard	<ul style="list-style-type: none"> <li>Combustible.</li> <li>Slight fire hazard when exposed to heat or flame.</li> <li>Acids may react with metals to produce hydrogen, a highly flammable and explosive gas.</li> <li>Heating may cause expansion or decomposition leading to violent rupture of containers.</li> </ul> <p>Combustion products include: carbon monoxide (CO) carbon dioxide (CO<sub>2</sub>) nitrogen oxides (NO<sub>x</sub>) phosphorus oxides (PO<sub>x</sub>) sulfur oxides (SO<sub>x</sub>) other pyrolysis products typical of burning organic material</p>

## SECTION 6 ACCIDENTAL RELEASE MEASURES

## Personal precautions, protective equipment and emergency procedures

Minor Spills	<ul style="list-style-type: none"> <li>Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.</li> <li>Check regularly for spills and leaks.</li> <li>Clean up all spills immediately.</li> <li>Avoid breathing vapours and contact with skin and eyes.</li> <li>Control personal contact with the substance, by using protective equipment.</li> <li>Contain and absorb spill with sand, earth, inert material or vermiculite.</li> </ul>
Major Spills	<ul style="list-style-type: none"> <li>Clear area of personnel and move upwind.</li> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear full body protective clothing with breathing apparatus.</li> <li>Prevent, by any means available, spillage from entering drains or water course.</li> </ul>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

## Precautions for safe handling

Safe handling	<ul style="list-style-type: none"> <li><b>DO NOT allow clothing wet with material to stay in contact with skin</b></li> <li>Avoid all personal contact, including inhalation.</li> <li>Wear protective clothing when risk of exposure occurs.</li> <li>Use in a well-ventilated area.</li> <li>Avoid contact with moisture.</li> </ul>
Other information	<ul style="list-style-type: none"> <li>Store in original containers.</li> <li>Keep containers securely sealed.</li> <li>Store in a cool, dry, well-ventilated area.</li> <li>Store away from incompatible materials and foodstuff containers.</li> </ul>

## Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> <li><b>DO NOT use aluminium or galvanised containers</b></li> <li>Check regularly for spills and leaks</li> <li>Lined metal can, lined metal pail/ can.</li> <li>Plastic pail.</li> <li>Polyliner drum.</li> <li>Packing as recommended by manufacturer.</li> </ul> <p>For low viscosity materials</p> <ul style="list-style-type: none"> <li>Drums and jerricans must be of the non-removable head type.</li> <li>Where a can is to be used as an inner package, the can must have a screwed enclosure.</li> </ul> <p>For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):</p> <ul style="list-style-type: none"> <li>Removable head packaging;</li> </ul>
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Continued...

## Osmoflo Osmotreat Si P01077, P01078, P01079

	<ul style="list-style-type: none"> <li>▶ Cans with friction closures and</li> <li>▶ low pressure tubes and cartridges may be used.</li> </ul>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"> <li>▶ Segregate from alkalies, oxidising agents and chemicals readily decomposed by acids, i.e. cyanides, sulfides, carbonates.</li> <li>▶ Reacts with mild steel, galvanised steel / zinc producing hydrogen gas which may form an explosive mixture with air.</li> <li>▶ Avoid strong bases.</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA

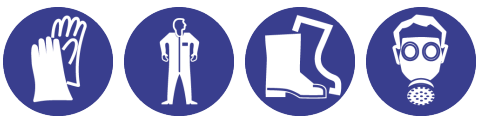
Not Available

## EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
Osmoflo Osmotreat Si P01077, P01078, P01079	Not Available	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
polycarboxylic acids	Not Available	Not Available
phosphonic acid derivative.	Not Available	Not Available
water	Not Available	Not Available

## Exposure controls

<b>Appropriate engineering controls</b>	<p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>▶ Safety glasses with side shields.</li> <li>▶ Chemical goggles.</li> <li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<ul style="list-style-type: none"> <li>▶ Wear chemical protective gloves, e.g. PVC.</li> <li>▶ Wear safety footwear or safety gumboots, e.g. Rubber</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>▶ Overalls.</li> <li>▶ PVC Apron.</li> <li>▶ PVC protective suit may be required if exposure severe.</li> <li>▶ Eyewash unit.</li> </ul>
<b>Thermal hazards</b>	Not Available

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

"Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

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Material	CPI
BUTYL	A
NEOPRENE	A
VITON	A
NATURAL RUBBER	C
PVA	C

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

Continued...



## Osmoflo Osmotreat Si P01077, P01078, P01079

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	Light or pale yellow liquid with a slight odour; mixes with water.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	Not Available
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Available
<b>pH (as supplied)</b>	<2	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	-5	<b>Viscosity (cSt)</b>	9-15 @ 20C
<b>Initial boiling point and boiling range (°C)</b>	100	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	200	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Available	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Available	<b>Volatile Component (%vol)</b>	Not Available
<b>Vapour pressure (kPa)</b>	2.3 @ 20C	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	Not Available
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	► Contact with alkaline material liberates heat
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	The material is not thought to produce adverse health effects or irritation of the respiratory tract (as classified by EC Directives using animal models). Nevertheless, good hygiene practice requires that exposure be kept to a minimum and that suitable control measures be used in an occupational setting.
<b>Ingestion</b>	Accidental ingestion of the material may be damaging to the health of the individual. Ingestion may result in nausea, abdominal irritation, pain and vomiting
<b>Skin Contact</b>	This material can cause inflammation of the skin on contact in some persons. The material may accentuate any pre-existing dermatitis condition. Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
<b>Eye</b>	This material can cause eye irritation and damage in some persons.
<b>Chronic</b>	Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.

<b>Osmoflo Osmotreat Si P01077, P01078, P01079</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (Rat) LD50: 2400 mg/kg <sup>[2]</sup>	Not Available
<b>water</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	Not Available
<b>Legend:</b>	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

<b>Osmoflo Osmotreat Si P01077, P01078, P01079</b>	No significant acute toxicological data identified in literature search.
	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as

Continued...

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	reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.		
<b>WATER</b>	No significant acute toxicological data identified in literature search.		
<b>Acute Toxicity</b>	✗	<b>Carcinogenicity</b>	⊖
<b>Skin Irritation/Corrosion</b>	✓	<b>Reproductivity</b>	⊖
<b>Serious Eye Damage/Irritation</b>	✓	<b>STOT - Single Exposure</b>	⊖
<b>Respiratory or Skin sensitisation</b>	⊖	<b>STOT - Repeated Exposure</b>	⊖
<b>Mutagenicity</b>	⊖	<b>Aspiration Hazard</b>	⊖

**Legend:** ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊖ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3
<b>Legend:</b>	Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data				

Prevent, by any means available, spillage from entering drains or water courses.

**DO NOT discharge into sewer or waterways.**

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

<b>Product / Packaging disposal</b>	<p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>▶ Reduction</li> <li>▶ Reuse</li> <li>▶ Recycling</li> <li>▶ Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li>▶ <b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>▶ It may be necessary to collect all wash water for treatment before disposal.</li> <li>▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>▶ Where in doubt contact the responsible authority.</li> <li>▶ Recycle wherever possible.</li> <li>▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.</li> <li>▶ Treat and neutralise at an approved treatment plant. Treatment should involve: Neutralisation with soda-ash or soda-lime followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or incineration in a licenced apparatus</li> <li>▶ Decontaminate empty containers with 5% aqueous sodium hydroxide or soda ash, followed by water.</li> </ul>
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## SECTION 14 TRANSPORT INFORMATION

## Labels Required

## Osmoflo Osmotreat Si P01077, P01078, P01079



Marine Pollutant	NO
HAZCHEM	2X

## Land transport (ADG)

UN number	3265
Packing group	III
UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains polycarboxylic acids & phosphonic acid)
Environmental hazard	Not Applicable
Transport hazard class(es)	Class : 8 Subrisk : Not Applicable
Special precautions for user	Special provisions : 223 274 Limited quantity : 5 L

## Air transport (ICAO-IATA / DGR)

UN number	3265
Packing group	III
UN proper shipping name	Corrosive liquid, acidic, organic, n.o.s. * (contains polycarboxylic acids & phosphonic acid)
Environmental hazard	Not Applicable
Transport hazard class(es)	ICAO/IATA Class : 8 ICAO / IATA Subrisk : Not Applicable ERG Code : 8L
Special precautions for user	Special provisions : A3A803 Cargo Only Packing Instructions : 856 Cargo Only Maximum Qty / Pack : 60 L Passenger and Cargo Packing Instructions : 852 Passenger and Cargo Maximum Qty / Pack : 5 L Passenger and Cargo Limited Quantity Packing Instructions : Y841 Passenger and Cargo Limited Maximum Qty / Pack : 1 L

## Sea transport (IMDG-Code / GGVSee)

UN number	3265
Packing group	III
UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (contains polycarboxylic acids & phosphonic acid)
Environmental hazard	Not Applicable
Transport hazard class(es)	IMDG Class : 8 IMDG Subrisk : Not Applicable
Special precautions for user	EMS Number : F-A, S-B Special provisions : 223 274 Limited Quantities : 5 L

## Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

## SECTION 15 REGULATORY INFORMATION

## Safety, health and environmental regulations / legislation specific for the substance or mixture

## WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water)

Continued...

## Osmoflo Osmotreat Si P01077, P01078, P01079

China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

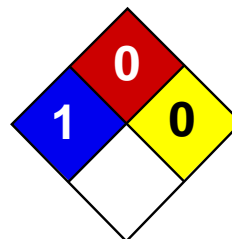
## Definitions and abbreviations

PC – TWA: Permissible Concentration-Time Weighted Average  
 PC – STEL: Permissible Concentration-Short Term Exposure Limit  
 IARC: International Agency for Research on Cancer  
 ACGIH: American Conference of Governmental Industrial Hygienists  
 STEL: Short Term Exposure Limit  
 TEEL: Temporary Emergency Exposure Limit,  
 IDLH: Immediately Dangerous to Life or Health Concentrations  
 OSF: Odour Safety Factor  
 NOAEL :No Observed Adverse Effect Level  
 LOAEL: Lowest Observed Adverse Effect Level  
 TLV: Threshold Limit Value  
 LOD: Limit Of Detection  
 OTV: Odour Threshold Value  
 BCF: BioConcentration Factors  
 BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.



Health	1
Fire	0
Reactivity	0
Personal Protection	E

## Material Safety Data Sheet

### Sodium chloride MSDS

#### Section 1: Chemical Product and Company Identification

**Product Name:** Sodium chloride

**Catalog Codes:** SLS3262, SLS1045, SLS3889, SLS1669, SLS3091

**CAS#:** 7647-14-5

**RTECS:** VZ4725000

**TSCA:** TSCA 8(b) inventory: Sodium chloride

**CI#:** Not applicable.

**Synonym:** Salt; Sea Salt

**Chemical Name:** Sodium chloride

**Chemical Formula:** NaCl

#### Contact Information:

**Sciencelab.com, Inc.**

14025 Smith Rd.

Houston, Texas 77396

US Sales: **1-800-901-7247**

International Sales: **1-281-441-4400**

Order Online: [ScienceLab.com](http://ScienceLab.com)

**CHEMTREC (24HR Emergency Telephone), call:**

1-800-424-9300

**International CHEMTREC, call:** 1-703-527-3887

**For non-emergency assistance, call:** 1-281-441-4400

#### Section 2: Composition and Information on Ingredients

##### Composition:

Name	CAS #	% by Weight
Sodium chloride	7647-14-5	100

**Toxicological Data on Ingredients:** Sodium chloride: ORAL (LD50): Acute: 3000 mg/kg [Rat]. 4000 mg/kg [Mouse]. DERMAL (LD50): Acute: >10000 mg/kg [Rabbit]. DUST (LC50): Acute: >42000 mg/m 1 hours [Rat].

#### Section 3: Hazards Identification

**Potential Acute Health Effects:** Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.

##### Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Not available. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. Repeated or prolonged exposure is not known to aggravate medical condition.

#### Section 4: First Aid Measures

**Eye Contact:**

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention.

**Skin Contact:**

Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

**Serious Skin Contact:** Not available.

**Inhalation:**

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

**Serious Inhalation:** Not available.

**Ingestion:**

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

**Serious Ingestion:** Not available.

## Section 5: Fire and Explosion Data

**Flammability of the Product:** Non-flammable.

**Auto-Ignition Temperature:** Not applicable.

**Flash Points:** Not applicable.

**Flammable Limits:** Not applicable.

**Products of Combustion:** Not available.

**Fire Hazards in Presence of Various Substances:** Not applicable.

**Explosion Hazards in Presence of Various Substances:**

Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

**Fire Fighting Media and Instructions:** Not applicable.

**Special Remarks on Fire Hazards:** When heated to decomposition it emits toxic fumes.

**Special Remarks on Explosion Hazards:**

Electrolysis of sodium chloride in presence of nitrogenous compounds to produce chlorine may lead to formation of explosive nitrogen trichloride. Potentially explosive reaction with dichloromaleic anhydride + urea.

## Section 6: Accidental Release Measures

**Small Spill:**

Use appropriate tools to put the spilled solid in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

**Large Spill:**

Use a shovel to put the material into a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.

## Section 7: Handling and Storage

**Precautions:**

Keep locked up.. Do not ingest. Do not breathe dust. Avoid contact with eyes. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids.

**Storage:** Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic

## Section 8: Exposure Controls/Personal Protection

### Engineering Controls:

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

### Personal Protection:

Splash goggles. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

### Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

**Exposure Limits:** Not available.

## Section 9: Physical and Chemical Properties

**Physical state and appearance:** Solid. (Solid crystalline powder.)

**Odor:** Slight.

**Taste:** Saline.

**Molecular Weight:** 58.44 g/mole

**Color:** White.

**pH (1% soln/water):** 7 [Neutral.]

**Boiling Point:** 1413°C (2575.4°F)

**Melting Point:** 801°C (1473.8°F)

**Critical Temperature:** Not available.

**Specific Gravity:** 2.165 (Water = 1)

**Vapor Pressure:** Not applicable.

**Vapor Density:** Not available.

**Volatility:** Not available.

**Odor Threshold:** Not available.

**Water/Oil Dist. Coeff.:** Not available.

**Ionicity (in Water):** Not available.

**Dispersion Properties:** See solubility in water.

### Solubility:

Easily soluble in cold water, hot water. Soluble in glycerol, and ammonia. Very slightly soluble in alcohol. Insoluble in Hydrochloric Acid.

## Section 10: Stability and Reactivity Data

**Stability:** The product is stable.

**Instability Temperature:** Not available.

**Conditions of Instability:** Incompatible materials, high temperatures.

**Incompatibility with various substances:** Reactive with oxidizing agents, metals, acids.

**Corrosivity:** Not considered to be corrosive for metals and glass.

**Special Remarks on Reactivity:**

Hygroscopic. Reacts with most nonnoble metals such as iron or steel, building materials (such as cement) Sodium chloride is rapidly attacked by bromine trifluoride. Violent reaction with lithium.

**Special Remarks on Corrosivity:** Not available.

**Polymerization:** Will not occur.

## Section 11: Toxicological Information

**Routes of Entry:** Inhalation. Ingestion.

**Toxicity to Animals:**

WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE. Acute oral toxicity (LD50): 3000 mg/kg [Rat.]. Acute dermal toxicity (LD50): >10000 mg/kg [Rabbit]. Acute toxicity of the dust (LC50): >42000 mg/m<sup>3</sup> 1 hours [Rat].

**Chronic Effects on Humans:** MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.

**Other Toxic Effects on Humans:** Slightly hazardous in case of skin contact (irritant), of ingestion, of inhalation.

**Special Remarks on Toxicity to Animals:** Lowest Published Lethal Dose (LDL) [Man] - Route: Oral; Dose: 1000 mg/kg

**Special Remarks on Chronic Effects on Humans:**

Causes adverse reproductive effects in humans (fetotoxicity, abortion, ) by intraplacental route. High intake of sodium chloride, whether from occupational exposure or in the diet, may increase risk of TOXEMIA OF PREGNANCY in susceptible women (Bishop, 1978). Hypertonic sodium chloride solutions have been used to induce abortion in late pregnancy by direct infusion into the uterus (Brown et al, 1972), but this route of administration is not relevant to occupational exposures. May cause adverse reproductive effects and birth defects in animals, particularly rats and mice (fetotoxicity, abortion, musculoskeletal abnormalities, and maternal effects (effects on ovaries, fallopian tubes) by oral, intraperitoneal, intraplacental, intrauterine, parenteral, and subcutaneous routes. While sodium chloride has been used as a negative control in some reproductive studies, it has also been used as an example that almost any chemical can cause birth defects in experimental animals if studied under the right conditions (Nishimura & Miyamoto, 1969). In experimental animals, sodium chloride has caused delayed effects on newborns, has been fetotoxic, and has caused birth defects and abortions in rats and mice (RTECS, 1997). May affect genetic material (mutagenic)

**Special Remarks on other Toxic Effects on Humans:**

Acute Potential Health Effects: Skin: May cause skin irritation. Eyes: Causes eye irritation. Ingestion: Ingestion of large quantities can irritate the stomach (as in overuse of salt tablets) with nausea and vomiting. May affect behavior (muscle spasticity/contraction, somnolence), sense organs, metabolism, and cardiovascular system. Continued exposure may produce dehydration, internal organ congestion, and coma. Inhalation: Material is irritating to mucous membranes and upper respiratory tract.

## Section 12: Ecological Information

**Ecotoxicity:** Not available.

**BOD5 and COD:** Not available.

**Products of Biodegradation:**

Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

**Toxicity of the Products of Biodegradation:** The product itself and its products of degradation are not toxic.



**Special Remarks on the Products of Biodegradation:** Not available.

### Section 13: Disposal Considerations

**Waste Disposal:**

Waste must be disposed of in accordance with federal, state and local environmental control regulations.

### Section 14: Transport Information

**DOT Classification:** Not a DOT controlled material (United States).

**Identification:** Not applicable.

**Special Provisions for Transport:** Not applicable.

### Section 15: Other Regulatory Information

**Federal and State Regulations:** TSCA 8(b) inventory: Sodium chloride

**Other Regulations:** EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

**Other Classifications:**

**WHMIS (Canada):** Not controlled under WHMIS (Canada).

**DSCL (EEC):**

R40- Possible risks of irreversible effects. S24/25- Avoid contact with skin and eyes.

**HMIS (U.S.A.):**

**Health Hazard:** 1

**Fire Hazard:** 0

**Reactivity:** 0

**Personal Protection:** E

**National Fire Protection Association (U.S.A.):**

**Health:** 1

**Flammability:** 0

**Reactivity:** 0

**Specific hazard:**

**Protective Equipment:**

Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Splash goggles.

### Section 16: Other Information

**References:**

-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -SAX, N.I. Dangerous Properties of Industrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II.

**Other Special Considerations:** Not available.

**Created:** 10/11/2005 12:33 PM

**Last Updated:** 05/21/2013 12:00 PM

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# sodium hypochlorite solution

Osmoflo Water Management Pty Ltd

Chemwatch: 1791-1

Version No: 6.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 3

Issue Date: 01/01/2013

Print Date: 07/03/2016

Initial Date: Not Available

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	sodium hypochlorite solution
Synonyms	Antiformin B-K liquid, Carrel-Darkin solution, Chloro, Chlorox Clorox, Dakin's solution bleach, Hypochlorite Milton, Ikon sodium hypochlorite solution 13.0%, Liquid pool chlorine, Na-O-Cl, Newland sodium hypochloride, Soda bleach liquor, Surchlor household bleach, hypochlorous acid, sodium salt
Proper shipping name	HYPOCHLORITE SOLUTION
Other means of identification	Not Available

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation. In the bleaching of paper pulp and textiles, for the purification of water. Sterilising disinfectant and as fungicide, microbiocide in laundry. An oxidising agent used in the manufacture of organic chemicals and as a chemical intermediate. [~Intermediate ~]
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton 5110 SA Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008 +61 (2) 9186 1132
Other emergency telephone numbers	1800 039 008 +61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	+612 9186 1132	Not Available

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the WHS Regulations and the ADG Code.**

#### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	1	
Body Contact	3	
Reactivity	2	
Chronic	0	


0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Poisons Schedule	Not Applicable
Classification <sup>[1]</sup>	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1B, Serious Eye Damage Category 1, Acute Aquatic Hazard Category 1
Legend:	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

Continued...

## sodium hypochlorite solution

GHS label elements	 
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## SIGNAL WORD

DANGER

## Hazard statement(s)

H290	May be corrosive to metals
H314	Causes severe skin burns and eye damage
H318	Causes serious eye damage
H400	Very toxic to aquatic life
AUH031	Contact with acid liberates toxic gas

## Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P234	Keep only in original container.
P273	Avoid release to the environment.

## Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.

## Precautionary statement(s) Storage

P405	Store locked up.
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## Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

## Substances

See section below for composition of Mixtures

## Mixtures

CAS No	%[weight]	Name
7681-52-9	5-30	sodium hypochlorite
		@ 136.4 gram / Litre = 11.3 % hypochlorite or
		as 13% available chlorine
7732-18-5	>60	water
7782-50-5		chlorine

## SECTION 4 FIRST AID MEASURES

## Description of first aid measures

Eye Contact	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>▶ Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>▶ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>▶ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>▶ Transport to hospital or doctor without delay.</li> <li>▶ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
Skin Contact	<p>If skin or hair contact occurs:</p> <ul style="list-style-type: none"> <li>▶ Immediately flush body and clothes with large amounts of water, using safety shower if available.</li> <li>▶ Quickly remove all contaminated clothing, including footwear.</li> <li>▶ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.</li> <li>▶ Transport to hospital, or doctor.</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>▶ If fumes or combustion products are inhaled remove from contaminated area.</li> <li>▶ Lay patient down. Keep warm and rested.</li> <li>▶ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>▶ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>▶ Transport to hospital, or doctor.</li> </ul>

Continued...

## sodium hypochlorite solution

## Ingestion

- ▶ For advice, contact a Poisons Information Centre or a doctor at once.
- ▶ Urgent hospital treatment is likely to be needed.
- ▶ **If swallowed do NOT induce vomiting.**
- ▶ If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.
- ▶ Observe the patient carefully.
- ▶ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.
- ▶ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink.
- ▶ Transport to hospital or doctor without delay.

## Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

Excellent warning properties force rapid escape of personnel from chlorine vapour thus most inhalations are mild to moderate. If escape is not possible, exposure to high concentrations for a very short time can result in dyspnea, haemophysis and cyanosis with later complications being tracheobroncho-pneumonitis and pulmonary oedema. Oxygen, intermittent positive pressure breathing apparatus and aerosolised bronchodilators are of therapeutic value where chlorine inhalation has been light to moderate. Severe inhalation should result in hospitalisation and treatment for a respiratory emergency.

Any chlorine inhalation in an individual with compromised pulmonary function (COPD) should be regarded as a severe inhalation and a respiratory emergency. [CCINFO, Dow 1988]

Effects from exposure to chlorine gas include pulmonary oedema which may be delayed. Observation in hospital for 48 hours is recommended

Diagnosed asthmatics and those people suffering from certain types of chronic bronchitis should receive medical approval before being employed in occupations involving chlorine exposure.

If burn is present, treat as any thermal burn, after decontamination.

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of lung oedema often do not manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorised by him/her should be considered.

(ICSC24419/24421

for corrosives:

## BASIC TREATMENT

- ▶ Establish a patent airway with suction where necessary.
- ▶ Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- ▶ Administer oxygen by non-rebreather mask at 10 to 15 l/min.
- ▶ Monitor and treat, where necessary, for pulmonary oedema.
- ▶ Monitor and treat, where necessary, for shock.
- ▶ Anticipate seizures.
- ▶ Where eyes have been exposed, flush immediately with water and continue to irrigate with normal saline during transport to hospital.
- ▶ **DO NOT use emetics.** Where ingestion is suspected rinse mouth and give up to 200 ml water (5 ml/kg recommended) for dilution where patient is able to swallow, has a strong gag reflex and does not drool.
- ▶ Skin burns should be covered with dry, sterile bandages, following decontamination.
- ▶ **DO NOT attempt neutralisation as exothermic reaction may occur.**

## ADVANCED TREATMENT

- ▶ Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- ▶ Positive-pressure ventilation using a bag-valve mask might be of use.
- ▶ Monitor and treat, where necessary, for arrhythmias.
- ▶ Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- ▶ Drug therapy should be considered for pulmonary oedema.
- ▶ Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- ▶ Treat seizures with diazepam.
- ▶ Proparacaine hydrochloride should be used to assist eye irrigation.

## EMERGENCY DEPARTMENT

- ▶ Laboratory analysis of complete blood count, serum electrolytes, BUN, creatinine, glucose, urinalysis, baseline for serum aminotransferases (ALT and AST), calcium, phosphorus and magnesium, may assist in establishing a treatment regime.
- ▶ Positive end-expiratory pressure (PEEP)-assisted ventilation may be required for acute parenchymal injury or adult respiratory distress syndrome.
- ▶ Consider endoscopy to evaluate oral injury.
- ▶ Consult a toxicologist as necessary.

BRONSTEIN, A.C. and CURRANCE, P.L. *EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994*

For acute or repeated exposures to hypochlorite solutions:

- ▶ Release of small amounts of hypochlorous acid and acid gases from the stomach following ingestion, is usually too low to cause damage but may be irritating to mucous membranes. Buffering with antacid may be helpful if discomfort is evident.
- ▶ Evaluate as potential caustic exposure.
- ▶ Decontaminate skin and eyes with copious saline irrigation. Check exposed eyes for corneal abrasions with fluorescein staining.
- ▶ Emesis or lavage and catharsis may be indicated for mild caustic exposure.
- ▶ Chlorine exposures require evaluation of acid/base and respiratory status.
- ▶ Inhalation of vapours or mists may result in pulmonary oedema.

ELLENHORN and BARCELOUX: Medical Toxicology.

## SECTION 5 FIREFIGHTING MEASURES

## Extinguishing media

- ▶ Water spray or fog.
- ▶ Foam.
- ▶ Dry chemical powder.
- ▶ BCF (where regulations permit).

## Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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## Advice for firefighters

## Fire Fighting

- ▶ Alert Fire Brigade and tell them location and nature of hazard.
- ▶ Wear full body protective clothing with breathing apparatus.
- ▶ Prevent, by any means available, spillage from entering drains or water course.
- ▶ Use fire fighting procedures suitable for surrounding area.

## sodium hypochlorite solution

<b>Fire/Explosion Hazard</b>	<ul style="list-style-type: none"> <li>Non combustible.</li> <li>Not considered a significant fire risk, however containers may burn.</li> </ul> <p>Decomposition may produce toxic fumes of; hydrogen chloride nitrogen oxides (NOx) metal oxides</p> <p><b>Contains low boiling substance:</b> Closed containers may rupture due to pressure buildup under fire conditions.</p>
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## SECTION 6 ACCIDENTAL RELEASE MEASURES

## Personal precautions, protective equipment and emergency procedures

<b>Minor Spills</b>	<ul style="list-style-type: none"> <li>Clean up all spills immediately.</li> <li>Avoid breathing vapours and contact with skin and eyes.</li> <li>Control personal contact with the substance, by using protective equipment.</li> <li>Contain and absorb spill with sand, earth, inert material or vermiculite.</li> </ul> <p>Neutralise with sodium metabisulfite or sodium thiosulfate.</p>
<b>Major Spills</b>	<ul style="list-style-type: none"> <li><b>DO NOT touch the spill material</b></li> <li>Clear area of personnel and move upwind.</li> <li>Alert Fire Brigade and tell them location and nature of hazard.</li> <li>Wear full body protective clothing with breathing apparatus.</li> <li>Prevent, by any means available, spillage from entering drains or water course.</li> </ul> <p>Neutralise with sodium metabisulfite or sodium thiosulfate.</p>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

## SECTION 7 HANDLING AND STORAGE

## Precautions for safe handling

<b>Safe handling</b>	<p><b>Contains low boiling substance:</b></p> <p>Storage in sealed containers may result in pressure buildup causing violent rupture of containers not rated appropriately.</p> <ul style="list-style-type: none"> <li>Check for bulging containers.</li> <li>Vent periodically</li> <li>Always release caps or seals slowly to ensure slow dissipation of vapours</li> <li><b>DO NOT allow clothing wet with material to stay in contact with skin</b></li> <li>Avoid all personal contact, including inhalation.</li> <li>Wear protective clothing when risk of exposure occurs.</li> <li>Use in a well-ventilated area.</li> <li>Avoid contact with moisture.</li> </ul>
<b>Other information</b>	<ul style="list-style-type: none"> <li>Store in an upright position.</li> <li>Store in original containers.</li> <li>Keep containers securely sealed.</li> <li>Store in a cool, dry, well-ventilated area.</li> <li>Store away from incompatible materials and foodstuff containers.</li> </ul>

## Conditions for safe storage, including any incompatibilities

<b>Suitable container</b>	<p>Liquid inorganic hypochlorites shall not be transported in unlined metal drums. Inner packagings shall be fitted with vented closures and plastics drums and carboys shall have vented closures or be performance tested to a minimum of 250 kPa. All non-vented packagings shall be filled so that the ullage is at least 10% at 21-25 deg.C. Vented packagings may be filled to an ullage not less than 5% at 21-25 deg.C, provided that this ullage does not result in leakage from, nor distortion of, the packaging.</p> <ul style="list-style-type: none"> <li>Glass container is suitable for laboratory quantities</li> <li>Lined metal can, lined metal pail/ can.</li> <li>Plastic pail.</li> <li>Polyliner drum.</li> <li>Packing as recommended by manufacturer.</li> </ul> <p>For low viscosity materials</p> <ul style="list-style-type: none"> <li>Drums and jerricans must be of the non-removable head type.</li> <li>Where a can is to be used as an inner package, the can must have a screwed enclosure.</li> </ul> <p>For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.):</p> <ul style="list-style-type: none"> <li>Removable head packaging;</li> <li>Cans with friction closures and</li> <li>low pressure tubes and cartridges</li> </ul> <p>may be used.</p>
<b>Storage incompatibility</b>	<ul style="list-style-type: none"> <li>Contact with acids produces toxic fumes</li> <li>Presence of rust (iron oxide) or other metal oxides catalyses decomposition of inorganic hypochlorites.</li> <li>Contact with water can cause heating and decomposition giving off chlorine and oxygen gases. Solid hypochlorites in contact with water or moisture may generate sufficient heat to ignite combustible materials. Thermal decomposition can be sustained in the absence of oxygen.</li> </ul> <p>Contact with acids produces toxic fumes of chlorine</p> <ul style="list-style-type: none"> <li>Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous</li> <li>Avoid storage with reducing agents.</li> </ul>

## SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	chlorine	Chlorine	Not Available	Not Available	3 mg/m3 / 1 ppm	Not Available

## EMERGENCY LIMITS

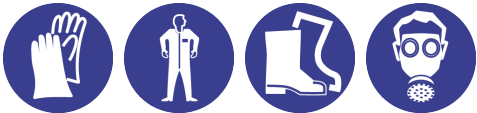
Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
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## sodium hypochlorite solution

sodium hypochlorite	Sodium hypochlorite pentahydrate	4.6 mg/m3	51 mg/m3	290 mg/m3
sodium hypochlorite	Sodium hypochlorite	2 mg/m3	20 mg/m3	630 mg/m3
chlorine	Chlorine	Not Available	Not Available	Not Available
chlorine	Chlorine Hi dry granular (as Cl)	1 ppm	2.52 ppm	30 ppm

Ingredient	Original IDLH	Revised IDLH
sodium hypochlorite	Not Available	Not Available
water	Not Available	Not Available
chlorine	30 ppm	10 ppm

## Exposure controls

<b>Appropriate engineering controls</b>	<p><b>CARE:</b> Use of a quantity of this material in confined space or poorly ventilated area, where rapid build up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear</p> <p>Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.</p> <p>The basic types of engineering controls are:</p> <p>Process controls which involve changing the way a job activity or process is done to reduce the risk.</p> <p>Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.</p>
<b>Personal protection</b>	
<b>Eye and face protection</b>	<ul style="list-style-type: none"> <li>Chemical goggles.</li> <li>Full face shield may be required for supplementary but never for primary protection of eyes.</li> <li>Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li> </ul>
<b>Skin protection</b>	See Hand protection below
<b>Hands/feet protection</b>	<ul style="list-style-type: none"> <li>Wear chemical protective gloves, e.g. PVC.</li> <li>Wear safety footwear or safety gumboots, e.g. Rubber</li> <li>When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.</li> </ul> <p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>The material may produce skin sensitisation in predisposed individuals. Care must be taken, when removing gloves and other protective equipment, to avoid all possible skin contact.</li> <li>Contaminated leather items, such as shoes, belts and watch-bands should be removed and destroyed.</li> </ul> <p>The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.</p> <p>The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.</p> <p>Suitability and durability of glove type is dependent on usage.</p>
<b>Body protection</b>	See Other protection below
<b>Other protection</b>	<ul style="list-style-type: none"> <li>Overalls.</li> <li>PVC Apron.</li> <li>PVC protective suit may be required if exposure severe.</li> <li>Eyewash unit.</li> </ul>
<b>Thermal hazards</b>	Not Available

## Recommended material(s)

## GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:

"Forsberg Clothing Performance Index".

The effect(s) of the following substance(s) are taken into account in the **computer-generated** selection:

sodium hypochlorite solution

Material	CPI
NEOPRENE	A
BUTYL	C
NATURAL RUBBER	C
NATURAL+NEOPRENE	C
NITRILE	C
NITRILE+PVC	C
PVA	C
PVC	C
VITON	C

\* CPI - Chemwatch Performance Index

A: Best Selection

B: Satisfactory; may degrade after 4 hours continuous immersion

C: Poor to Dangerous Choice for other than short term immersion

**NOTE:** As a series of factors will influence the actual performance of the glove, a final

## Respiratory protection

Type B-P Filter of sufficient capacity: (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.

Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	B-AUS P2	-	B-PAPR-AUS / Class 1 P2
up to 50 x ES	-	B-AUS / Class 1 P2	-
up to 100 x ES	-	B-2 P2	B-PAPR-2 P2 ^

^ - Full-face

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

## sodium hypochlorite solution

selection must be based on detailed observation. -

\* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	<b>CORROSIVE</b> and Oxidising Agent  Pale yellow or greenish liquid with chlorine odour; mixes with water. Freezing point 12% approx minus 25 deg.C. Evolves very poisonous and corrosive chlorine gas on contact with acids and is mildly corrosive to most metals. Evolves oxygen and chlorine on heating. Commercial grades have 3-14% available chlorine.  Items with 4% or less are not a scheduled poison.		
<b>Physical state</b>	Liquid	<b>Relative density (Water = 1)</b>	1.15-1.2
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Applicable
<b>pH (as supplied)</b>	10-11	<b>Decomposition temperature</b>	Not Available
<b>Melting point / freezing point (°C)</b>	< 0	<b>Viscosity (cSt)</b>	Not Available
<b>Initial boiling point and boiling range (°C)</b>	100-110	<b>Molecular weight (g/mol)</b>	Not Applicable
<b>Flash point (°C)</b>	Not Applicable	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Available	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Available
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	Not Available
<b>Vapour pressure (kPa)</b>	2.4 @ 20 C	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Miscible	<b>pH as a solution (1%)</b>	9.5-10.5
<b>Vapour density (Air = 1)</b>	Not Available	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Unstable in the presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>  Sodium hypochlorite solutions slowly decompose when exposed to heat, light.
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	Not normally a hazard due to non-volatile nature of product Chlorine vapour is extremely irritating to the airways and lungs, causing coughing, choking, breathing difficulty, chest pain, headache, vomiting, fluid accumulation in the lungs, chest infection and loss of consciousness. Effects may be delayed. Long term exposure (at workplace) may lead to corrosion of the teeth, irritate the linings of the nose and may increase the likelihood of developing tuberculosis. Recent studies have not confirmed these findings. The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.  If warmed to temperatures greater than 40 deg.C or mixed with acids, toxic and irritating chlorine gas is released.
<b>Ingestion</b>	The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion. Accidental ingestion of the material may be damaging to the health of the individual. Ingestion of hypochlorites may cause burning in the mouth and throat, abdominal cramps, nausea, vomiting, diarrhoea, pain and inflammation of the mouth and stomach, fall of blood pressure, shock, confusion, and delirium. Severe poisonings may lead to convulsion, coma and death. Ingestion irritates the mouth, throat, and stomach. The hypochlorous acid liberated in the stomach can cause wall perforation, toxemia, haemorrhage and death.
<b>Skin Contact</b>	The material can produce chemical burns following direct contact with the skin. Skin contact is not thought to have harmful health effects (as classified under EC Directives); the material may still produce health damage following entry through wounds, lesions or abrasions. Skin contact will result in rapid drying, bleaching, leading to chemical burns on prolonged contact Contact may cause severe itchiness, skin lesions and mild eczema. A 5.25% solution of sodium hypochlorite applied to intact human skin for 4 hours and observed at 4, 24 and 48 hours resulted in exudation an slight sloughing of the skin on 4 of 7 subjects.



## sodium hypochlorite solution

	Two patients were reported with chronic allergic dermatitis of the hand related to sensitisation to sodium hypochlorite as the active component of laundry bleach. Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected. There is some evidence to suggest that this material can cause inflammation of the skin on contact in some persons. [Contact may cause severe itchiness, skin lesions and mild eczema.]
Eye	The material can produce chemical burns to the eye following direct contact. Vapours or mists may be extremely irritating. If applied to the eyes, this material causes severe eye damage. Eye contact with a 5% hypochlorite solution may produce a temporary burning discomfort and slight irritation of the corneal epithelium with no injury. Hypochlorite in pool water at concentrations of 1 ppm chlorine or less is non irritating to eyes if the pH is higher than 7.2 (slightly alkaline); At lower pH sensation of stinging, smarting of eyes with transient reddening may occur but generally no injury.
Chronic	Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue. There has been some concern that this material can cause cancer or mutations but there is not enough data to make an assessment. Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure. There is limited evidence that, skin contact with this product is more likely to cause a sensitisation reaction in some persons compared to the general population. Reduced respiratory capacity may result from chronic low level exposure to chlorine gas. Chronic poisoning may result in coughing, severe chest pains, sore throat and haemoptysis (bloody sputum). Moderate to severe exposures over 3 years produced decreased lung capacity in a number of workers. Delayed effects can include shortness of breath, violent headaches, pulmonary oedema and pneumonia.

sodium hypochlorite solution	TOXICITY Not Available	IRRITATION Not Available
sodium hypochlorite	TOXICITY Dermal (rabbit) LD50: >10000 mg/kg <sup>[1]</sup> Oral (rat) LD50: >237 mg/kg <sup>[1]</sup>	IRRITATION Eye (rabbit): 10 mg - moderate Eye (rabbit): 100 mg - moderate Skin (rabbit): 500 mg/24h-moderate
water	TOXICITY Oral (rat) LD50: >90000 mg/kg <sup>[2]</sup>	IRRITATION Not Available
chlorine	TOXICITY Dermal (rabbit) LD50: >10000 mg/kg <sup>[1]</sup> Inhalation (rat) LC50: 293 ppm/1H <sup>[2]</sup> Oral (rat) LD50: >237 mg/kg <sup>[1]</sup>	IRRITATION Not Available
Legend:	1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. * Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances	

sodium hypochlorite solution	Hypochlorite salts are classified by IARC as Group 3: <b>NOT</b> classifiable as to its carcinogenicity to humans. Evidence of carcinogenicity may be inadequate or limited in animal testing. The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.  Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. The material may produce respiratory tract irritation, and result in damage to the lung including reduced lung function. The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Hypochlorite salts are extremely corrosive and can cause severe damage to the eyes and skin. A number of skin cancers have been observed in mice, when applied to their skin.
SODIUM HYPOCHLORITE	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. Hypochlorite salts are classified by IARC as Group 3: <b>NOT</b> classifiable as to its carcinogenicity to humans. Evidence of carcinogenicity may be inadequate or limited in animal testing. The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. Hypochlorite salts are extremely corrosive and can cause severe damage to the eyes and skin. A number of skin cancers have been observed in mice, when applied to their skin. as sodium hypochlorite pentahydrate
WATER	No significant acute toxicological data identified in literature search.
CHLORINE	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS.

## sodium hypochlorite solution

Acute Toxicity	☐	Carcinogenicity	☐
Skin Irritation/Corrosion	✓	Reproductivity	☐
Serious Eye Damage/Irritation	✓	STOT - Single Exposure	☐
Respiratory or Skin sensitisation	☐	STOT - Repeated Exposure	☐
Mutagenicity	☐	Aspiration Hazard	☐

Legend: ✗ – Data available but does not fill the criteria for classification  
✓ – Data required to make classification available  
☐ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

## Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
sodium hypochlorite	EC50	0.08	Crustacea	0.002mg/L	4
sodium hypochlorite	LC50	96	Fish	0.032mg/L	4
sodium hypochlorite	EC50	48	Crustacea	0.026mg/L	2
sodium hypochlorite	EC50	72	Algae or other aquatic plants	0.0183mg/L	2
sodium hypochlorite	NOEC	72	Algae or other aquatic plants	0.0054mg/L	2
water	EC50	384	Crustacea	199.179mg/L	3
water	EC50	96	Algae or other aquatic plants	8768.874mg/L	3
water	LC50	96	Fish	897.520mg/L	3
chlorine	EC50	24	Crustacea	0.0186mg/L	4
chlorine	LC50	96	Fish	0.014mg/L	4
chlorine	EC50	48	Crustacea	0.026mg/L	2
chlorine	NOEC	504	Crustacea	0.01mg/L	2
chlorine	EC50	96	Algae or other aquatic plants	ca.0.1- ca.0.4mg/L	2

## Legend:

Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

Very toxic to aquatic organisms.

Do NOT allow product to come in contact with surface waters or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash-waters.

Wastes resulting from use of the product must be disposed of on site or at approved waste sites.

For Chlorine:

Atmospheric Fate: Atmospheric chlorine forms hydrochloric or hypochlorous acid in the atmosphere, either through reactions with hydroxyl radicals or, other trace species, such as hydrocarbons.

These acids are believed to be removed from the atmosphere primarily through precipitation washout/dry deposition. When chlorine, hypochlorous acid or hydrogen chloride mixes in the atmosphere with water vapor, dilute solutions of strong mineral acids form which fall to earth as acid rain, snow, fog, or acidified dry particles.

Terrestrial Fate: Soil - Chlorine may react with soil components to form chlorides; depending on their water solubility, these chlorides are easily washed out from the soil.

In freshwater, the hypochlorites break down rapidly into non-toxic compounds when exposed to sunlight. While chlorine levels decline rapidly in seawater, hypobromite (which is acutely toxic to aquatic organisms) is formed. Sodium and calcium hypochlorite exhibit low levels of toxicity to birds, but they are highly toxic to freshwater fish and invertebrates. As hypochlorite is a highly reactive chemical, it undergoes a series of reactions, including oxidation of inorganic and organic species, and chlorination, forming organohalogen by-products.

Prevent, by any means available, spillage from entering drains or water courses.

**DO NOT discharge into sewer or waterways.**

## Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
water	LOW	LOW

## Bioaccumulative potential

Ingredient	Bioaccumulation
water	LOW (LogKOW = -1.38)

## Mobility in soil

Ingredient	Mobility
water	LOW (KOC = 14.3)

## SECTION 13 DISPOSAL CONSIDERATIONS

## Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"> <li>Containers may still present a chemical hazard/ danger when empty.</li> <li>Return to supplier for reuse/ recycling if possible.</li> </ul> <p>Otherwise:</p> <ul style="list-style-type: none"> <li>If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill.</li> <li>Where possible retain label warnings and SDS and observe all notices pertaining to the product.</li> </ul>
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Continued...

## sodium hypochlorite solution

Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.

A Hierarchy of Controls seems to be common - the user should investigate:



- ▶ Reduction
- ▶ Reuse
- ▶ Recycling
- ▶ Disposal (if all else fails)

This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.

- ▶ **DO NOT allow wash water from cleaning or process equipment to enter drains.**
- ▶ It may be necessary to collect all wash water for treatment before disposal.
- ▶ In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.
- ▶ Where in doubt contact the responsible authority.
- ▶ Recycle wherever possible.
- ▶ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.
- ▶ Treat and neutralise at an approved treatment plant. Treatment should involve: Neutralisation followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material)
- ▶ Decontaminate empty containers.

## SECTION 14 TRANSPORT INFORMATION

## Labels Required

	
Marine Pollutant	
HAZCHEM	2X

## Land transport (ADG)

UN number	1791				
Packing group	III				
UN proper shipping name	HYPOCHLORITE SOLUTION				
Environmental hazard	Not Applicable				
Transport hazard class(es)	<table border="1"> <tr> <td>Class</td><td>8</td></tr> <tr> <td>Subrisk</td><td>Not Applicable</td></tr> </table>	Class	8	Subrisk	Not Applicable
Class	8				
Subrisk	Not Applicable				
Special precautions for user	<table border="1"> <tr> <td>Special provisions</td><td>223</td></tr> <tr> <td>Limited quantity</td><td>5 L</td></tr> </table>	Special provisions	223	Limited quantity	5 L
Special provisions	223				
Limited quantity	5 L				

## Air transport (ICAO-IATA / DGR)

UN number	1791														
Packing group	III														
UN proper shipping name	Hypochlorite solution														
Environmental hazard	Not Applicable														
Transport hazard class(es)	<table border="1"> <tr> <td>ICAO/IATA Class</td><td>8</td></tr> <tr> <td>ICAO / IATA Subrisk</td><td>Not Applicable</td></tr> <tr> <td>ERG Code</td><td>8L</td></tr> </table>	ICAO/IATA Class	8	ICAO / IATA Subrisk	Not Applicable	ERG Code	8L								
ICAO/IATA Class	8														
ICAO / IATA Subrisk	Not Applicable														
ERG Code	8L														
Special precautions for user	<table border="1"> <tr> <td>Special provisions</td><td>A3A803</td></tr> <tr> <td>Cargo Only Packing Instructions</td><td>856</td></tr> <tr> <td>Cargo Only Maximum Qty / Pack</td><td>60 L</td></tr> <tr> <td>Passenger and Cargo Packing Instructions</td><td>852</td></tr> <tr> <td>Passenger and Cargo Maximum Qty / Pack</td><td>5 L</td></tr> <tr> <td>Passenger and Cargo Limited Quantity Packing Instructions</td><td>Y841</td></tr> <tr> <td>Passenger and Cargo Limited Maximum Qty / Pack</td><td>1 L</td></tr> </table>	Special provisions	A3A803	Cargo Only Packing Instructions	856	Cargo Only Maximum Qty / Pack	60 L	Passenger and Cargo Packing Instructions	852	Passenger and Cargo Maximum Qty / Pack	5 L	Passenger and Cargo Limited Quantity Packing Instructions	Y841	Passenger and Cargo Limited Maximum Qty / Pack	1 L
Special provisions	A3A803														
Cargo Only Packing Instructions	856														
Cargo Only Maximum Qty / Pack	60 L														
Passenger and Cargo Packing Instructions	852														
Passenger and Cargo Maximum Qty / Pack	5 L														
Passenger and Cargo Limited Quantity Packing Instructions	Y841														
Passenger and Cargo Limited Maximum Qty / Pack	1 L														

## Sea transport (IMDG-Code / GGVSee)

UN number	1791
Packing group	III
UN proper shipping name	HYPOCHLORITE SOLUTION
Environmental hazard	Marine Pollutant

## sodium hypochlorite solution

Transport hazard class(es)	IMDG Class	8
	IMDG Subrisk	Not Applicable
Special precautions for user	EMS Number	F-A, S-B
	Special provisions	223
	Limited Quantities	5 L

## Transport in bulk according to Annex II of MARPOL and the IBC code

Source	Product name	Pollution Category	Ship Type
IMO MARPOL (Annex II) - List of Noxious Liquid Substances Carried in Bulk	Sodium hypochlorite solution (15% or less)	Y	2

## SECTION 15 REGULATORY INFORMATION

## Safety, health and environmental regulations / legislation specific for the substance or mixture

## SODIUM HYPOCHLORITE(7681-52-9) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Hazardous Substances Information System - Consolidated Lists	International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs
Australia Inventory of Chemical Substances (AICS)	

## WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)
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## CHLORINE(7782-50-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards	Australia Inventory of Chemical Substances (AICS)
Australia Hazardous Substances Information System - Consolidated Lists	International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List Passenger and Cargo Aircraft

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (chlorine; water; sodium hypochlorite)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (chlorine; water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

## Other information

## Ingredients with multiple cas numbers

Name	CAS No
sodium hypochlorite	10022-70-5, 7681-52-9

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

## Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average  
 PC—STEL: Permissible Concentration-Short Term Exposure Limit  
 IARC: International Agency for Research on Cancer  
 ACGIH: American Conference of Governmental Industrial Hygienists  
 STEL: Short Term Exposure Limit  
 TEEL: Temporary Emergency Exposure Limit  
 IDLH: Immediately Dangerous to Life or Health Concentrations  
 OSF: Odour Safety Factor  
 NOAEL: No Observed Adverse Effect Level  
 LOAEL: Lowest Observed Adverse Effect Level  
 TLV: Threshold Limit Value

**sodium hypochlorite solution**

LOD: Limit Of Detection

OTV: Odour Threshold Value

BCF: BioConcentration Factors

BEI: Biological Exposure Index

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TEL (+61 3) 9572 4700.

# SODIUM METABISULFITE

Osmoflo Water Management Pty Ltd

Chemwatch Hazard Alert Code: 3

Chemwatch: 21889

Version No: 14.1.1.1

Safety Data Sheet according to WHS and ADG requirements

Issue Date: 01/01/2013

Print Date: 16/08/2016

S.GHS.AUS.EN

## SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

### Product Identifier

Product name	SODIUM METABISULFITE
Chemical Name	sodium metabisulfite
Synonyms	Fisher Scientific Sodium Metabisulfite reagent 97%, APS FOOD00004251, AR00000487 04506808 015705, Dura 5973, Food Additive 223, German Metal Dura 5973, Hach TN (Total Nitrogen) Reagent A, IONAC 140, Na2-S2-O5, Nalco, Redox SOMETA39, Roemex RX-5207, SBS powder, SMB POWder, SMBS, anhydrous sodium bisulfite, disodium pyrosulfite, disodium pyrosulphite, pyrosulfurous acid, disodium salt, sodium meta-bisulfite, sodium meta-bisulphite, sodium pyrosulfite
Chemical formula	O5-S2.2Na[SO2]H2O5S2.2Na
Other means of identification	Not Available
CAS number	7681-57-4

### Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Reducing agent Reagent. Widely used in food as preservative; as Food Additive 223. Amounts in foods are subject to regulation. Usually only 0.01 to 0.10%. Used as a reagent and as a source of sulfur dioxide.
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### Details of the supplier of the safety data sheet

Registered company name	Osmoflo Water Management Pty Ltd
Address	382 Diment Road, Burton SA 5110 Australia
Telephone	+61 (8) 8282 9700
Fax	+61 (8) 8280 3015
Website	osmoflo.com
Email	mail@osmoflo.com

### Emergency telephone number

Association / Organisation	Chemwatch
Emergency telephone numbers	1800 039 008
Other emergency telephone numbers	+61 (2) 9186 1132

## CHEMWATCH EMERGENCY RESPONSE

Primary Number	Alternative Number 1	Alternative Number 2
1800 039 008	1800 039 008	+612 9186 1132

Once connected and if the message is not in your preferred language then please dial 01

## SECTION 2 HAZARDS IDENTIFICATION

### Classification of the substance or mixture

**HAZARDOUS CHEMICAL. NON-DANGEROUS GOODS.** According to the WHS Regulations and the ADG Code.

### CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	2	
Body Contact	3	
Reactivity	1	
Chronic	1	



0 = Minimum  
1 = Low  
2 = Moderate  
3 = High  
4 = Extreme

Continued...

## SODIUM METABISULFITE

<b>Poisons Schedule</b>	S5
<b>Classification</b> [1]	Acute Toxicity (Oral) Category 4, Skin Corrosion/Irritation Category 2, Serious Eye Damage Category 1, Specific target organ toxicity - single exposure Category 3 (respiratory tract irritation)
<b>Legend:</b>	1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI

### Label elements

<b>GHS label elements</b>	 
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**SIGNAL WORD** **DANGER**

### Hazard statement(s)

<b>H302</b>	Harmful if swallowed.
<b>H315</b>	Causes skin irritation.
<b>H318</b>	Causes serious eye damage.
<b>H335</b>	May cause respiratory irritation.
<b>AUH031</b>	Contact with acid liberates toxic gas

### Precautionary statement(s) Prevention

<b>P271</b>	Use only outdoors or in a well-ventilated area.
<b>P280</b>	Wear protective gloves/protective clothing/eye protection/face protection.
<b>P261</b>	Avoid breathing dust/fumes.
<b>P270</b>	Do not eat, drink or smoke when using this product.

### Precautionary statement(s) Response

<b>P305+P351+P338</b>	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
<b>P310</b>	Immediately call a POISON CENTER or doctor/physician.
<b>P362</b>	Take off contaminated clothing and wash before reuse.
<b>P301+P312</b>	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.

### Precautionary statement(s) Storage

<b>P405</b>	Store locked up.
<b>P403+P233</b>	Store in a well-ventilated place. Keep container tightly closed.

### Precautionary statement(s) Disposal

<b>P501</b>	Dispose of contents/container in accordance with local regulations.
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## SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

### Substances

CAS No	%[weight]	Name
7681-57-4	>95	sodium metabisulfite
		Slowly releases toxic
7446-09-5		sulfur dioxide

### Mixtures

See section above for composition of Substances

## SECTION 4 FIRST AID MEASURES

### Description of first aid measures

<b>Eye Contact</b>	<p>If this product comes in contact with the eyes:</p> <ul style="list-style-type: none"> <li>Immediately hold eyelids apart and flush the eye continuously with running water.</li> <li>Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.</li> <li>Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.</li> <li>Transport to hospital or doctor without delay.</li> <li>Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.</li> </ul>
<b>Skin Contact</b>	<p>If skin contact occurs:</p> <ul style="list-style-type: none"> <li>Immediately remove all contaminated clothing, including footwear.</li> <li>Flush skin and hair with running water (and soap if available).</li> <li>Seek medical attention in event of irritation.</li> </ul>

## SODIUM METABISULFITE

Inhalation	<ul style="list-style-type: none"> <li>▶ If fumes or combustion products are inhaled remove from contaminated area.</li> <li>▶ Lay patient down. Keep warm and rested.</li> <li>▶ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.</li> <li>▶ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.</li> <li>▶ Transport to hospital, or doctor, without delay.</li> <li>▶ Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.</li> <li>▶ Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).</li> <li>▶ As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.</li> <li>▶ Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.</li> </ul> <p><b>This must definitely be left to a doctor or person authorised by him/her.</b> (ICSC13719)</p>
Ingestion	<ul style="list-style-type: none"> <li>▶ <b>IF SWALLOWED, REFER FOR MEDICAL ATTENTION, WHERE POSSIBLE, WITHOUT DELAY.</b></li> <li>▶ For advice, contact a Poisons Information Centre or a doctor.</li> <li>▶ Urgent hospital treatment is likely to be needed.</li> <li>▶ In the mean time, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition.</li> <li>▶ If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the SDS should be provided. Further action will be the responsibility of the medical specialist.</li> <li>▶ If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the SDS.</li> </ul> <p><b>Where medical attention is not immediately available or where the patient is more than 15 minutes from a hospital or unless instructed otherwise:</b></p> <ul style="list-style-type: none"> <li>▶ <b>INDUCE</b> vomiting with fingers down the back of the throat, <b>ONLY IF CONSCIOUS</b>. Lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.</li> </ul> <p><b>NOTE:</b> Wear a protective glove when inducing vomiting by mechanical means.</p>

## Indication of any immediate medical attention and special treatment needed

As in all cases of suspected poisoning, follow the ABCDEs of emergency medicine (airway, breathing, circulation, disability, exposure), then the ABCDEs of toxicology (antidotes, basics, change absorption, change distribution, change elimination).

For poisons (where specific treatment regime is absent):

## BASIC TREATMENT

- ▶ Establish a patent airway with suction where necessary.
- ▶ Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- ▶ Administer oxygen by non-rebreather mask at 10 to 15 L/min.
- ▶ Monitor and treat, where necessary, for pulmonary oedema.
- ▶ Monitor and treat, where necessary, for shock.
- ▶ Anticipate seizures.
- ▶ **DO NOT** use emetics. Where ingestion is suspected rinse mouth and give up to 200 ml water (5 ml/kg recommended) for dilution where patient is able to swallow, has a strong gag reflex and does not drool.

## ADVANCED TREATMENT

- ▶ Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- ▶ Positive-pressure ventilation using a bag-valve mask might be of use.
- ▶ Monitor and treat, where necessary, for arrhythmias.
- ▶ Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- ▶ Drug therapy should be considered for pulmonary oedema.
- ▶ Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- ▶ Treat seizures with diazepam.
- ▶ Proparacaine hydrochloride should be used to assist eye irrigation.

BRONSTEIN, A.C. and CURRANCE, P.L.

EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

Treat symptomatically.

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of lung oedema often do not manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorised by him/her should be considered.

(ICSC24419/24421)

## SECTION 5 FIREFIGHTING MEASURES

## Extinguishing media

- ▶ There is no restriction on the type of extinguisher which may be used.
- ▶ Use extinguishing media suitable for surrounding area.

## Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.
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## Advice for firefighters

Fire Fighting	<ul style="list-style-type: none"> <li>▶ Alert Fire Brigade and tell them location and nature of hazard.</li> <li>▶ Wear breathing apparatus plus protective gloves in the event of a fire.</li> <li>▶ Prevent, by any means available, spillage from entering drains or water courses.</li> <li>▶ Use fire fighting procedures suitable for surrounding area.</li> </ul>
Fire/Explosion Hazard	<ul style="list-style-type: none"> <li>▶ Non combustible.</li> <li>▶ Not considered a significant fire risk, however containers may burn.</li> </ul> <p>Decomposition may produce toxic fumes of; sulfur oxides (SOx) sulfur dioxide (SO<sub>2</sub>) metal oxides May emit poisonous fumes. May emit corrosive fumes. In some fires a sodium sulfide residue may remain and is an explosion hazard and is strongly alkaline in the presence of water.</p>



## SODIUM METABISULFITE

### SECTION 6 ACCIDENTAL RELEASE MEASURES

#### Personal precautions, protective equipment and emergency procedures

See section 8

#### Environmental precautions

See section 12

#### Methods and material for containment and cleaning up

Minor Spills	<ul style="list-style-type: none"> <li>Remove all ignition sources.</li> <li>Clean up all spills immediately.</li> <li>Avoid contact with skin and eyes.</li> <li>Control personal contact with the substance, by using protective equipment.</li> </ul>
Major Spills	<ul style="list-style-type: none"> <li><b>DO NOT touch the spill material</b></li> </ul> <p>Moderate hazard.</p> <ul style="list-style-type: none"> <li><b>CAUTION:</b> Advise personnel in area.</li> <li>Alert Emergency Services and tell them location and nature of hazard.</li> <li>Control personal contact by wearing protective clothing.</li> </ul> <p> To neutralise: Add an equivalent volume of a hypochlorite solution or diluted hydrogen peroxide. WARNING: Beware of vigorous reaction. Neutralise oxidized solution. Collect residues and seal in drums for disposal.</p>

Personal Protective Equipment advice is contained in Section 8 of the SDS.

### SECTION 7 HANDLING AND STORAGE

#### Precautions for safe handling

Safe handling	<ul style="list-style-type: none"> <li>Avoid all personal contact, including inhalation.</li> <li>Wear protective clothing when risk of exposure occurs.</li> <li>Use in a well-ventilated area.</li> <li>Prevent concentration in hollows and sumps.</li> </ul>
Other information	<ul style="list-style-type: none"> <li>Store in original containers.</li> <li>Keep containers securely sealed.</li> <li>Store in a cool, dry, well-ventilated area.</li> <li>Store away from incompatible materials and foodstuff containers.</li> </ul>

#### Conditions for safe storage, including any incompatibilities

Suitable container	<ul style="list-style-type: none"> <li>Glass container is suitable for laboratory quantities</li> <li>Polyethylene or polypropylene container.</li> <li>Check all containers are clearly labelled and free from leaks.</li> </ul>
Storage incompatibility	<ul style="list-style-type: none"> <li>Contact with acids produces toxic fumes</li> <li>Metals and their oxides or salts may react violently with chlorine trifluoride and bromine trifluoride.</li> <li>These trifluorides are hypergolic oxidisers. They ignite on contact (without external source of heat or ignition) with recognised fuels - contact with these materials, following an ambient or slightly elevated temperature, is often violent and may produce ignition.</li> <li>The state of subdivision may affect the results.</li> <li>Inorganic reducing agents react with oxidizing agents to generate heat and products that may be flammable, combustible, or otherwise reactive. Their reactions with oxidizing agents may be violent.</li> <li>Incidents involving interaction of active oxidants and reducing agents, either by design or accident, are usually very energetic and examples of so-called redox reactions.</li> </ul> <p>Metabisulfites:</p> <ul style="list-style-type: none"> <li>decompose with heat</li> <li>are slowly oxidised on exposure to air and water</li> <li>hydrates are bisulfites; conversely when dehydrated they become metabisulfites - a maximum strength of about 40% bisulfite solution is attainable with certain counter-ions</li> <li>may produce corrosive acids when mixed with water dependent on the counter-ion</li> <li>react with acids to produce sulfur dioxide (SO<sub>2</sub>)</li> <li>Segregate from alcohol, water.</li> </ul> <p>Sulfur dioxide:</p> <ul style="list-style-type: none"> <li>reacts with water or steam forming sulfurous acid; reaction may be violent</li> <li>reacts with acrolein, alcohols, aluminium powder, alkali metals, amines, bromine, pentafluoride, caustics, caesium, acetylene carbide, chlorates, chlorine trifluoride, chromium powder, copper or its alloy powders, diethylzinc, fluorine, lead dioxide, lithium acetylene carbide, metal powders, monolithium acetylide-ammonia, nitril chloride, potassium acetylene carbide, potassium acetylide, potassium chlorate, rubidium carbide, silver azide, sodium, sodium acetylide, stannous oxide; reaction may be violent</li> <li>decomposes above 60 deg. C releasing oxides of sulfur</li> <li>Incompatible with alkalis, alkylene oxides, ammonia, aliphatic amines, alkanolamines, amides, organic anhydrides, caesium monoxide, epichlorohydrin, ferrous oxide, halogens, interhalogens, isocyanates, lithium nitrate, manganese, metal acetylides, metal oxides, perbromyl fluoride, red phosphorus, potassium azide, rubidium acetylide, sodium hydride, sulfuric acid</li> <li>attacks some plastics, coatings and rubber</li> <li>attacks metals, especially chemically active metals, in the presence of moisture.</li> </ul> <p>Sulfites and hydrosulfites (dithionites) :</p> <ul style="list-style-type: none"> <li>may react explosively with strong oxidising agents.</li> <li>react with water or steam to produce corrosive acid solutions and sulfur oxide fumes - aqueous solutions are incompatible with oxidisers, strong acids, alkalis, ammonia, aliphatic amines, alkanolamines, alkylene oxides, amides, epichlorohydrin, organic anhydrides, isocyanates, nitromethane, vinyl acetate</li> <li>aqueous solutions attack metals in presence of moisture</li> <li>generate gaseous sulfur dioxide in contact with oxidising and nonoxidising acids</li> </ul> <p><b>NOTE:</b> May develop pressure in containers; open carefully. Vent periodically.  Mixing with sodium nitrite results in vigorous exothermic reaction.</p>

### SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Continued...

## SODIUM METABISULFITE

## Control parameters

## OCCUPATIONAL EXPOSURE LIMITS (OEL)

## INGREDIENT DATA


Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sodium metabisulfite	Sodium metabisulphite	5 mg/m3	Not Available	Not Available	Not Available
Australia Exposure Standards	sulfur dioxide	Sulphur dioxide	5.2 mg/m3 / 2 ppm	13 mg/m3 / 5 ppm	Not Available	Not Available

## EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sodium metabisulfite	Sodium metabisulfite	5 mg/m3	5 mg/m3	220 mg/m3
sulfur dioxide	Sulfur dioxide	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sodium metabisulfite	Not Available	Not Available
sulfur dioxide	100 ppm	100 [Unch] ppm

## Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk. Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.
Personal protection	
Eye and face protection	<ul style="list-style-type: none"><li>▶ Safety glasses with side shields.</li><li>▶ Chemical goggles.</li><li>▶ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.</li></ul>
Skin protection	See Hand protection below
Hands/feet protection	<b>NOTE:</b> <ul style="list-style-type: none"><li>▶ The material may produce skin sensitisation in predisposed individuals. Care must be taken, when removing gloves and other protective equipment, to avoid all possible skin contact.</li><li>▶ Contaminated leather items, such as shoes, belts and watch-bands should be removed and destroyed.</li></ul> The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application. The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice. Suitability and durability of glove type is dependent on usage. Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present. <ul style="list-style-type: none"><li>▶ polychloroprene.</li><li>▶ nitrile rubber.</li><li>▶ butyl rubber.</li></ul>
Body protection	See Other protection below
Other protection	<ul style="list-style-type: none"><li>▶ Overalls.</li><li>▶ P.V.C. apron.</li><li>▶ Barrier cream.</li></ul>
Thermal hazards	Not Available

## Respiratory protection

Type E-P Filter of sufficient capacity. (AS/NZS 1716 &amp; 1715, EN 143:2000 &amp; 149:2001, ANSI Z88 or national equivalent)

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	E P1 Air-line*	- -	E PAPR-P1 -
up to 50 x ES	Air-line**	E P2	E PAPR-P2
up to 100 x ES	-	E P3	-
		Air-line*	-
100+ x ES	-	Air-line**	E PAPR-P3

\* - Negative pressure demand \*\* - Continuous flow

A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

- ▶ Respirators may be necessary when engineering and administrative controls do not adequately prevent exposures.
- ▶ The decision to use respiratory protection should be based on professional judgment that takes into account toxicity information, exposure measurement data, and frequency and likelihood of the worker's exposure - ensure users are not subject to high thermal loads which may result in heat stress or distress due to personal protective equipment (powered, positive flow, full face

Continued...

## SODIUM METABISULFITE

- ▶ apparatus may be an option).
- ▶ Published occupational exposure limits, where they exist, will assist in determining the adequacy of the selected respiratory protection. These may be government mandated or vendor recommended.
- ▶ Certified respirators will be useful for protecting workers from inhalation of particulates when properly selected and fit tested as part of a complete respiratory protection program.
- ▶ Use approved positive flow mask if significant quantities of dust becomes airborne.
- ▶ Try to avoid creating dust conditions.

## SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

## Information on basic physical and chemical properties

<b>Appearance</b>	White crystals or powder with a pungent sulfur dioxide odour. Freely soluble in water, glycerol and slightly soluble in alcohol. The material slowly releases sulfur dioxide at ambient temperatures. Acts as a reducing agent.		
<b>Physical state</b>	Divided Solid	<b>Relative density (Water = 1)</b>	1.40-1.48
<b>Odour</b>	Not Available	<b>Partition coefficient n-octanol / water</b>	Not Available
<b>Odour threshold</b>	Not Available	<b>Auto-ignition temperature (°C)</b>	Not Applicable
<b>pH (as supplied)</b>	Not Applicable	<b>Decomposition temperature</b>	120-150
<b>Melting point / freezing point (°C)</b>	>300 dec.120-150	<b>Viscosity (cSt)</b>	Not Applicable
<b>Initial boiling point and boiling range (°C)</b>	Not Available	<b>Molecular weight (g/mol)</b>	190.13 pure
<b>Flash point (°C)</b>	Not Applicable	<b>Taste</b>	Not Available
<b>Evaporation rate</b>	Not Applicable	<b>Explosive properties</b>	Not Available
<b>Flammability</b>	Not Applicable	<b>Oxidising properties</b>	Not Available
<b>Upper Explosive Limit (%)</b>	Not Applicable	<b>Surface Tension (dyn/cm or mN/m)</b>	Not Applicable
<b>Lower Explosive Limit (%)</b>	Not Applicable	<b>Volatile Component (%vol)</b>	Not Applicable
<b>Vapour pressure (kPa)</b>	Not Applicable	<b>Gas group</b>	Not Available
<b>Solubility in water (g/L)</b>	Reacts	<b>pH as a solution (1%)</b>	3.5-5.0 @ 50%
<b>Vapour density (Air = 1)</b>	Not Applicable	<b>VOC g/L</b>	Not Available

## SECTION 10 STABILITY AND REACTIVITY

<b>Reactivity</b>	See section 7
<b>Chemical stability</b>	<ul style="list-style-type: none"> <li>▶ Unstable in the presence of incompatible materials.</li> <li>▶ Product is considered stable.</li> <li>▶ Hazardous polymerisation will not occur.</li> </ul>
<b>Possibility of hazardous reactions</b>	See section 7
<b>Conditions to avoid</b>	See section 7
<b>Incompatible materials</b>	See section 7
<b>Hazardous decomposition products</b>	See section 5

## SECTION 11 TOXICOLOGICAL INFORMATION

## Information on toxicological effects

<b>Inhaled</b>	<p>The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage. Inhalation of dusts, generated by the material during the course of normal handling, may be damaging to the health of the individual. Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled.</p> <p>If prior damage to the circulatory or nervous systems has occurred or if kidney damage has been sustained, proper screenings should be conducted on individuals who may be exposed to further risk if handling and use of the material result in excessive exposures.</p> <p>Sulfur dioxide is irritating. Short-term exposure causes constriction of the bronchi.</p>
<b>Ingestion</b>	<p>Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual.</p> <p>Ingestion of sulfite salts may cause gastric irritation. Large doses may produce violent colic, diarrhoea, circulatory disturbance, depression of vital functions and, sometimes, death.</p>
<b>Skin Contact</b>	<p>This material can cause inflammation of the skin on contact in some persons.</p> <p>The material may accentuate any pre-existing dermatitis condition</p> <p>Open cuts, abraded or irritated skin should not be exposed to this material</p> <p>Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.</p>
<b>Eye</b>	If applied to the eyes, this material causes severe eye damage.

## SODIUM METABISULFITE

<b>Chronic</b>	<p>Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems. There has been some concern that this material can cause cancer or mutations but there is not enough data to make an assessment. Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure. There is some evidence that inhaling this product is more likely to cause a sensitisation reaction in some persons compared to the general population. There is limited evidence that, skin contact with this product is more likely to cause a sensitisation reaction in some persons compared to the general population.</p> <p>Sulfites and bisulfites can cause narrowing of the airways, stomach upset, flushing, low blood pressure, tingling sensation, itchy wheal, swelling and shock, and asthmatics are especially prone. They induce allergic-like reactions which can occur on first contact with the material.</p> <p>Long term exposure to high dust concentrations may cause changes in lung function i.e. pneumoconiosis, caused by particles less than 0.5 micron penetrating and remaining in the lung.</p> <p>Chronic exposure to sulfur dioxide (SO<sub>2</sub>) particle complexes in polluted air can aggravate chronic disease, such as asthma, chronic pulmonary disease, and coronary artery disease. It is not clear what is the concentration level required to cause these effects.</p> <p>Animal testing showed that simultaneous exposure to benz(a)pyrene and sulfur dioxide increases the rate of cancer development compared to exposure to only one of the above substances.</p> <p>Occupational asthma has been reported in laundry workers and a vinegar worker exposed to sodium metabisulfite</p>
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<b>sodium metabisulfite</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	dermal (rat) LD50: >2000 mg/kg <sup>[1]</sup>	*CCInfo. No. 1478367 [BASF]
	Oral (rat) LD50: 500 mg/kg <sup>[2]</sup>	[ICI UK]
		[Sigma/Aldrich]
		Eye (rabbit): IRRITANT *
<b>sulfur dioxide</b>	<b>TOXICITY</b>	<b>IRRITATION</b>
	Inhalation (rat) LC50: 2520 ppm/1hr <sup>[2]</sup>	Nil reported

**Legend:** 1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2. \* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances

<b>SODIUM METABISULFITE</b>	The substance is classified by IARC as Group 3: <b>NOT</b> classifiable as to its carcinogenicity to humans. Evidence of carcinogenicity may be inadequate or limited in animal testing.
<b>SULFUR DIOXIDE</b>	The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. 400-500 ppm - immediately dangerous to life. NOTE: Aggravates chronic pulmonary disease and increases the risk of acute and chronic respiratory disease - condition aggravated by smoking.
<b>SODIUM METABISULFITE &amp; SULFUR DIOXIDE</b>	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

<b>Acute Toxicity</b>	✓	<b>Carcinogenicity</b>	⊘
<b>Skin Irritation/Corrosion</b>	✓	<b>Reproductivity</b>	⊘
<b>Serious Eye Damage/Irritation</b>	✓	<b>STOT - Single Exposure</b>	✓
<b>Respiratory or Skin sensitisation</b>	⊘	<b>STOT - Repeated Exposure</b>	⊘
<b>Mutagenicity</b>	⊘	<b>Aspiration Hazard</b>	⊘

**Legend:**  
 ✗ – Data available but does not fill the criteria for classification  
 ✓ – Data required to make classification available  
 ⊘ – Data Not Available to make classification

## SECTION 12 ECOLOGICAL INFORMATION

### Toxicity

Ingredient	Endpoint	Test Duration (hr)	Species	Value	Source
sodium metabisulfite	EC20	96	Algae or other aquatic plants	≈20mg/L	1
sodium metabisulfite	EC50	96	Algae or other aquatic plants	≈40mg/L	1
sodium metabisulfite	LC50	96	Fish	≈21mg/L	1
sodium metabisulfite	EC50	48	Crustacea	89mg/L	2
sodium metabisulfite	NOEC	504	Crustacea	>10mg/L	2
sulfur dioxide	EC50	384	Crustacea	2757.902mg/L	3
sulfur dioxide	EC50	96	Algae or other aquatic plants	12.60493mg/L	3
sulfur dioxide	LC50	96	Fish	1322.54506mg/L	3

**Legend:** Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data

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For Sulfur Dioxide (SO<sub>2</sub>): Vapor Pressure: 3,000 mm Hg @ 20°C; Henry's Law Constant: 1.23 mol.L<sup>-1</sup>/atm-1 @ 25°C.

Environmental Fate: Natural sources of sulfur dioxide include volcanoes and volcanic vents, decaying organic matter, solar action on seawater and oxidation of dimethyl sulfide emitted from the ocean. On a global scale, man-made emissions represent a significant contribution to the SO<sub>2</sub> emitted to the atmosphere and these emissions are approximately equal to natural emissions.

Atmospheric Fate: Sulfur dioxide is typically present in a gaseous phase and, once released into the atmosphere, may be converted to other compounds, and/or removed from the atmosphere by various mechanisms.

**DO NOT discharge into sewer or waterways.**

[log Pow (Octanol/water partition coefficient): -3.7]Risk of bioaccumulation in aquatic species is low.[Inorganic product which cannot be eliminated from effluent treatment plants by biological purification processes. The product may lead to a high chemical consumption of oxygen in biological sewage works or natural waters and have a negative effect on aquatic organisms.[Toxicity to fish- LC50: 15-220 mg/L/96Hr (Salmo gairdneri)]Toxicity to bacteria- EC/LC50: 56 mg/L/17Hr (Pseudomonas putida)]COD: 165 mg O<sub>2</sub>/g product. [BASF Aust.]

### Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
sulfur dioxide	LOW	LOW

### Bioaccumulative potential

Ingredient	Bioaccumulation
sulfur dioxide	LOW (LogKOW = -2.2002)

### Mobility in soil

Ingredient	Mobility
sulfur dioxide	MEDIUM (KOC = 2.989)

## SECTION 13 DISPOSAL CONSIDERATIONS

### Waste treatment methods

Product / Packaging disposal	<ul style="list-style-type: none"> <li>Containers may still present a chemical hazard/ danger when empty.</li> <li>Return to supplier for reuse/ recycling if possible.</li> </ul>
	<p>Otherwise:</p> <ul style="list-style-type: none"> <li>If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill.</li> <li>Where possible retain label warnings and SDS and observe all notices pertaining to the product.</li> </ul> <p>Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.</p> <p>A Hierarchy of Controls seems to be common - the user should investigate:</p> <ul style="list-style-type: none"> <li>Reduction</li> <li>Reuse</li> <li>Recycling</li> <li>Disposal (if all else fails)</li> </ul> <p>This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use.</p> <ul style="list-style-type: none"> <li><b>DO NOT allow wash water from cleaning or process equipment to enter drains.</b></li> <li>It may be necessary to collect all wash water for treatment before disposal.</li> <li>In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.</li> <li>Where in doubt contact the responsible authority.</li> <li>Recycle wherever possible or consult manufacturer for recycling options.</li> <li>Consult State Land Waste Management Authority for disposal.</li> <li>Bury residue in an authorised landfill.</li> <li>Recycle containers if possible, or dispose of in an authorised landfill.</li> </ul>

## SECTION 14 TRANSPORT INFORMATION

### Labels Required

Marine Pollutant	NO
HAZCHEM	Not Applicable

Land transport (ADG): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Air transport (ICAO-IATA / DGR): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Sea transport (IMDG-Code / GGVSee): NOT REGULATED FOR TRANSPORT OF DANGEROUS GOODS

Transport in bulk according to Annex II of MARPOL and the IBC code

Not Applicable

## SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

**SODIUM METABISULFITE(7681-57-4) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

Australia Exposure Standards	Australia Inventory of Chemical Substances (AICS)
Australia Hazardous Substances Information System - Consolidated Lists	International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs

**SULFUR DIOXIDE(7446-09-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS**

## SODIUM METABISULFITE

Australia Exposure Standards	International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs
Australia Hazardous Substances Information System - Consolidated Lists	International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List
Australia Inventory of Chemical Substances (AICS)	Passenger and Cargo Aircraft

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (sulfur dioxide; sodium metabisulfite)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
<b>Legend:</b>	Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing (see specific ingredients in brackets)

## SECTION 16 OTHER INFORMATION

### Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

[www.chemwatch.net](http://www.chemwatch.net)

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

### Definitions and abbreviations

PC — TWA: Permissible Concentration-Time Weighted Average  
PC — STEL: Permissible Concentration-Short Term Exposure Limit  
IARC: International Agency for Research on Cancer  
ACGIH: American Conference of Governmental Industrial Hygienists  
STEL: Short Term Exposure Limit  
TEEL: Temporary Emergency Exposure Limit,  
IDLH: Immediately Dangerous to Life or Health Concentrations  
OSF: Odour Safety Factor  
NOAEL :No Observed Adverse Effect Level  
LOAEL: Lowest Observed Adverse Effect Level  
TLV: Threshold Limit Value  
LOD: Limit Of Detection  
OTV: Odour Threshold Value  
BCF: BioConcentration Factors  
BEI: Biological Exposure Index

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## **APPENDIX C GROUNDWATER FATE AND TRANSPORT MODEL OUTPUT**

## 1.0 GROUNDWATER FATE AND TRANSPORT MODELLING

Based on the chemicals present within the drilling fluids the following Constituents of Potential Concern (CoPCs) have been identified for further evaluation using BIOSCREEN-AT fate and transport modelling. These constituents were selected to represent the most mobile constituents (sodium and methanol) and other key constituents such as biocides used in the drilling fluid. These constituents provide a broad spectrum of constituent physical properties that cover the range of potential mobilities associated with chemicals used in drilling fluids. The constituents considered include:

- Sodium or Potassium (monovalent ions in salts)
- Methyl isothiocyanate or MITC (breakdown product of Dazomet)
- Methanol
- Glyoxal
- Glutaraldehyde.

The following sections discuss the rationale and assumptions applied in the selection of the model input parameters, model constraints and limitations and results based on the various modelling scenarios.

### 1.1 Model Input Parameters and Assumptions

#### 1.1.1 Hydrogeology

Hydrogeologic input parameters required for the BIOSCREEN-AT model include either direct input of seepage velocity or calculation of seepage velocity using hydraulic conductivity, hydraulic gradient and effective porosity values as defined by the following equation:

$$V_s = K \times i / n$$

Where:

$V_s$  = seepage velocity  
 $K$  = horizontal hydraulic conductivity  
 $i$  = horizontal hydraulic gradient  
 $n$  = effective porosity

**Table 1: Hydrogeologic Parameters**

Aquifer of Interest	Model Scenario	Hydraulic Conductivity K (cm/sec)	Hydraulic gradient i (m/m)	Effective Porosity n (unitless)	Seepage Velocity $V_s$ (m/year)
Data Sources		CDM Smith (2016) <sup>1</sup>	CDM Smith (2016) <sup>2</sup>	Younger (1993) <sup>3</sup>	Calculated
Alluvial sediments	Slow Flow	5.8 E-04	0.0001	0.2	0.1
	High Flow	3.0 E-02	0.001	0.1	95
Pilliga Sandstone	Slow Flow	4.6 E-06	0.0001	0.3	0.0005
	High Flow	3.0 E-04	0.001	0.2	0.5

<sup>1</sup> Based on hydraulic conductivity values provided in Table 5-3 in CDM Smith (2016)

<sup>2</sup> Based on range of hydraulic gradients measured from Figure 5-10 in CDM Smith (2016)

<sup>3</sup> Effective porosity estimated based on expected amount of consolidation, grain size and specific yield – method sourced from Younger (1993)



For the purposes of this modelling exercise, seepage velocities were calculated based on hydraulic conductivity, hydraulic gradient and effective porosity values sourced from the Groundwater Impact Assessment (CDM Smith, 2016) as shown in **Table 1** above.

## 1.2 Dispersion

Dispersion is the process by which a constituent will spread out with distance from the source with respect to the direction of groundwater flow. Longitudinal dispersivity is spreading in the direction of groundwater flow while transverse and vertical dispersivity represent spreading in the directions perpendicular to groundwater flow. Given the limitations associated with measuring dispersivity in the field, values are often derived as a function of plume length. The dispersivity values calculated based on plume length for various model scenarios and aquifers of interest are shown on **Table 2**. Note that vertical dispersivity is typically very low and thus has conservatively been set to zero for all scenarios.

**Table 2: Dispersivity Parameters**

Aquifer of Interest	Model Scenario	Longitudinal Dispersivity (m)	Transverse Dispersivity (m)	Vertical Dispersivity (m)
Alluvial sediments	Slow Flow	1.245	0.125	0
	High Flow	12.038	1.204	0
Pilliga Sandstone	Slow Flow	0.014	0.001	0
	High Flow	5.464	0.546	0

### 1.2.1 Adsorption

The rate at which dissolved constituents move through an aquifer can be reduced by sorption to the solid aquifer matrix. Sorption processes and the degree of retardation depend on both aquifer and chemical properties. The retardation factor is the ratio of the groundwater seepage velocity to the rate that organic chemicals migrate in the groundwater. For example, a retardation value of 2 indicates that if the groundwater seepage velocity is 100 metres per year (m/yr), then the organic solute migrates at approximately 50 m/yr. It is important to note that adsorption only affects organic constituents and thus dissolved sodium is not subject to retardation via adsorption. Therefore, retardation for these constituents is set to 1.

For organic constituents, adsorption is a function of the aquifer properties, bulk density and fraction of organic carbon, and the chemical property, organic carbon-water partition coefficient. Retardation via adsorption is expressed as follows:

$$R = 1 + (K_{oc} \times f_{oc} \times \rho \times 1/n)$$

Where:

R = retardation factor

K<sub>oc</sub> = organic carbon-water partition coefficient f<sub>oc</sub> = fraction of organic carbon

ρ = bulk density

n = effective porosity

The bulk density values have been sourced from available literature (Manger, 1963) and are expected to range from 1.8 to 2 grams per cubic metre (g/cm<sup>3</sup>) for the alluvial sediments and from 2.55 to 2.75 g/cm<sup>3</sup> for the Pilliga Sandstone.

The alluvial deposits and Pilliga Sandstone are likely to be low in organic carbon and, based on available literature values (Lovanh et al, 2000), are expected to range from 0.0005 to 0.001.

Organic carbon-water partition coefficient values for the organic compounds subject to this review are presented in **Table 3**. The low-value  $K_{oc}$  will be used as the model parameter, where a range of values was sourced.

**Table 3: Adsorption Parameters**

Compound	$K_{oc}$		
	low	mean	high
MITC	9	15.8	27
Glutaraldehyde	120	284	500
Glyoxal	2.1		
Methanol	0.61		

### 1.2.2 Degradation

Abiotic and biotic degradation may further reduce chemical transport and residence times within the subsurface. As presented in **Table 4**, MITC, methanol, glyoxal and glutaraldehyde may be subject to abiotic and biotic degradation. Therefore, biodegradation is only considered for MITC, methanol, glyoxal and glutaraldehyde as shown in **Table 5**. Similar to the  $K_{oc}$  values referenced in **Table 3** above, literature values for degradation half-lives range widely. Degradation values utilised in the model were therefore conservatively assigned the longest half-life of 178 days (0.49 years).

**Table 4: Mechanisms of Degradation**

Component of Interest	Degradation	
	Abiotic	Biotic
Sodium or Potassium	No	No
MITC	✓	✓
Methanol	✓	✓
Glyoxal	unknown	✓
Glutaraldehyde	✓	✓

**Table 5: Biodegradation Parameters**

Component of Interest	$\frac{1}{2}$ life (days)	
	Abiotic	Biotic
Sodium or Potassium	Not applicable	
MITC	65 to 178 <sup>4</sup>	0.5 to 50 <sup>2</sup>
Methanol	1 to 7 <sup>5</sup>	1 to 7 <sup>3</sup>
Glyoxal	no data	20 <sup>6</sup>
Glutaraldehyde	102 <sup>5</sup>	2 <sup>7</sup>

<sup>4</sup> [https://pubchem.ncbi.nlm.nih.gov/compound/methyl\\_isothiocyanate#section=Top](https://pubchem.ncbi.nlm.nih.gov/compound/methyl_isothiocyanate#section=Top)

<sup>5</sup> Howard et al., (1991) Environmental degradation rates Lewis Publishers

<sup>6</sup> <https://pubchem.ncbi.nlm.nih.gov/compound/glyoxal#section=Top>

<sup>7</sup> <https://pubchem.ncbi.nlm.nih.gov/compound/3485#section=Top>

### 1.2.3 General Model Dimensions

The model dimensions specify the physical extent and simulation timeframe that will be modelled. Model dimensions do not materially impact model outputs, however, the extent and timeframe must be great enough to model the entire solute plume and/or consider potential points of exposure to achieve specific modelling objectives. Model extent and simulation timeframe selected for the alluvial deposits and Pilliga Sandstone area provided for the two scenarios on **Table 6** below.

**Table 6: Source Dimensions**

Aquifer of Interest	Scenario	Model Area Length (m)	Model Area Width (m)	Simulation Time (years)
Alluvial sediments	Slow Flow	30.5	457.2	25
	High Flow	1067	457.2	25
Pilliga Sandstone	Slow Flow	1.5	457.2	1000
	High Flow	152.4	457.2	100

The simulation timeframes are based on iterative runs of the model and once stability is observed and/or concentrations are below criteria, modelling simulations are terminated. The simulation time for the Alluvial sediments is considerably shorter than the Pilliga Sandstone based on the higher velocities in these sediments.

### 1.2.4 Source Data

The solute plume geometry for all of the constituents was conservatively conceptualised as a constant source discharged over the entire width of the receiving aquifers. This conceptualisation was based on a scenario where fluid was retained in the formation during drilling and then dissolution occurred under natural groundwater flow conditions. Therefore, the thickness, assigned as the average diameter of a borehole, was assigned a value of 0.3 m and the width, defined as the average height of the aquifer was assigned values of 6 and 240 m for the Alluvium and Pilliga Sandstone, respectively (**Table 7** below). It should be noted that the constant source conceptualisation is highly conservative as drilling activities occur for a relatively short period of time and the drilling fluid utilised is closely monitored.

**Table 7: Source Dimensions (references)**

Aquifer of Interest	Thickness (m)	Width (m)*
Alluvial sediments	0.3	6
Pilliga Sandstone	0.3	240

\*Source: Groundwater Impact Assessment of EIS, CDM Smith (2016)

The source component concentrations presented in **Table 8** have been calculated based on the theoretical concentrations of each chemical within the drilling fluid. The mass concentrations of sodium (or potassium) have been derived based on the anticipated maximum concentrations of sodium (or potassium) in sodium (or potassium) chloride.

**Table 8: Source Concentration**

Component	Maximum concentration g/L
Sodium or Potassium (both monovalent ions behave similarly)	31.1
MITC	0.03

Component	Maximum concentration g/L
Methanol	0.005
Glyoxal 50% solution	0.05
Glutaraldehyde	0.67

The total mass of the chemicals that can potentially impact localised groundwater surrounding the well have been estimated based on a theoretical loss of 80 litres (half a barrel) of drilling fluid (into the formation) per 1 m of well depth across the height of the water bearing zones identified in **Table 6** above. As previously discussed based on the viscosity of the drilling fluids, potential loss into formation is anticipated to be low and limited to discrete zones (if any) and does not take into consideration:

- The flushing of the borehole prior to cementing; and
- The displacement of residual fluids to surface during the cementing process.

The 80 litre/m loss across the entire aquifer thickness is therefore considered a conservative volume lost to formation for the purposes of the fate and transport evaluation.

An exponentially decaying source term has been calculated for each chemical based on the potential drilling fluid volumes described above. The source half-life is dependent upon the groundwater flux through the source zone, the total mass of the chemical in the source zone and the maximum concentration of the chemical that can dissolve. The method for deriving the source zone half-life is detailed within the BIOSCREEN user manual and described by the expression:

$$\text{Half - life of source} = (0.693 \times Mo)/(Q \times Co)$$

Where

Mo = mass of dissolvable compound in source zone (mg)

Co = effective source zone concentration (mg/L)

Q = groundwater flow through source zone (L/year)

This methodology was originally formulated for the BIOSCREEN analytical model to conceptualise the surficial dissolution from a hydrocarbon source zone. It does not take into account degradation within the source zone. Calculated source zone half-life values are provided in **Table 9**.

**Table 9: Source Zone Half-life Values**

Component	Pilliga Sandstone Formation		Narrabri Province sediments	
	Low K	High K	Low K	High K
Sodium	380 years	0.4 years	2 years	0.002 years
MITC	380 years	0.4 years	2 years	0.002 years
Methanol	380 years	0.4 years	2 years	0.002 years
Glyoxal 50% solution	380 years	0.4 years	2 years	0.002 years
Glutaraldehyde	380 years	0.4 years	2 years	0.002 years

### **1.2.5 Model Constraints and Limitations**

It is important to remember that while this modelling effort is useful in facilitating an evaluation of the fate and transport of CoPCs, the following constraints and limitations should be kept in mind while considering the input parameters and evaluating the results:

- Distance values inputted to BIOSCREEN-AT must be in feet. For conversion from metres to feet, a factor of 0.3048 has been used.
- BIOSCREEN-AT assumes a homogenous and isotropic model domain and that hydraulic parameters, degradation rates and retardation mechanisms are constant along the flow path. These assumptions are considered appropriate for the modelled water bearing zones identified in the Project area.
- The behaviour of a compound in groundwater including mechanical influences, interaction with aquifer sediments and abiotic/biotic degradation reactions, will determine how much retardation occurs along a groundwater flow path. As discussed above, BIOSCREEN-AT is capable of model retardation through sorption processes and degradation of organic constituents. As shown on **Table 10** below, there are other mechanisms that will retard the movement of chemicals within groundwater that are not considered in the BIOSCREEN-AT model. The assumptions that these chemicals are not subject to additional retardation/degradation mechanisms are considered appropriate as they provide for more conservative estimates of potential mobility and residence time of the CoPCs within groundwater.

**Table 10: Mechanisms of Retardation**

Chemical of Interest	Retardation	
	Mechanical	Sorption
Sodium and Potassium	✓	✓*
MITC	✓	✓
Methanol	✓	✓
Glyoxal 50% solution	✓	✓
Glutaraldehyde	✓	✓

\* sorption by ion exchange

### 1.3 Fate and Transport Results and Discussion

To facilitate discussion of the model results, the modelled source zone concentrations (from **Table 8**) are provided along with drinking water and irrigation screening levels for the CoPCs in **Table 11** below. While the primary uses within the Project area are stock watering and irrigation, drinking water screening levels were selected as the basis of comparison to provide the most conservative estimates for the distances and timeframes required to ensure that no unacceptable risks to human health and the environment exist. Reference to irrigation guidelines are provided, where applicable. The drinking water criteria for sodium is based on aesthetic criteria, as no health-based guideline value is provided by the Australian Drinking Water Guidelines (ADWG).

**Table 11: Maximum CoPC Concentrations and Screening Levels**

Component	Maximum Concentration (mg/L)	Drinking Water Screening Level – Aesthetic (mg/L)	Irrigation Screening Level (mg/L)
Sodium	31,100	180	460 (tolerant species)
Potassium <sup>8</sup>	31,100	180	NA
MITC	30	0.018 <sup>9</sup>	NA

<sup>8</sup> Both mono-valent ions sodium and potassium behave similarly and given the potential use of potassium as a substitute for sodium based salts both have been assigned a similar concentration in the modelling.

<sup>9</sup> Derived drinking water guideline values (see risk assessment text in main report)

Component	Maximum Concentration (mg/L)	Drinking Water Screening Level – Aesthetic (mg/L)	Irrigation Screening Level (mg/L)
Methanol	5	7 <sup>10</sup>	NA
Glyoxal	50	0.88 <sup>11</sup>	NA
Glutaraldehyde	670	0.14 <sup>12</sup>	NA

As shown in **Table 12**, the increases in groundwater concentrations (relative to drinking water criteria) from the introduction of drilling fluids are confined to the immediate vicinity of the well (< 67 m) within the key water bearing units.

For the mono-valent ions sodium and potassium which may be present in the drilling fluids the lateral extent of migration is limited with exceedances of water quality standards for irrigation (sodium only) observed within the immediate vicinity of the well (< 17 m).

For the organic constituents, no exceedances of criteria were observed for methanol, even within the immediate vicinity of the well. MITC and glutaraldehyde provided the greatest area of potential exceedances of drinking water criteria (< 67 m and < 55 m respectively) within the Narrabri alluvial sediments based on the conservative attenuation assumptions used in the model. These constituents do not limit the use of groundwater for irrigation as irrigation criteria for these constituents have not been established. Rapid degradation of these organic compounds will not result in them persisting within groundwater.

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<sup>10</sup> Derived drinking water guideline values (see risk assessment text in main report)

<sup>11</sup> Derived drinking water guideline values (see risk assessment text in main report)

<sup>12</sup> Derived drinking water guideline values (see risk assessment text in main report)

**Table 12: Modelled Results**

	<b>Sodium or Potassium</b>	<b>MITC</b>	<b>Methanol</b>	<b>Glyoxal</b>	<b>Glutaraldehyde</b>
<b>Narrabri Alluvial sediments (fast seepage velocity)</b>					
<b>Max concentration at plume extent (mg/L)</b>	850 at 9 m	0.08 at 32m	0.12 at 35 m	0.12 at 34 m	1.5 at 25 m
<b>Maximum lateral extent relative to drinking water criteria</b>	21 m	< 67 m	not applicable (source concentration below drinking water criteria)	< 40 m	< 55 m
<b>Maximum lateral extent relative to irrigation criteria</b>	17 m	not applicable	not applicable	not applicable	not applicable
<b>Narrabri Alluvial sediments (slow seepage velocity)</b>					
<b>Max concentration at plume extent (mg/L)</b>	31,100 at 0 m	31 at 0 m	4.75 at 0 m	45.7 at 0 m	671 at 0 m
<b>Maximum lateral extent relative to drinking water criteria</b>	3 m	< 15 m	not applicable (source concentration below drinking water criteria)	< 10 m	< 12 m
<b>Maximum lateral extent relative to irrigation criteria</b>	2.5 m	not applicable	not applicable	not applicable	not applicable
<b>Pilliga Sandstone (fast seepage velocity)</b>					
<b>Max concentration at plume extent (mg/L)</b>	243 at 34 m	0.24 at 34m	0.037 at 34 m	0.36 at 33 m	4.3 at 21 m
<b>Maximum lateral extent relative to drinking water criteria</b>	< 45 m	< 65 m	not applicable (source concentration below drinking water criteria)	< 14 m	< 51 m
<b>Maximum lateral extent relative to irrigation criteria</b>	< 34 m	not applicable	not applicable	not applicable	not applicable
<b>Pilliga Sandstone (slow seepage velocity)</b>					
<b>Max concentration at plume extent (mg/L)</b>	8,148 at 0.4 m	16 at 1.2 m	2.5 at 0.4 m	24 at 0.4 m	318 at 0.2 m
<b>Maximum lateral extent relative to drinking water criteria</b>	0.8 m	< 1 m	not applicable (source concentration below drinking water criteria)	< 0.7 m	< 0.7 m
<b>Maximum lateral extent relative to irrigation criteria</b>	0.7 m	not applicable	not applicable	not applicable	not applicable

## 2.0 CONCLUSIONS

As described, a highly conservative model of the fate and transport of key constituents of concern within drilling fluid has been conducted within the Narrabri alluvial and Pilliga Sandstone aquifers. Key constituents were identified based on their solubility mobility and toxicity to provide a broad spectrum of understanding of the potential area of groundwater impacts around a recently drilled well.

This modelling has demonstrated that potential exceedances of water quality criteria are confined to the immediate vicinity of the well (less than 67 m). However, the modelled scenarios are based on large-scale losses of drilling fluids to the formation (which rarely occur). Drilling processes are conducted in accordance with international best practices and are designed to prevent fluid losses into the formation and ultimately the establishment of the casing which provides protection for aquifer systems during subsequent phases of commissioning and operation. Further in the process of establishing casing, the hole is flushed further reducing the mass of drilling fluids in the subsurface. In addition, physical and chemical processes within groundwater and interaction with aquifer media are likely to mitigate any constituent concentrations in groundwater.

While screening criteria are potentially exceeded the potential for unacceptable exposures are considered limited based on the limited number of potable bores within the project area and the well pad siting requirements outlined in the Field Development Protocol (Santos FDP 2016). This protocol has been developed considering other key project constraints (noise, ecological receptors, cultural heritage etc.) and also provides the benefit of limiting the potential for exposures as well pad locations are directed away from sensitive receptors. In accordance with the protocol wells will not be located within:

- 200 m of an occupied residences including associated bores potentially used for potable purposes (unless a written agreement is in place with the relevant landholder).

Further, the fate and transport of constituents have been conservatively evaluated, and attenuation of concentrations is anticipated well within the distances modelled. Key considerations supporting the conservative nature of the modelling include:

1. The organic compounds (MITC, methanol, glyoxal and glutaraldehyde) are all expected to have half-lives that will ensure impacts are less than those predicted by the conservative fate and transport modelling.
2. The geochemistry of the aquifer is conducive to complexation of metals in the aquifer. Further cation exchange between calcium and sodium will occur within the aquifer matrix. These processes have not been accounted for within the modelling but have the potential to increase the retardation factor by 1-2 orders of magnitude. A retardation factor of 10 would be sufficient to reduce the observed concentrations to below the relevant criteria for sodium within 20 m of the well.

Based on the highly conservative nature of the fate and transport modelling assessment, the additional natural attenuation processes of constituents not accounted for in the assessment and the protective measures adopted within the Santos FDP (2016), deleterious impacts from drilling fluid losses are highly unlikely.



### **3.0 REFERENCES**

CDM Smith (2016) Narrabri Gas Project Groundwater Impact Assessment Report. October 2016.

Howard et al., (1991) Handbook of Environmental degradation rates. Lewis Publishers

Lovanh, N., Zhang, Y-K., Heathcote, R.C. and Alvarez, P.J.J. (2000) Guidelines to determine site specific parameters for modelling the fate and transport of Monoaromatic Hydrocarbons in groundwater The University of Iowa

Younger, P. (1993) Simple generalized methods for estimating aquifer storage parameters Quaterley Journal of Engineering Geology and Hydrogeology v.26 pp 127-135

## **APPENDIX D RISK ASSESSMENT DOSSIERS**

**Table D-1**  
**Summary of Risk Assessment Dossiers for Drilling Fluids**

Chemical name	CAS Number	Summary
Copolymer of Acrylamide/Sodium Acrylate/ Copolymer of Acrylamide/Potassium Acrylate	25085-02-3/ 31212-13-2	Copolymer of Acrylamide/Sodium Acrylate and Acrylamide/Potassium Acrylate are polymers that range in molecular weights from 100,000 to >3,000,000. They are not expected to undergo significant biodegradation; nor are they expected to bioaccumulate because of their poor water solubility and high molecular weight. No studies are available for the human health hazard assessment. NICNAS has assessed these polymers and considered them a "polymer identified as low concern to human health by application of expert validated rules." These polymers are expected to be a low concern for toxicity to aquatic organisms. Due to their poor solubility and high molecular weight, they are not expected to be bioavailable. Neither do they contain any reactive functional groups, i.e., cationic groups.
Calcined petroleum coke	64743-05-1	Calcined petroleum coke is a black-colored solid produced by the high pressure thermal decomposition of heavy (high-boiling) petroleum process streams and residues. If released to the environment, petroleum coke is expected to be chemically and physically inert. Calcined petroleum coke is not expected to biodegrade since it is composed mainly of elemental carbon which does not contain the chemical bonds that microbes require for metabolism. Being water-insoluble and physically and biologically inert, calcined petroleum coke is not expected to bioaccumulate. No acute toxicity, irritation, or sensitisation studies are available on petroleum coke. Inhalation studies have shown no systemic toxicity in rats and monkeys exposed by inhalation to petroleum coke for up to two years. Petroleum coke has a low potential for genotoxicity (based on in vivo studies) and for reproductive/developmental toxicity. It is of low toxicity concern to aquatic and terrestrial organisms.
Calcium carbonate	471-34-1	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 exhibits low toxicity by the oral, dermal, and inhalation routes. It is not irritating to the skin and minimally irritating to the eyes; and it is not a skin sensitiser. An oral study in rats showed no systemic, reproductive or developmental toxicity even at very high oral doses. It is not genotoxic. Calcium carbonate is of low toxicity concern to aquatic and terrestrial organisms.
Sodium carbonate	497-19-8	Sodium carbonate dissociates in water to sodium ( $\text{Na}^+$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions; aqueous solutions are strongly alkaline. The ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Sodium carbonate has a low order of acute toxicity by the oral, dermal, and inhalation routes. It is not a skin irritant, but it is an eye irritant. Sodium carbonate is not expected to be systemically available in the body from oral exposure due to its dissociation in bodily fluids and the neutralisation of the carbonate ion in the stomach. It does not pose a developmental hazard. Sodium carbonate is of low toxicity concern to aquatic and terrestrial organisms.
Glutaraldehyde	111-30-8	Glutaraldehyde is a liquid at room temperature. It is readily biodegradable and is expected to have a low potential for bioaccumulation. Glutaraldehyde is moderately to highly toxic by the oral route, low to moderately toxic by the dermal route, and moderately to highly toxic by the inhalation route. Acute inhalation exposure may cause respiratory irritation. Glutaraldehyde is corrosive to the skin and eyes; and it is a skin and respiratory sensitiser. Repeated oral exposures via drinking water to rats have resulted in general systemic toxicity, but no target organ effects. In contrast, the upper respiratory tract, particularly the nasal cavity, is the target organ in rats and mice from repeated inhalation exposure. Glutaraldehyde may exhibit weak genotoxic effects in some in vitro tests, whereas the in vivo studies consistently show no genotoxic activity. Glutaraldehyde is not a reproductive toxicant; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity. Glutaraldehyde is slightly to moderately toxic to fish and invertebrates, and moderately to highly toxic to algae. It is of low toxic concern to terrestrial invertebrates and plants. To birds, glutaraldehyde is moderately toxic on an acute basis and slightly toxic on a subacute dietary basis.

**Table D-1**  
**Summary of Risk Assessment Dossiers for Drilling Fluids**

Chemical name	CAS Number	Summary
Methanol	67-56-1	Methanol is a liquid at room temperature. It is readily bioavailable and will not bioaccumulate. Methanol has a low order of acute toxicity by the oral, dermal, and inhalation routes in animals, as measured by lethality. Sublethal doses, however, have been shown to produce central nervous system (CNS) effects and ocular injury that may result in blindness. This effect has been seen in primates but not in rodents, and has been contributed to the differences in blood levels of the metabolites. Acute toxicity in humans is characterised in a well-defined pattern, that includes CNS effects, ocular symptoms, and acidosis. Methanol is not irritating to the skin, but it is slightly irritating to the eyes. Repeated exposures by the oral and inhalation routes have not resulted in any systemic toxicity to rodents. Methanol was not carcinogenic to rats or mice in chronic inhalation studies. Increased tumors from methanol in drinking water was reported in one study; however, there are methodological problems with this study and questions have been raised about the validity of the results. Methanol is generally inactive in a variety of in vitro and in vivo genotoxicity studies. Conflicting results have been obtained concerning the effect of methanol on testicular hormones in rats; nevertheless, methanol does not appear to a male reproductive toxicant. The primate data indicates that methanol is unlikely to be a reproductive hazard in females. Methanol causes developmental effects at very high exposure levels in both rats ( $\geq 10,000$ ppm) and mice ( $\geq 2000$ ppm); there is also some evidence that it is a developmental neurotoxicant in rodents, but not in primates. Methanol exhibits a low toxicity concern for aquatic organisms, terrestrial invertebrates and plants.
Polyalkylene	9038-95-3	Polyalkylene is polyalkylene glycol monobutyl ether polymers that vary in molecular weight (size). Depending on the molecular weight the degree of biodegradability can vary from slowly biodegradable to readily biodegradable. The bioaccumulation potential is expected to be low. Polyalkylene polymers have low acute toxicity by the oral and inhalation routes. Oral studies over the lifetime of rats showed no systemic toxicity or carcinogenicity. Inhalation studies with rats showed respiratory irritation and inflammation at high, repeated exposures to an aerosol or dust of polyalkylene polymers. No studies are available to evaluate genotoxicity, reproductive or developmental toxicity. Polyalkylene is practically non-toxic to aquatic organisms on an acute basis.
Glyoxal	107-22-2	Glyoxal is a non-volatile liquid at room temperature and is commonly supplied commercially as a 40% aqueous solution. Glyoxal is readily biodegradable and is not expected to bioaccumulate. Glyoxal exhibits low acute toxicity by the oral and dermal routes; it has moderate acute toxicity by the inhalation route. Glyoxal is an irritant to the skin and eyes, and is a skin sensitiser. Rats given repeated oral doses of glyoxal has shown liver effects of questionable toxicological significance. Lifetime oral studies showed stomach lesions in female rats but no carcinogenic effects in either rats or mice. Glyoxal has shown mutagenic or genotoxic effects in a variety of in vitro assays; in vivo studies indicate that glyoxal is genotoxic in organs at the point of entry (the stomach) and immediately downstream (the liver), but not in more remote organs. Glyoxal exhibits a low concern for toxicity to aquatic organisms, as well as to terrestrial invertebrates and plants.
Ethylene oxide/propylene oxide copolymer	9003-11-6	Ethylene oxide/propylene oxide copolymer (EO/PO copolymer) is a group of polymers that can vary in molecular weight (size). They are non-volatile and vary in water solubility. EO/PO copolymers are either readily biodegradable or inherently biodegradable and are not expected to bioaccumulate. EO/PO copolymers are essentially not acutely toxic by the oral route. These polymers are not skin irritants or sensitisers. Lifetime oral studies in rats showed no toxicity. Inhalation studies with rats showed a slight indication of respiratory irritation at very high, repeated exposures to an aerosol or dust of this polymer. EO/PO copolymer is not mutagenic. No studies are available to evaluate reproductive or developmental toxicity. EO/PO copolymers are practically non-toxic to aquatic organisms on an acute basis.
Potassium chloride	7747-40-7	Potassium chloride dissociates completely to potassium ( $K^+$ ) and chloride ( $Cl^-$ ) ions in aqueous solutions. Both ions are ubiquitous in the environment and present in all living cells. Potassium chloride is not acutely toxic by the oral route. It is not a skin or eye irritant. Lifetime studies showed no toxicity or carcinogenic effects in rats. Potassium chloride has shown some genotoxic effects in vitro assays; these occurred at high concentrations of potassium chloride and is thought to be due to a disruption of osmotic balance of the cells. No developmental toxicity was seen when pregnant female rats were fed high doses of potassium chloride. Potassium chloride is of low toxicity concern to aquatic organisms.

**Table D-1**  
**Summary of Risk Assessment Dossiers for Drilling Fluids**

Chemical name	CAS Number	Summary
Silicic acid, potassium salt	1312-76-1	Silicic acid, potassium salt or potassium silicate is an amorphous glass in the form of fine powders or granules. As an inorganic substance, it is not amenable to biodegradation; it is not expected to bioaccumulate. Potassium silicate exhibits low acute toxicity by the oral and dermal routes. It can be irritating to corrosive depending its molar ratio and concentration; it is not a dermal sensitiser. There is a low potential for toxicity from repeated oral exposures to potassium silicate. It is not genotoxic. Limited data indicate that potassium silicate does not pose a developmental hazard. Potassium silicate is of low toxicity concern to aquatic organisms.
Polypropylene glycol	25322-69-4	Polypropylene glycol are a group of polymers of propylene glycol that vary in molecular weight (size). They are viscous liquids and are considered readily biodegradable with low potential to bioaccumulate. The acute oral toxicity of polypropylene glycols vary from moderately to non-toxic, depending on the molecular (toxicity decreases with increasing molecular weight). These substances are non-toxic by the dermal route. Polypropylene glycols are not skin and eye irritants; nor are they skin sensitisers. These polymers show low potential for systemic toxicity following repeated exposure by the oral and dermal routes. They are not genotoxic and they do not pose a developmental hazard. Polypropylene glycol is of low toxicity concern to aquatic organisms.
Sodium carboxymethyl cellulose	9004-32-4	Sodium carboxymethyl cellulose (Na CMC) is a white or slightly yellowish powder. It is biodegradable, but not readily biodegradable, and it is not expected to bioaccumulate. Limited mammalian toxicity studies are available on Na CMC. Lifetime oral studies showed no toxicity or carcinogenic effects in rats or mice. It does not pose a reproductive or developmental hazard, and it is not genotoxic. Sodium carboxymethylcellulose is a low concern for toxicity to aquatic organisms.
Sodium hydroxide	1310-73-2	Sodium hydroxide (NaOH) is a strong alkaline substance that dissociates completely in water to sodium( $\text{Na}^+$ ) and hydroxide ( $\text{OH}^-$ ) ions. A release of sodium hydroxide into the aquatic environment from the use of NaOH could potentially increase the sodium concentration and the pH in the aquatic environment. The $\text{Na}^+$ and $\text{OH}^-$ ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Limited human health toxicity data exist for sodium hydroxide. Depending on the concentration, solutions of NaOH are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. NaOH is not a skin sensitiser. The hazard of NaOH for aquatic organisms is caused by the hydroxyl ion ( $\text{OH}^-$ ) which has the potential to increase the pH of the aquatic environment, depending of the buffering capacity.
Sodium polyacrylate	9003-04-7	Sodium polyacrylate are a group of polymers that range in molecular weight from 1,000 to 78,000. These polymers are not readily biodegradable but are partly accessible to ultimate biodegradation. They are not expected to bioaccumulate. Sodium polyacrylates have low acute toxicity by the oral and dermal routes. They are not irritating to the skin and eyes, and are not skin sensitisers. Sodium polyacrylate was not toxic to rats when given repeated high oral doses; it was also not systemically toxic to rats following repeated inhalation exposures, although there was evidence of respiratory irritation. Sodium polyacrylate does not pose a developmental hazard and it is not genotoxic. Sodium acrylate exhibits a low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants.
Starch	9005-25-8	Starch is a polysaccharide comprising of glucose; it is manufactured in plants during photosynthesis. Starch is expected to be biodegradable and not bioaccumulate. No mammalian toxicity studies are available on starch; it is a common component of human diets. NICNAS has assessed starch and considers it "a chemical identified as low concern to human health." Starch is not toxic to aquatic organisms.

**Table D-1**  
**Summary of Risk Assessment Dossiers for Drilling Fluids**

Chemical name	CAS Number	Summary
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)/Methylisothiocyanate (MITC)	533-74-4/556-61-6	<p>Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) is a colorless solid that is rapidly hydrolyzed to methylisothiocyanate (MITC). Dazomet is not readily biodegradable, but it is inherently biodegradable. Dazomet is not likely to volatilize due to its very low vapour pressure; however, MITC will rapidly evaporate. Both dazomet and MITC have a low potential to bioaccumulate. Dazomet is moderately to acutely toxic by the oral route, but exhibits low acute toxicity by the dermal and inhalation routes. MITC is highly acutely toxic by the oral and inhalation routes; by the dermal route, a wide range has been reported for rodents and rabbits that range from highly toxic to low toxicity. Dazomet is not irritating to the skin and eyes, and it is not a skin sensitizer when tested on animals. MITC is severely irritating to the skin and eyes; and it is a skin sensitizer. Repeated oral exposures to dazomet show the liver and red blood cell (RBC) as target organs in rats, mice, and dogs. No toxicity was seen in rats exposed repeatedly by inhalation to dazomet; nor any systemic toxicity in a rabbit dermal study. The nasal cavity is a target organ for repeated inhalation exposures to MITC. In oral studies, repeated exposures have resulted in systemic toxicity with no clear target organ effects. Lifetime studies showed no carcinogenic effects in rats and mice with either dazomet or MITC. Dazomet was weakly genotoxic in some in vitro assays, but was not genotoxic in the in vivo tests. MITC is not genotoxic. Dazomet and MITC are not reproductive toxicants; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity. Dazomet exhibits high acute toxicity to aquatic organism, particularly to fish (96-hr LC50 = 0.16 mg/L). This effect, however, is unlikely to be attributed only to dazomet since dazomet is rapidly degraded to MITC in water. MITC exhibits a higher acute toxicity to fish compared to dazomet (96-hr LC50 = 0.053 mg/L). Both dazomet and MITC show moderate toxicity to earthworms. To birds, dazomet is moderately toxic on an acute basis and slightly toxic on a subacute dietary basis.</p>
Xanthan gum	11138-66-2	<p>Xanthan gum is a high molecular weight polysaccharide produced by the bacterium <i>Xanthomonas campestris</i>. It may be degraded, but it is not readily biodegradable. Due to its high molecular weight, it is not expected to be bioavailable and thus not bioaccumulate. Xanthan gum is not acutely toxic. It is neither irritating nor sensitizing to the skin. Lifetime feeding studies showed no carcinogenic effects in rats. It does not pose a reproductive or developmental hazard.</p>

Note: PBT Persistent, bioaccumulative, toxic

## ACRYLAMIDE/SODIUM ACRYLATE COPOLYMER

This dossier on acrylamide/sodium acrylate copolymer does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of acrylamide/sodium acrylate copolymer in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** 2-Propenoic acid, sodium salt, polymer with 2-propenamide

**CAS RN:** 25085-02-3

**Molecular formula:**  $(C_3H_5NO.C_3H_4O_2.NA)_x-$

**Molecular weight:** No information is available. Based on the type and intended use of the copolymer, the molecular weight would likely range from 100,000 to >3,000,000 (Hamilton et al., 1997).

**Synonyms:** Acrylamide/sodium acrylate copolymer; 2-propenamide, polymer with 2-propenoic acid, sodium salt; 2-propenoic acid, sodium salt, polymer with 2-propenamide; 2-Propenamide-sodium 2 propenoate copolymer; sodium acrylate acrylamide polymer; sodium acrylate-acrylamide copolymer

**SMILES:** Not applicable.

### II. PHYSICO-CHEMICAL PROPERTIES

No information is available.

### III. ENVIRONMENTAL FATE PROPERTIES

No studies are available. The acrylamide/sodium acrylate copolymer is not expected to be readily biodegradable. The physico-chemical properties of the copolymer would preclude it from undergoing significant biodegradation (Guiney et al., 1997). Biodegradation is limited due to the very high molecular weight and the low water solubility of the copolymer. The copolymer will likely bind tightly to organic matter found within soils and sediments (Guiney et al., 1997). The copolymer is not expected to bioaccumulate because of its poor water solubility and high molecular weight.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

No studies are available.

### V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

NICNAS has assessed acrylamide/sodium acrylate copolymer in an IMAP Tier 1 assessment and considers it a “polymer identified as a low concern to human health by application of expert validated rules”<sup>1</sup>.

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<sup>1</sup> [https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A\\_25085-02-3](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_25085-02-3)

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Acrylamide/sodium acrylate copolymer does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

No studies are available. Acrylamide/sodium acrylate copolymer is expected to be a low concern for toxicity to aquatic organisms (Guiney et al., 1997). Due to its poor solubility and high molecular weight, it is not expected to be bioavailable. It does not contain any reactive functional groups (i.e., cationic groups).

### **A. Calculation of PNEC**

No PNEC values were calculated.

## **VIII. PBT ASSESSMENT**

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).

Acrylamide/sodium acrylate copolymer is not readily biodegradable; therefore, it meets the screening criteria for persistence.

Acrylamide/sodium acrylate copolymer is expected to have a very high molecular weight and poor water solubility. It is not expected to be bioavailable. Therefore, this copolymer does not meet the criteria for bioaccumulation.

There are no aquatic toxicity studies on acrylamide/sodium acrylate copolymer. It is expected to have low concern for aquatic toxicity because of its very high molecular weight and poor water solubility. Therefore, the copolymer does not meet the criteria for toxicity.

The overall conclusion is that acrylamide/sodium acrylate copolymer is not a PBT substance.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Not classified.

### **B. Labelling**

No signal word.

### **C. Pictograms**

None.



## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) on EZ-Mud® DP (revision date: 3 March 2016).

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

### **B. Fire Fighting Information**

Firefighting information was obtained from the Halliburton SDS on EZ-Mud® DP (revision date: 3 March 2016).

#### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

#### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

### **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS on EZ-Mud® DP (revision date: 3 March 2016).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling were obtained from the Halliburton SDS on EZ-Mud® DP (revision date: 3 March 2016)

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Slippery when wet.

### Storage

Store away from oxidizers. Store in a cool, dry location. The product has a shelf life of 36 months.

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for acrylamide/sodium acrylate copolymer.

The following information on exposure controls and personal protection was obtained from the Halliburton SDS on EZ-Mud® DP (revision date: 3 March 2016).

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed; however, if significant exposures are possible, then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves

*Skin Protection:* Normal work coveralls

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None known.

## **F. Transport Information**

Acrylamide/sodium acrylate copolymer is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. 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.

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

Guiney, P. D., McLaughlin, J. E., Hamilton, J. D., and Reinert, K. H. (1997). Dispersion Polymers. In: Ecological Assessment of Polymers Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and Sutcliffe, R. eds.), pp. 147-165, Van Nostrand Reinhold.

Hamilton, J. D., Vasconcellos, S. R., and Keener, R. L. (1997). Introduction. In: Ecological Assessment of Polymers Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and Sutcliffe, R. eds.), pp. 3-15, Van Nostrand Reinhold.

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.

#### **XIV. ACRONYMS AND GLOSSARY**

AICS	Australian Inventory of Chemical Substances
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
PBT	Persistent, Bioaccumulative and Toxic
SDS	Safety Data Sheet
SMILES	simplified molecular-input line-entry system

## CALCINED PETROLEUM COKE

This dossier on calcined petroleum coke does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of calcined petroleum coke in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained from the American Petroleum Institute (API) Test Plan, and Robust Summaries on Petroleum Coke submitted to the U.S. USEPA High Production Volume (HPV) Chemical Program (API, 2000; API, 2008). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Coke (petroleum), calcined

**CAS RN:** 64743-05-1

**Molecular formula:** UVCB (Unknown or Variable Composition, Complex Reaction Products and Biological Materials)

**Molecular weight:** UVCB

**Synonyms:** Coke (petroleum), calcined; coke, petroleum, calcined

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-chemical Properties of Calcined Petroleum Coke**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Black-coloured solid	-	API, 2008; USEPA, 2011
Melting Point	Not applicable	-	API, 2008; USEPA, 2011
Boiling Point	Not applicable	-	API, 2008; USEPA, 2011
Vapour Pressure	Negligible	-	API, 2008; USEPA, 2011
Partition Coefficient (log Pow)	Not applicable	-	API, 2008; USEPA, 2011
Water Solubility	Insoluble	-	API, 2008; USEPA, 2011
Henry's Law Constant	Negligible	-	API, 2008; USEPA, 2011

Petroleum coke consists of two substances: green coke and calcined coke. The principal difference between the substances is the amount of residual hydrocarbon in the two products. Petroleum coke (both green and calcined) is produced by the high-pressure thermal decomposition of heavy (high-boiling) petroleum process streams and residues. Green coke is the initial product from the cracking and carbonisation of the feedstocks to produce a substance with a high carbon-to-hydrogen ratio. Green coke undergoes additional thermal processing to produce calcined coke. The additional processing removes the residual hydrocarbons and increases the percentage of elemental carbon, which results in a lower potential for toxicity (API, 2008).

Green petroleum coke exists as a solid substance composed of predominantly carbon in a polycrystalline porous matrix. Approximately 9-21% by weight of green petroleum coke is a volatile matter that is

driven off during the calcining process. This volatile matter consists of the heavy hydrocarbons remaining from the feedstocks that have not undergone complete carbonisation. It exists in green coke as a hardened residuum in the carbon matrix. The specific chemical composition of any given batch of petroleum coke is determined by the composition of the feedstocks used in the coking process, which in turn are dependent on the composition of the crude oil and refinery processing from which the feedstock is derived.

### **III. ENVIRONMENTAL FATE PROPERTIES**

Elemental carbon and the residual components are not water-soluble and are not volatile in the environment. If released to the environment, petroleum coke is expected to be chemical and physically inert. Petroleum coke will either be incorporated into sediment or float to the surface, depending on the particle size and density in relation to water (API, 2008; USEPA, 2011).

Calcined petroleum coke is not expected to biodegrade since it is composed mainly of elemental carbon which does not contain the chemical bonds that microbes require for metabolism. Other potential constituents embedded in the carbon matrix include inorganic substances and high molecular weight hydrocarbon compounds that may remain as a residuum from the coking process. These constituents would not be expected to be available for microbial degradation (API, 2008; USEPA, 2011).

Being water-insoluble and physically and biologically inert, calcined petroleum coke is not expected to bioaccumulate.

### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

#### **A. Summary**

There are limited toxicity data on petroleum coke; with the exception of one study (a 5-day inhalation study), all of the toxicity studies on petroleum coke have been conducted on green petroleum coke. Green petroleum coke contains a higher level of volatile matter (residual hydrocarbons) than calcined petroleum coke; it would thus be expected to have a high potential for human health effects than calcined petroleum coke, representing a “worst case” by comparison. No acute toxicity, irritation, or sensitization studies are available on petroleum coke. Repeated dose toxicity studies with inhalation exposures up to two years resulted in inflammatory and non-carcinogenic proliferative changes in the nose and lungs of rats, but not in monkeys. These respiratory tract effects were considered to be non-specific responses of the respiratory tract due to high concentrations of insoluble particles rather than a compound specific-induced effect. No systemic toxicity was seen in these repeated dose toxicity studies. Petroleum coke was not mutagenic in the standard bacterial reverse mutation assay; however, it was mutagenic in the modified Ames test (DMSO extract) developed for petroleum substances. Petroleum coke (green coke) was not genotoxic when tested for chromosomal aberrations in the bone marrow of rats. In a reproductive/developmental toxicity screening study, inhalation exposure to green petroleum coke resulted in a reproductive effect (reduced fertility) in rats at 30, but not 10 mg/m<sup>3</sup>; no developmental toxicity was, however, noted in this study.

#### **B. Acute Toxicity**

No studies are available.

#### **C. Irritation**

No studies are available.

## D. Sensitisation

No studies are available.

## E. Repeated Dose Toxicity

### Oral

No studies are available.

### Inhalation

Male F344 rats were exposed by inhalation to green petroleum coke dust (58.2 mg/m<sup>3</sup>) or calcined petroleum coke dust (45 mg/m<sup>3</sup>) for 5 consecutive days. Controls groups were silicon dioxide (positive control) and titanium dioxide (negative control). The mass median aerodynamic diameters for green and calcined petroleum coke particles were 2.71 and 2.69 µm, respectively. Animal groups were sacrificed at 7, 28, and 63 days post-exposure. No deaths occurred during the study, and there were no significant exposure-related clinical findings, except a slight discoloration of the fur in the coked-exposed animals and a slight increase in the incidence of chromodacryorrhea (red tears) in all groups except the titanium dioxide group. The bronchioalveolar lavage (BAL) at the 7 and 28-day post-exposure groups showed no indication of pulmonary in the coke-exposed or control groups; but there was a pulmonary effect (increased n-acetylglucosaminidase, neutrophils, lymphocytes, total protein and total cell count) in the silicon dioxide and, to a lesser degree, in the coke-exposed animals at 63 days post-exposure. At 63 days, lung weights of the coke-exposed animals were comparable to those of both control groups. Red discoloration of the lungs and parabronchial lymph nodes were seen in the coke-exposed animals; the study authors did not consider these changes to be of toxicological significance. Some inflammation was observed in all treatment groups. The severity increased in the following order: titanium dioxide < calcined petroleum coke < green petroleum coke < silicon dioxide. There were no signs of pulmonary fibrosis in any of the treated groups (API, 2000). [Kl. score = 1]

Male and female SD rats were exposed by inhalation (whole-body) to 0, 10.2, or 30.7 mg/m<sup>3</sup> delayed process green petroleum coke dust 6 hours/day, 5 days/weeks for two years. The average mass median aerodynamic diameter was  $3.1 \pm 1.9$  µm. Scheduled interim sacrifices were after 5 days; and 1, 3, 6, 12, and 18 months of exposure. There were no treatment-related effects on mortality, body weights, serum biochemistry parameters, ophthalmologic examination, or organ weights. Although there were statistically significant differences in the segmented neutrophils and lymphocytes between treated and control animals, these differences were not consistent throughout the study. The study authors concluded that these changes were probably indicative of a mild inflammatory reaction as a result of deposition of test substance in the lungs. A significant, dose-related increase in absolute and relative lung (including trachea) weights was seen in the exposed animal groups. At necropsy, the exposed rats had grey/black discoloration and foci of the lung and black thoracic lymph nodes at interim time points during the study and at the end of two years. Lung masses or nodules were observed at the 18 and 24-month sacrifices and in rats dying spontaneously or sacrificed in extremis between 18 and 24 months. These masses or nodules corresponded to the microscopic findings of keratin cysts. Histopathologic examination of the coke-exposed animals showed chronic pulmonary inflammation after 3, 6, 12, and 18 months of exposure. Pulmonary sclerosis, squamous alveolar metaplasia, and a keratin cyst were first observed in rats at the 18-month sacrifice and the incidence of these findings increased during the last 6 months of the study. Overall, the microscopic changes observed increased in severity with increasing exposure concentration and increasing duration of exposure. The LOAEC for this study is 10.2 mg/m<sup>3</sup>; an NOAEC was not established (Klönne et al., 1987; API, 2000). [Kl. score = 1]

Male and female Cynomolgus (*Macaca fascicularis*) monkeys were exposed by inhalation (whole-body) to 0, 10.2, or 30.7 mg/m<sup>3</sup> delayed process green petroleum coke dust 6 hours/day, 5 days/weeks for two years. The average mass median aerodynamic diameter was  $3.1 \pm 1.9$  µm. There were no

treatment-related effects on mortality, body weights, haematology and serum chemistry parameters, ophthalmologic evaluation, or organ weights. A significant, dose-related increase in absolute and relative lung (including trachea) weights was seen in the exposed animal groups at the end of two years. At necropsy, the monkeys in the exposed groups had grey/black discoloration and foci of the lung and black thoracic lymph nodes. Histopathologic evaluation showed trace to moderate accumulations of alveolar macrophages containing test material in both sexes and at both dose levels. Similar accumulations of macrophages were also seen in the thoracic lymph nodes and in paratracheal lymphoid tissue. The LOAEC for this study is 10.2 mg/m<sup>3</sup>; an NOAEC was not established (Klönne et al., 1987; API, 2000). [Kl. score = 1]

#### Dermal

No studies are available.

### **F. Genotoxicity**

#### *In Vitro Studies*

Delayed and fluid process green coke have been tested in an *in vitro* bacterial reverse mutation assay. No mutagenic response was seen to *S. typhimurium* strains TA98, TA100, TA1535, TA1537 and TA1538 with or without metabolic activation. DMSO was used as a solvent (API, 2000). Delayed and fluid process coke samples were not mutagenic to L5187Y mouse lymphoma cells with or without metabolic activation (API, 2008).

Green coke (sponge-form delayed process) was tested in a modified bacterial mutagenicity assay used for testing petroleum substances. Samples are typically dissolved in cyclohexane and subsequently extracted with DMSO to produce aqueous solutions which readily interact with the tester bacterial strains. Instead of rat liver homogenate being for the metabolic activation system, a hamster liver homogenate is used, and only one bacterial strain is tested. Green coke was mutagenic in this assay to *S. typhimurium* strain TA 98 (Dalbey et al., 1998).

Four petroleum coke samples were mutagenic to *S. typhimurium* strains TA 98 and TA 100 in the presence, but not absence, of a metabolic activation system. The coke samples were sonicated in DMSO for 30 minutes (Jongeneelen et al., 1989).

#### *In Vivo Studies*

Male Sprague-Dawley rats were exposed by inhalation to 0, 10 and 40 mg/m<sup>3</sup> fluid process green coke with a particle size of <5 µm. Rats in the 10 mg/m<sup>3</sup> group were exposed 6 hours/day, 5 days/week for 28 days (20 exposures). Rats in the 40 mg/m<sup>3</sup> group were exposed 6 hours/day for 5 days only. There were no significant differences in chromosomal aberrations in bone marrow between exposed and control animals at any dose level at either time point (API, 2000; USEPA, 2011). [Kl. score = 1]

Male and female Sprague-Dawley were exposed by inhalation to 0, 10 or 30 mg/m<sup>3</sup> delayed process green coke dust 6 hours/day for five days; or 6 hours/day, 5 days/week for 12 or 22 months. There were no significant differences in chromosomal aberrations in bone marrow between exposed and control animals at any dose level at either of the three-time points (Klönne et. al., 1987; API, 2000). [Kl. score = 1]

### **G. Carcinogenicity**

#### Oral

No studies are available.



## Inhalation Studies

A reproductive/developmental toxicity screening (OECD 421) study has been conducted on green coke. Male and female Sprague-Dawley rats were exposed nose-only to 0, 30, 100 or 300 mg/m<sup>3</sup> micronized green coke with an average mass median aerodynamic diameter of 2.29 µm. Animals were exposed 6 hours/day, 7 days/week for two weeks prior to mating. Males continued to be exposed for 28 days during the mating and post-mating period. During the mating period, females were exposed until evidence of mating was observed or for 14 consecutive days. Once mated, female rats were treated daily during gestation (days 0–19) until euthanised on post-natal day 4. Among the treatment groups, there were no statistically significant differences in fertility (number pregnant/number cohabited) or gestation (number of live litters/number of confirmed pregnant). In the 300 mg/m<sup>3</sup> group, however, the fertility and gestation indices were outside the testing facility's historical control lower ranges, and a low number of implantation sites with no viable foetuses for one female in this group was noted. The high-dose groups had a fertility index of 75% versus a historical control value of 87.5% and a concurrent control value of 91.7%, and a gestational index of 88.9% versus a historical control value of 95.2% and a concurrent control value of 100%. All other measurements of reproductive performance (i.e., mating index, days to mating, gestation length, pre-/post-implantation loss, the number of litters with stillborn pups) were similar between treated and control groups. No developmental or post-parturition effects were observed. The NOAECs for reproductive and developmental effects were considered to be 100 and 300 mg/m<sup>3</sup>, respectively (API, 2000).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

### **A. Non-cancer**

#### Oral

No repeated dose, reproductive, or developmental toxicity studies have been conducted on petroleum coke by the oral route. Thus, an oral Reference Dose (RfD) and drinking water guidance values were not derived.

#### Inhalation

### **B. Cancer**

Green petroleum coke was not carcinogenic to rats or monkeys in two-year inhalation carcinogenicity studies. Therefore, a cancer reference value was not derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Calcined petroleum coke does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Calcined petroleum coke is of low toxicity concern to aquatic and terrestrial organisms.

## B. Aquatic Toxicity

Green petroleum coke was tested for potential aquatic toxicity using aqueous exposure solutions prepared as water accommodated fractions (WAFs). An attempt was made to analytically quantify specific organic and inorganic constituents of petroleum coke in the WAF solutions. None of those constituents of petroleum coke was present in the WAF solutions at their analytical detection limits. Because a solubility level could not be established by analytical means, aquatic toxicity test endpoints are presented as nominal WAF loading rates.

### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on green petroleum coke.

**Table 2: Acute Aquatic Toxicity Studies on Green Petroleum Coke**

Test Species	Endpoint	Results (mg/L)*	Klimisch score	Reference
<i>Pimephales promelas</i>	96-hr LL <sub>50</sub> 96-h NOELR	>1,000 1,000	1	API, 2008; USEPA, 2011
<i>Daphnia magna</i>	48-hr EL <sub>50</sub> 48-hr NOELR	>1,000 1,000	1	API, 2008; USEPA, 2011
<i>Selenastrum capricornutum</i>	96-hr EL <sub>50</sub> 96-hr NOELR	>1,000 1,000	1	API, 2008; USEPA, 2011

\*WAF nominal loading rate.

### Chronic Studies

No studies are available.

## C. Terrestrial Toxicity

Green petroleum coke was tested for potential aquatic toxicity using aqueous exposure solutions prepared as WAFs (see above text for aquatic toxicity).

The results of acute terrestrial toxicity studies conducted on green petroleum coke are presented in Table 3.

**Table 3: Terrestrial Toxicity Tests on Green Petroleum Coke**

Test Species	Endpoint	Results (mg/kg soil dw)	Klimisch score	Reference
Earthworm ( <i>Eisenia fetida</i> )	14-d LC <sub>50</sub> 14-d NOEC	>1,000 1,000	1	API, 2008; USEPA, 2011
Terrestrial plant (corn)	21-d LC <sub>50</sub> 21-d NOEC	>1,000 1,000	1	API, 2008; USEPA, 2011
Terrestrial plant (radish)	21-d LC <sub>50</sub> 21-d NOEC	>1,000 1,000	1	API, 2008; USEPA, 2011
Terrestrial plant (soybean)	21-d LC <sub>50</sub> 21-d NOEC	>1,000 1,000	1	API, 2008; USEPA, 2011

\*WAF nominal loading rate.

#### **D. Calculation of PNEC**

Calcined petroleum coke is water-insoluble and is expected to be chemical and physically inert. Therefore, PNEC values for water, sediment, and soil were not derived.

### **VIII. PBT ASSESSMENT**

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).

Calcined petroleum coke is not biodegradable and thus meets the screening criteria for persistence.

Calcined petroleum coke is not expected to bioaccumulate. Coke is composed of elemental carbon and volatile matter, neither of which are water-soluble and hence not bioavailable. Therefore, calcined petroleum coke does not meet the screening criteria for bioaccumulation.

No chronic aquatic toxicity studies are available for calcined petroleum coke. However, acute toxicity studies on green petroleum coke showed EC<sub>50</sub> values of >1,000 mg/L the nominal WAF loading rate. Therefore, calcined petroleum coke does not meet the screening criteria for toxicity.

The overall conclusion is that calcined petroleum coke is not a PBT substance.

### **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

#### **A. Classification**

Not classified.

#### **B. Labelling**

No signal word.

#### **C. Pictograms**

None.

### **X. SAFETY AND HANDLING**

#### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) for STEELSEAL® (revision date: 22 Sept 2015).

##### Eye Contact

In the case of contact or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

##### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS for STEELSEAL® (revision date: 22 Sept 2015).

### Extinguishing Media

All standard firefighting media.

### Special Protective Equipment for Firefighters

Not applicable.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS for STEELSEAL® (revision date: 22 Sept 2015).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

### Environmental Precautions

None known.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS for STEELSEAL® (revision date: 22 Sept 2015).

### General Handling

Avoid creating or inhaling dust. Avoid dust accumulations. Wet activated carbon removes oxygen from the air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and dark procedures for low oxygen levels should be taken to ensure ample oxygen availability.

## Storage

Store away from oxidizers. Store in a dry location. Keep from heat, sparks, and open flames. The product has a shelf life of 60 months.

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

Occupational exposure standards for calcined petroleum coke have not been established.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS for STEELSEAL® (revision date: 22 Sept 2015).

### Engineering Controls

Use in a well-ventilated area to control dust levels.

### Personal Protection Equipment

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended: <sup>[1]</sup><sub>SEP</sub> Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves

*Skin Protection:* Normal work coveralls

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None Known

## **F. Transport Information**

Calcined petroleum coke is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

American Petroleum Institute (API). (2000). Robust Summary of Information on Petroleum Coke, dated 30 August 2000. Available at: [www.petroleumhvp.org](http://www.petroleumhvp.org).

- American Petroleum Institute (API). (2008). Petroleum coke category analysis and hazard characterization. Submitted to the U.S. USEPA by the American Petroleum Institute Petroleum HPV Testing Group, Consortium Registration #1100997, revised August 22, 2008. Available at: [www.petroleumhpv.org](http://www.petroleumhpv.org).
- Dalbey, W.E., Blackburn, G.R., Roy, T.A., Sasaki, S., Krueger, A.J., and Mackerer, C.R. (1998). Use of a surrogate aerosol in a preliminary screening for the potential carcinogenicity of coal coated with No. 6 fuel oil. *Am. Ind. Hyg. Assoc. J.* 59: 90-95.
- 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: <http://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.
- Jongeneelen, F.J., Anzion, R.B.M., Theuws, J.L.G., and Bos, R.P. (1989). Urinary 1-hydroxypyrene levels in workers handling petroleum coke. *J. Toxicol. Environ. Health* 26: 133-136.
- 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.
- Klonne, D.R., Burns, J.M., Halder, C.A., Holdsworth, C.E., and Ulrich, C.E. (1987). Two year inhalation study of petroleum coke in rats and monkey. *Am. J. Ind. Med.* 11: 375-389.
- United States Environmental Protection Agency (USEPA). (2011). Screening-Level Hazard Characterization: Petroleum Coke Category. Sponsored Chemicals: Petroleum coke, green (CASRN 64741-79-3); Petroleum coke, calcined (CASRN 64743-05-1), dated June 2011. Available at: [www.petroleumhpv.org](http://www.petroleumhpv.org).

#### **XIV. ACRONYMS AND GLOSSARY**

µm	micrometre
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg-day	milligrams per kilogram-day

mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
OECD	Organisation for Economic Co-operation and Development
KI	Klimisch scoring system
PBT	Persistent Bioaccumulative Toxic
PNEC	Predicted No Effect Concentration
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
USEPA	United States Environmental Protection Agency
UVCB	Unknown or Variable Composition, Complex Reaction Products and Biological Materials
WAFs	water accommodated fractions

## CALCIUM CARBONATE

This dossier on calcium carbonate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of calcium carbonate in its use in drilling muds and hydraulic fracturing fluids. 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Calcium Carbonate

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

**Molecular formula:**  $\text{CH}_2\text{O}_3\cdot\text{Ca}$  -

**Molecular weight:** 100.09

**Synonyms:** Carbonic acid, calcium salt (1:1); calcium monocarbonate; monocalcium carbonate

**SMILES:**  $\text{C(=O)}([\text{O-}][\text{O-}][\text{Ca+2}]$

### II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Physico-chemical Properties of Calcium Carbonate

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White powder	1	ECHA
Melting Point	825°C (decomposes)	2	ECHA
Boiling Point	-	-	-
Density	2.7 to 2.95 @ 20°C	2	ECHA
Vapour Pressure	-	-	-
Partition Coefficient (log Pow)	-	-	-
Water Solubility	16.6 mg/L @ 20°C (slightly soluble)	1	ECHA
Flammability	No	1	ECHA

\*Mass median diameter

### III. ENVIRONMENTAL FATE PROPERTIES

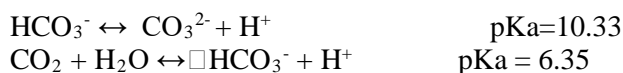
“Calcium carbonate, or  $\text{CaCO}_3$ , comprises more than 4% of the earth’s crust and is found throughout the world. Its most natural forms are chalk, limestone, and marble, produced by the sedimentation of the shells of small fossilised snails, shellfish, and coral over millions of years.”<sup>1</sup>

Calcium carbonate is partially soluble in water, dissociating into calcium ( $\text{Ca}^{2+}$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions. Both ions are ubiquitous in the environment.

The addition of calcium carbonate to an aquatic ecosystem could result in a shift towards in alkalinity and a tendency to increase the pH. The carbonate ions will react with water, forming bicarbonate ( $\text{HCO}_3^-$ ) and hydroxide ( $\text{OH}^-$ ) ions, until an equilibrium is reached. A re-equilibration takes place when carbonate ( $\text{CO}_3^{2-}$ ) is dissolved in water according to the following equations:

<sup>1</sup> ([http://www.ima-na.org/page/what\\_is\\_calcium\\_carb](http://www.ima-na.org/page/what_is_calcium_carb)).





Only a small fraction of the dissolved  $\text{CO}_2$  is present as  $\text{H}_2\text{CO}_3$  (carbonic acid); the major part is present as  $\text{CO}_2$ . The amount of  $\text{CO}_2$  in water is in equilibrium with the partial pressure of  $\text{CO}_2$  in the atmosphere. The  $\text{CO}_2/\text{HCO}_3^-/\text{CO}_3^{2-}$  equilibria are the major buffer of the pH of freshwater.

Based on these equations,  $\text{CO}_2$  is the predominant species at a pH smaller than 6.35, while  $\text{HCO}_3^-$  is the predominant species at a pH in the range of 6.35-10.33 and  $\text{CO}_3^{2-}$  is the predominant species at a pH higher than 10.33.

$\text{Ca}^{2+}$  and  $\text{CO}_3^{2-}$  ions are not expected to adsorb on the particulate matter or surfaces and will not accumulate in living tissues.

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

Calcium carbonate exhibits low toxicity by the oral, dermal, and inhalation routes. It is not irritating to the skin and minimally irritating to the eyes, and it is not a skin sensitiser. No systemic, reproductive, or developmental toxicity was seen in rats dosed by oral gavage for 48 days in an OECD 422 study at doses up to 1,000 mg/kg-day, the highest dose tested, of a nano form of calcium carbonate. Calcium carbonate is not genotoxic.

##### B. Acute Toxicity

The acute oral  $\text{LD}_{50}$  in rats is  $>2,000$  mg/kg. There were no deaths, clinical signs of toxicity, adverse changes in body weight, or effects at gross necropsy (ECHA) [Kl. score = 1]. The acute 4-hour  $\text{LC}_{50}$  of an aerosol of calcium carbonate in rats was estimated to be  $>3$  mg/L, the highest technically achievable concentration. Inhalation exposure was by nose-only (ECHA) [Kl. score = 1]. The acute dermal  $\text{LD}_{50}$  in rats is  $>2,000$  mg/kg; no deaths were seen at this concentration (ECHA) [Kl. score = 1].

##### C. Irritation

Calcium carbonate is non-irritating to the skin of rabbits (ECHA) [Kl. score = 1]. It is minimally irritating to the eyes of rabbits (ECHA) [Kl. score = 1].

##### D. Sensitisation

Calcium carbonate did not induce a sensitising response in the mouse local lymph node assay (LLNA) (ECHA). [Kl. score = 1]

##### E. Repeated Dose Toxicity

###### Oral

A nano form of calcium carbonate was tested in a combined repeated dose toxicity study with a reproductive/developmental toxicity screen (OECD 422). Male and female rats were dosed by oral gavage with 0, 100, 300, or 1,000 mg/kg-day calcium carbonate for up to 48 consecutive days (including a 14-day pre-mating period, pairing, gestation and early lactation for females). 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 for systemic absorption. There were no adverse effects that were considered to be treatment-related at any dose level. The NOAEL for this study is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

Male and female SD rats were dosed by oral gavage with 0, 250, 500, or 1,000 mg/kg of a nano form of calcium carbonate for 90 days. There were no adverse effects that were considered to be treatment-related at any dose level. The NOAEL for this study is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 2]

#### Inhalation

No studies are available.

#### Dermal

No studies are available.

### **F. Genotoxicity**

#### *In vitro Studies*

The *in vitro* studies on calcium carbonate are presented in the table below.

**Table 2: In Vitro Genotoxicity Studies on Calcium Carbonate**

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>E. coli</i> strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Chromosomal aberration (human lymphocytes)	-	-	1	ECHA

<sup>a</sup>+, positive; -, negative

#### *In vivo studies*

No studies are available.

### **G. Carcinogenicity**

No studies are available.

### **H. Reproductive/Developmental Toxicity**

Calcium carbonate (nano) was tested in a combined repeated dose toxicity study with a reproductive/developmental toxicity screen (OECD 422). Male and female rats were dosed by oral gavage with 0, 100, 300, or 1,000 mg/kg-day calcium carbonate for up to 48 consecutive days (including a 14-day pre-mating period, pairing, gestation and early lactation for females). 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 for systemic absorption. There was no treatment-related reproductive or developmental toxicity at any dose level. The NOAEL for reproductive and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

NICNAS has assessed calcium carbonate in an IMAP Tier 1 assessment and considers it “a chemical identified as a low concern to human health by application of expert validated rules.”<sup>2</sup>

Therefore, no toxicological reference or drinking water guidance values were derived from calcium carbonate.

The Australian drinking water guideline values for pH may be applicable (ADWG, 2011).

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Calcium carbonate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### 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-hr LC <sub>50</sub>	>100% (saturated solution)	1	ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>100% (saturated solution)	1	ECHA
<i>Desmodescus subspicatus</i>	72-hr EC <sub>50</sub>	>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.

#### Chronic Studies

No studies are available.

### C. Terrestrial Toxicity

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

<sup>2</sup> [https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A\\_471-34-1](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_471-34-1)

**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-d LC <sub>50</sub> NOEC	>1,000 1000	1	ECHA
Nitrogen transformation	28-d 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.

#### **D. Calculation of PNEC**

The natural pH, bicarbonate and the calcium concentration (and their fluctuations in time) vary significantly between aquatic ecosystems; so deriving generic PNEC values from aquatic toxicity results on calcium carbonate determined in an experimental system with a defined pH, buffered media and/or media composition to real world conditions is not useful. Therefore, PNEC values for freshwater, sediment, and soil were not derived from calcium carbonate.

### **VIII. PBT ASSESSMENT**

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 organic 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(L)<sub>50</sub>s are >0.1 mg/L in fish, invertebrates and algae. Therefore, calcium carbonate does not meet the screening criteria for toxicity.

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

### **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

#### **A. Classification**

Not classified.

#### **B. Labelling**

No signal word.

#### **C. Pictograms**

None.

## **X. SAFETY AND HANDLING**

### **A. First Aid**

#### Eye Contact

In the case of contact or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

### **B. Firefighting Information**

#### Extinguishing Media

All standard firefighting media.

#### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

### **C. Accidental Release Measures**

#### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

#### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

#### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

### **D. Storage and Handling**

#### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid breathing vapours.

### Storage

Store in a cool, dry location.

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

Occupational exposure standards for calcium carbonate have not been established.

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

*Respiratory Protection:* Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves

*Skin Protection:* Normal work coveralls

*Eye protection:* Dustproof goggles.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

Calcium carbonate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://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.

#### **XIV. ACRONYMS AND GLOSSARY**

ADWG	Australian Drinking Water Guidelines
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
IMAP	Inventory Multi-Tiered Assessment and Prioritisation
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg-day	milligrams per kilogram-day
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
OECD	Organisation for Economic Co-operation and Development
KI	Klimisch scoring system
PNEC	Predicted No Effect Concentration
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SMILES	simplified molecular-input line-entry system

## TETRAHYDRO-3,5-DIMETHYL-1,3,5-THIADIAZINE-2-THIONE

This dossier on tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of dazomet in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Dazomet is rapidly hydrolysed to methylisothiocyanate (MITC). Hence, this dossier will include information on both dazomet and its hydrolysis product, MITC.

### I. SUBSTANCE IDENTIFICATION(A)

**Chemical Name (IUPAC):** Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione

**CAS RN:** 533-74-4

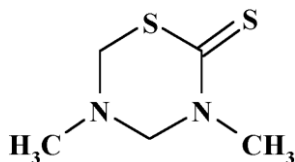
**Molecular formula:** C<sub>5</sub>H<sub>10</sub>N<sub>2</sub>S<sub>2</sub>

**Molecular weight:** 162.3

**Synonyms:** Dazomet; tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione; 3,5-dimethyl-1,3,5-thiadiazine-2-thione

**SMILES:** CN1CN(C(=S)SC1)C

**Structure:**



### I. SUBSTANCE IDENTIFICATION(B)

**Chemical Name (IUPAC):**

**CAS RN:** 556-61-6

**Molecular formula:** C<sub>2</sub>H<sub>3</sub>NS

**Molecular weight:** 73.12

**Synonyms:**

**SMILES:** CN=C=S

**Structure:** CH<sub>3</sub>-N=C=S



## II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-Chemical Properties of Dazomet**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colorless solid	-	EU, 2010
Melting Point	103.2 – 105.2°C	-	EU, 2010
Boiling Point	Decomposes before boiling	-	EU, 2010
Density	1.33	-	EU, 2010
Vapour Pressure	5.8 x 10 <sup>-4</sup> Pa @ 20°C	-	EU, 2010
Partition Coefficient (log Pow)	0.3 @ 24°C (pH 5-9) 0.63 @ 20°C (pH 5.8)		EU, 2010 EFSA, 2010
Water Solubility	3.5 g/L @ 20°C (pH 6-7)	-	EU, 2010
Flammability	Not highly flammable	-	EU, 2010
Auto flammability	No auto-flammable	-	EU, 2010
Henry's Law Constant	2.5 x 10 <sup>-5</sup> Pa m <sup>3</sup> /mol at 20°C	-	EU, 2010

**Table 2: Physico-Chemical Properties of Methylisothiocyanate**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	-	-	-
Melting Point	35.9°C	-	EU, 2010
Boiling Point	119°C		EU, 2010
Density	1.069 @ 37°C	-	EU, 2010
Vapour Pressure	2,500 Pa @ 20°C	-	EU, 2010
Partition Coefficient (log P <sub>ow</sub> )	1.2 at pH 6.8-7.1 @ 20°C	-	EU, 2010
Henry's Law Constant	22 Pa m <sup>3</sup> /mol @ 20°C	-	EU, 2010

## III. ENVIRONMENTAL FATE PROPERTIES

### A. Summary

Dazomet is rapidly hydrolysed to MITC (half-life of 5 hours at 25°C, pH = 7). It is not readily biodegradable, but it is inherently biodegradable. In biologically active soils, it is degraded to MITC with a half-life of 7-12 hours at 20°C. Dazomet does not adsorb much to soil and is rapidly degraded under the conditions of the tests. MITC adsorbs little to soil and is degraded with a half-life of 5-14 days at 20°C. Dazomet is not likely to volatilise due to its very low vapour pressure; however, MITC, with a vapour pressure of 2,500 Pa, will rapidly evaporate. Both dazomet and MITC have a low potential to bioaccumulate.

### B. Abiotic Degradation

#### Hydrolysis

The hydrolysis rate of Dazomet (DT<sub>50</sub>) in water was determined to be 0.36, 0.25, 0.21, and 0.12 days at pH values of 4, 5, 7, and 9 at 25°C (EU, 2010).

The hydrolysis rate of MITC in water was determined to be 107.25, 49.2, 104.59, and 11.14 days at pH values of 4, 5, 7, and 9 at 25°C (EU, 2010).

### C. Biodegradation

Dazomet and MITC were not readily biodegradable in an OECD 301D test (EU, 2010). Dazomet is inherently biodegradable (EU, 2010).

### D. Soil Degradation

The DT<sub>50</sub> (20°C, aerobic) values in laboratory studies for Dazomet were 0.28, 0.54, and 0.3 days (EU, 2010). The DT<sub>50</sub> (10°C, aerobic) value in a laboratory study was 1.3 days (EU, 2010). In field studies, the DT<sub>50</sub> values for Dazomet ranged from 0.9 to 1.6 days (EU, 2010).

The DT<sub>50</sub> laboratory study values for MITC ranged from 5.0 to 13.6 days (EU, 2010). The DT<sub>50</sub> (10°C, aerobic) value in a laboratory study was 32.7 days (EU, 2010). In field studies, the DT<sub>50</sub> values for MITC of 1.3 (trial 2, with plastic cover) and 2.1 days (trial 2, without plastic cover) were determined. In trial 1, the dissipation was slightly retarded during coverage of the soil (12 days) yielding a DT<sub>50</sub> value of 20.3 days. After removal of the plastic sheet and aeration of the soil, the dissipation of MITC was significantly enhanced resulting in a DT<sub>50</sub> value of 6.1 days from day 12 onwards.

### E. Environmental Distribution

#### Adsorption/desorption

Dazomet and MITC were found to adsorb very little to any soil type. For dazomet, K<sub>oc</sub> values of 129 to 394 (mean: 260) have been determined for adsorption (EU, 2010; EFSA, 2010). For MITC, K<sub>oc</sub> values of 9.0 to 27 (mean: 15.8) have been determined for adsorption (EU, 2010; EFSA, 2010).

### F. Bioaccumulation

The calculated BCF values using the QSAR model BCFWIN for dazomet and MITC were 2.39 and 3.16 (EU, 2010). The octanol-water partition coefficient (log Pow) for dazomet and MITC are 0.3 and 1.2 at 20°C, respectively. Thus, dazomet and MITC are not expected to bioaccumulate.

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

Dazomet is moderately acutely toxic by the oral route but exhibits low acute toxicity by the dermal and inhalation routes. It is not irritating to the skin and eyes, and it is not a skin sensitiser when tested on guinea pigs. Repeated oral exposures to dazomet have shown the liver and red blood cell (RBC) toxicity in rats, mice, and dogs; the dog studies were not included in the dossier. There was no toxicity in rats exposed by inhalation for 21-days, or was there any indication of systemic toxicity in rabbits when dazomet was applied to the skin for 21 days. Long-term studies in mice and rats showed no carcinogenic effects from dazomet exposure in feed, although there was a slight increase in the incidence of female mouse liver adenomas (at the highest dose level). Dazomet was weakly genotoxic in some in vitro assays, but was not genotoxic in the in vivo tests. Dazomet is not a reproductive toxicant; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity.

MITC is highly acutely toxic by the oral and inhalation routes. By the dermal route, a wide range has been reported for rodents and rabbits that range from highly toxic to low toxicity. MITC is severely irritating to the skin and eyes, and it is a skin sensitiser. The nasal cavity is a target organ for repeated inhalation exposures to MITC. In oral studies, repeated exposures have resulted in systemic toxicity

with no clear target organ effects. MITC is not genotoxic. Carcinogenicity studies showed no tumour increases in mice; in the rat studies, there was a slight increase mammary gland tumours. MITC is not a reproductive toxicant; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity.

## **B. Toxicokinetics and Metabolism**

### Dazomet

Rats were given by gavage a single dose of 10 or 100 mg/kg radiolabelled Dazomet. Oral absorption is rapid (within 24 hours) and complete. There is wide distribution, with affinity for the thyroid. Excretion is rapid (within 24 hours), with elimination predominantly in the urine (64-70%); exhaled air is 18-33%. Limited enterohepatic circulation was indicated. Extensive metabolism occurs with ring opening and formation of MITC. Further phase II detoxication pathway involves GSH, leading to M2 (cysteine conjugate, 4-6.5%), its oxidation product M4 (pyruvic derivative, 4-6%), and the N-acetylcysteine conjugate (16-30%); formation of 4-10% highly polar metabolites. Exhaled metabolites include carbon disulphide (CS<sub>2</sub>) and carbonyl sulphide (COS) both 3-6% at a low dose, 5-19% at high dose) and CO<sub>2</sub> (11-18%). Repeated dosing did not alter the excretion or distribution of radioactivity, indicating no bioaccumulation. (EFSA, 2010; CA EPA, 2002; NRA, 1997).

Dazomet applied topically to the skin of rats resulted in a dermal absorption of 3% of the undiluted product and 9% of a 10% aqueous solution after 168 hours (EU, 2010).

### MITC

Rats were given by gavage a single dose of 4.4 or 33 mg/kg radiolabelled MITC. Within 24 hours, 88 to 96% of the administered dose was absorbed. The major elimination pathway was in the urine (80-82%), followed by excretion in expired air as CO<sub>2</sub> (6-15%) and in the faeces (<1-2%). The remainder of the radioactivity was eliminated in the expired air as unmetabolised MITC (<1-2%) or as carbonyl sulphide/carbon disulphide (<1%), or bound to tissues (103% after 168 hours). Thyroid, liver, kidneys, whole blood and adrenals were sites of distribution. The major metabolites of MITC in the urine were N-acetyl-cysteine and cysteine conjugates. There was no unmetabolised MITC in the urine (CA EPA, 2002).

## **C. Acute Toxicity**

### Dazomet

The oral LD<sub>50</sub> in rats is 596 mg/kg for males and 415 mg/kg for females (EFSA, 2010). The dermal LD<sub>50</sub> in rats is >2,000 mg/kg (EFSA, 2010). The LC<sub>50</sub> (time duration not stated) in rats is >8.4 mg/L in males and 7.3 mg/L in females (EFSA, 2010). Clinical signs of toxicity seen in the acute oral toxicity study include shaking, salivation, tonic convulsions, trembling, dyspnoea, and lassitude.

### MITC

The oral LD<sub>50</sub> values in rats and mice are 72 and 90 mg/kg, respectively (NRA, 1997). The dermal LD<sub>50</sub> values in rabbits, mice, and rats are 33, 1,870, and approximately 1,000 mg/kg, respectively (NRA, 1997). The 4-hour LC<sub>50</sub> in rats is 540 mg/m<sup>3</sup>.

## **D. Irritation**

### Dazomet

Dermal irritation studies in rabbits have been conducted using a 50% aqueous solution of dazomet. When applied to the skin for four hours, there was no irritation; a longer exposure time (20 hours) resulted in moderated erythema and oedema (NRA, 1997). Instillation of 39 or 50 mg dazomet into the eyes of rabbits caused moderate conjunctival erythema and slight oedema.

### MITC

MITC is a severe eye and skin irritant in rabbits (NRA, 1997).

## **E. Sensitisation**

### Dazomet

Dazomet was not a skin sensitiser to guinea pigs (NRA, 1997). There have been some reports of contact dermatitis has been reported in humans from exposure to dazomet (Warin, 1992).

### MITC

MITC was considered a dermal sensitiser in a guinea pig maximisation test (NRA, 1997).

## **F. Repeated Dose Toxicity**

### Oral

#### **Dazomet**

Male and female mice were given in their diet 0, 800, or 1,200 ppm dazomet for 71 days. Body weight was reduced in the 1,200 ppm males. In the >800 ppm males and females, the following haematological changes were observed: decreased haemoglobin (Hb), RBC count, haematocrit (Hct) and corpuscular haemoglobin concentration (females only); and increased mean corpuscular haemoglobin (MCH), and mean corpuscular volume (MCV). (NRA, 1997).

Male and female mice were given in their diet 0, 20, 60, 180, 360, or 540 ppm dazomet for three months. There were no clinical signs of toxicity. In >360 ppm males and females, the haematological changes were reduced Hb, RBC counts, MCHC, and Hct (males only); and increased MCV, reticulocytes, polychromasia and anisocytosis. Splenic hemosiderin deposition was also observed. Absolute and relative liver weights were increased in the >180 ppm males and 540 ppm females. The NOAEL was considered to be 60 ppm (estimated to be 9 mg/kg-day) (NRA, 1997).

Male and female rats were given in their diet 0, 20, 60, 180, or 360 ppm dazomet for three months. Body weight gain was slightly reduced in the 540 ppm animals. Some changes were noted in the serum chemistry of the >180 ppm animals, and Hb was decreased in the 360 ppm dose group (both sexes). Liver weights were increased in the >60 ppm groups. Hepatocellular fatty degeneration was seen in the 60 ppm males and not at higher dose levels, indicating a possible spurious finding (lack of a consistent effect and a dose-response relationship). The NOAEL was considered to be 60 ppm (ca. 4.6 mg/kg-day) for males and females. (NRA, 1997).

Male and female mice were given in their diet 0, 20, 80, or 320 ppm dazomet for 78 weeks. The estimated mean daily intakes are: 0, 4, 16, and 68 mg/kg-day for males; and 0, 6, 22, and 93 mg/kg-day for females. There was no treatment-related mortality, clinical signs, body weight changes, or feed

consumption. Liver weights were significantly increased in the 320 ppm animals and an increased number in the 80 ppm animals. Liver discoloration, liver masses, and centrilobular lipid deposition occurred in the 320 ppm animals. Increased splenic hemosiderin deposition and extramedullary haematopoiesis were observed in the 320 ppm animals (both sexes) and in the 80 ppm males. The NOAEL for this study was considered to be 20 ppm (ca. 1 mg/kg-day) for males, and 80 ppm (ca. 4 mg/kg-day) for females (NRA, 1997).

Male and female rats were given in their diet 0, 5, 20, 80, and 320 ppm dazomet for two years. The estimated mean daily intakes are: 0, 0.3, 1, 4, and 18 mg/kg-day for males; and 0, 0.3, 1, 6, and 23 mg/kg-day for females. There was no treatment-related mortality, but body weight gain was reduced in the 320 ppm animals. The 320 ppm males and the >80 ppm females showed liver and RBC toxicity. The liver effects were increased relative weights, hepatocellular fat deposition, vacuolation, reduced plasma proteins and triglycerides; the RBC effects were reduced cell counts, Hb, and Hct values. The NOAEL was 20 ppm (ca. 1 mg/kg-day) for females and 80 ppm (ca. 4 mg/kg-day) for males (NRA, 1997).

Male and female rats were given in their diet 0, 5, 20, or 80 ppm for two years. The estimated mean daily intakes were: 0, 0.3, 1, and 4 mg/kg-day for males; and 0, 0.1, 1, and 6 mg/kg-day for females. There was no treatment-related mortality, clinical signs, body weight gain, and feed consumption. An increased incidence of diffuse hepatocellular fat deposition and vacuolation were noted in the 80 ppm animals, and mixed cell and basophilic cell foci in the 80 ppm females. The NOAEL was considered to be 20 ppm (ca. 1 mg/kg-day) (NRA, 1997).

Another rat chronic study was conducted on dazomet, which is older than the previous two studies. Male and female rats were given in their diet 0, 10, 40, 160, or 640 ppm dazomet for two years. The estimated mean daily intakes were: 0, 0.4, 1.7, 6.4, and 28 mg/kg-day for males; and 0, 0.5, 2.0, 7.4, and 31.8 mg/kg-day for females. There was no treatment-related mortality. Food consumption was reduced in the >160 ppm groups; and body weights were reduced in the 640 ppm males and >160 ppm females. Liver and kidney weights were increased in the 640 ppm animals. Histopathologic changes were glomerular nephritis and focal necrosis in the liver. The incidences of these histopathologic effects in the control and treated groups were not reported by NRA (1997), but the NRA (1997) concluded that there was no NOAEL for this study.

## MITC

Male and female dd-strain mice were dosed by oral gavage with 0, 1, 5, or 20 mg/kg MITC for 3 months. At the high dose, there was thickening of the forestomach lining, inflammation of the liver, and slight disturbance of spermatogenesis with oedema of the interstitial area of the testis. These effects were seen occasionally in the mid-dose animals, and slight changes were seen at the low dose. Absolute and relative ovary weights were increased in the low-dose animals; there were also changes in the adrenal weights, but the details are lacking. There were no histopathologic changes in the ovaries or adrenal glands. A LOAEL for this study is 1 mg/kg-day, the lowest dose tested. A NOAEL was not established (CA EPA, 2002).

In a subsequent study to investigate the ovarian effects, mice were dosed by oral gavage with 0, 0.35, 0.5, 0.7, or 1.0 mg/kg MITC. Reduced body weight gain and increased liver weights were seen in the 1.0 mg/kg dose group; no other treatment-related effects were observed. The NOAEL for this study is 0.7 mg/kg-day (CA EPA, 2002).

Mice (dd strain) were dosed by oral gavage with 0, 2.5, 5, or 10 mg/kg MITC for three months. An increase in total white blood cells count was noted in the high-dose animals, which was characterised by an increased proportion of neutrophils and decreased proportion of lymphocytes. The NOAEL for this study is 5 mg/kg-day (CA EPA, 2002).

Male and female Wistar rats were dosed by oral gavage with 0, 2, 10, or 40 mg/kg MITC for 3 months. The high-dose rats had undefined stomach lesions, inflammation of the liver, and a slight spermatogenic disorder. These changes were also seen in the mid-dose animals, with slight effects at the low dose. Absolute and relative ovary weights were increased in the low-dose animals; there were also changes in the adrenal weights, but the details are lacking. There were no histopathologic changes in the ovaries or adrenal glands. A LOAEL for this study is 2 mg/kg-day, the lowest dose tested. A NOAEL was not established (CA EPA, 2002).

Rats were dosed by oral gavage with 0, 3, 10, or 30 mg/kg MITC for 8 months, followed by a 6-month recovery period. In the high-dose animals, there was excessive salivation prior to dosing accompanied by rapid and unexpected aggressive movements after dosing. These clinical signs decreased in incidence by the end of the treatment period. There was significant body weight gain in the high-dose males which did not completely reverse following the 6-month recovery period. Absolute and relative liver weights were significantly reduced at the 5-month interim sacrifice. At the end of the treatment period, thickening of the lining of the stomach was observed at gross necropsy in the >10 ppm animals. Histopathologic examination in the animals at the end of the treatment period and the recovery period showed dose-related acanthosis, hyperkeratosis, and sub-mucosal cyst formation in the forestomach at all dose levels. The LOAEL for this study is 3 mg/kg-day, the lowest dose tested. A NOAEL was not established (CA EPA, 2002).

Male and female CD rats were given in their drinking water 0, 2, 10, or 50 ppm MITC for two years. The estimated daily intakes were: 0, 0.095, 0.463, and 2.075 mg/kg-day for males; and 0, 0.140, 0.692, and 3.189 mg/kg-day for females. The high-dose males had a 9-12% decrease in water consumption and body weight. The study authors considered the body weight change to be secondary to the reduced water consumption due to the palatability of the test material in the drinking water. There were no non-neoplastic lesions that were considered treatment-related. The NOAEL for this study is 10 ppm, which corresponds to 0.463 and 0.692 mg/kg-day for males and females, respectively (CA EPA, 2002).

Male and female ICI-JCR mice were given in their drinking water 0, 5, 20, 80, or 200 ppm MITC for two years. The estimated daily intakes were: 0, 0.68, 2.74, 9.82, and 21.34 mg/kg-day for males; and 0, 0.76, 3.04, 10.81, or 24.09 mg/kg-day for females. There was no treatment-related effect on survival. Clinical signs of toxicity (dull coat, raised hair), and decreased body weights were noted in the >80 ppm males and 200 ppm females. Water consumption was decreased in both sexes at >80 ppm. At study termination, serum glutamic-oxaloacetic transaminase (SGOT) levels were increased (125% compared to controls) in the 200 ppm females. Histopathologic examination showed small round cell infiltrations of the kidney in the >80 ppm females, and cellular infiltration of the spleen in the 200 ppm females. Ovarian cysts were increased in the 200 ppm females at study termination, with incidence rates showing a dose-response. The NOAEL for this study is considered to be 20 ppm, which corresponds to 2.74 and 3.04 mg/kg-day for males and females, respectively (CA EPA, 2002).

## Inhalation

### **Dazomet**

There were no observable signs of toxicity in a 21-day inhalation study in rats. Rats were exposed 6 hours/day to 33,000 mg/m<sup>3</sup> dazomet (NRA, 1997).

### **MITC**

Male and female Wistar rats were exposed by inhalation to 0, 5, 20, or 100 mg/m<sup>3</sup> (0, 1.7, 6.8, or 34 ppm) MITC 6 hours/day, 5 days/week for four weeks. No deaths occurred during the study. Statistically significantly lower body weights were seen in the high-dose males. Clinical signs of toxicity in the high-dose animals were indicative of marked respiratory tract irritation that resulted in a change in breathing pattern a whooping respiration. As the study progressed, certain signs (ruffled fur and



respiratory sound) stopped being reversible. At the mid dose, the clinical signs were less severe (i.e., eyelid closure, somnolence, and ruffled fur); unlike the high-dose animals these clinical would start disappearing before the end of the exposure period. Clinical chemistry changes were seen in the high-dose males (decreased serum urea, glucose, triglyceride, and albumin) and the high-dose females (decreased urea and glucose). The study authors considered these changes to be metabolic changes in the animals as a result of reduced body weight gain. Total bilirubin concentrations and thromboplastin time were markedly increased in the high-dose males, but not the females. Increased numbers of neutrophilic polymorphonuclear granulocytes were significantly increased in the  $>20 \text{ mg/m}^3$  males and the  $100 \text{ mg/m}^3$  females. Overall leukocyte counts were increased in the  $100 \text{ mg/m}^3$  females and were considered the result of the inflammatory response occurring in the respiratory tract. Liver and kidney weights were significantly lower in the  $100 \text{ mg/m}^3$  males compared to controls. The high-dose males and females had significantly increased lung weights. Histopathologic effects were seen in the nasal cavity. The LOAEL for this study is  $\text{mg/m}^3$ , the lowest exposure concentration tested, based on increased nasal epithelial atrophy in both males and females. A NOAEL was not established (CA EPA, 2002).

## Dermal

### **Dazomet**

Rabbits were dosed dermally with 0, 10, or  $100 \text{ mg/kg}$  dazomet 6 hours/day for 21 days. The abraded skin showed well-defined erythema and oedema. Skin lesions indicative of chemical burns (cutaneous hardening and discoloration) were seen in 8/10 and 10/10 animals in the 10 and  $100 \text{ mg/kg}$  dose groups, respectively (NRA, 1997).

Rabbits were dosed dermally with 0, 10, 100, or  $1,000 \text{ mg/kg}$  6 hours/day, 5 days/week for 21 days. The unabraded skin showed no signs of irritation and no indication of systemic toxicity. The NOAEL for systemic toxicity is  $1,000 \text{ mg/kg-day}$  (NRA, 1997).

### **MITC**

Rats were dosed dermally with 0, 120, 240, or  $480 \text{ mg/kg}$  MITC for one month. Depending on the dose given, there was damage to the skin which consisted of ulceration, crust formation, and neutrophil infiltrations. There was also a treatment-related enlargement of the peri-bronchial lymph nodes. No effects were noted that were considered to be treatment-related. Based on the information, a NOAEL cannot be determined (CA EPA, 2002).

Male and female Wistar rats were dosed dermally with 0, 1, 10, or  $100 \text{ mg/kg}$  MITC for 31 days. Severe necrosis was noted in the skin of the high-dose animals. At 1 and  $10 \text{ mg/kg}$ , there was desquamation and erythema of the skin. Weight gain and food consumption was reduced in females, and weight loss and decreased eosinophil production by the bone marrow was seen in males. A dose-dependent decrease in serum albumin was seen in all dosed males. Plasma cholinesterase inhibition was seen in the high-dose males and in all dosed females. The  $>10 \text{ mg/kg}$  males and  $>1 \text{ mg/kg}$  females had increased erythropoietic activity. The LOAEL for this study is  $1 \text{ mg/kg-day}$ , the lowest dose tested. A NOAEL was not established (CA EPA, 2002).

## **G. Genotoxicity**

### In Vitro Studies

#### **Dazomet**

Table 2 lists the results of the *in vitro* genotoxicity studies conducted on Dazomet. Dazomet was weakly positive in some of the studies.

**Table 2: In Vitro Genotoxicity Studies on Dazomet**

Test System	Results <sup>a</sup>	Reference
Reverse mutation bacterial assays using <i>S. typhimurium</i> strains [five different studies]	-	NRA, 1997
Reverse mutation bacterial assays using <i>E. coli</i> strains	-	NRA, 1997
HGPRT mutation assay in CHO cells	+ ( $\pm$ S9)*	NRA, 1997
Mouse lymphoma assay	Equivocal**	NRA, 1997
Cytogenetics assay in mouse lymphoma L5178Y cells (chromosomal aberrations)	+ (-S9) - (+S9)	NRA, 1997
Cytogenetics assay in mouse lymphoma L5178Y cells (chromosomal aberrations)	+ ( $\pm$ S9)	NRA, 1997
Cytogenetics assay in human lymphocytes (chromosomal aberration)	-	NRA, 1997
Cytogenetics assay [cells not stated] (SCE)	-	NRA, 1997
Cytogenetics assay [cells not stated] (SCE)	+ (-S9) - (+S9)	NRA, 1997
Rat liver Unscheduled DNA Synthesis (UDS) assay	+ (weak)	NRA, 1997
Cell transformation assay (BALB/c-3T3 cells)	-	NRA, 1997
Cell transformation assay (BALB/c-3T3 cells)	-	NRA, 1997

a+, positive; -, negative

\*Not concentration-dependent in the presence of metabolic activation.

\*\*Negative in the presence of S9; positive in the absence of S9 but not concentration-dependent.

Additional information is provided in NRA (1997) on the two chromosomal aberration studies conducted *in vitro* in mouse lymphoma L5187Y cells. In the study in which positive results were seen only the absence of metabolic activation, there was reproducible, concentration-dependent increases in both structural and numerical aberrations in two separate experiments. Endoreduplication, a rare numerical aberration, was observed at most concentrations levels of dazomet and translocations; triradials and quadriradial, which are rare structural aberrations, were also observed at some concentrations. In the other study which was conducted at a different laboratory, there were significant increases in the number of cells with aberrations in the presence and absence of metabolic activation, but the increases were not dose-dependent. Some rare structural aberrations were also noted, mainly in the absence of metabolic activation.

## MITC

MITC was not mutagenic in bacterial reverse mutation tests involving *S. typhimurium* or *E. coli* strains in the absence or presence of metabolic activation (CA EPA, 2002). MITC was not mutagenic in a mammalian cell assay with Chinese hamster V79 cells in the absence or presence of metabolic activation (CA EPA, 2002).

No chromosomal aberrations were observed when human peripheral lymphocytes were treated with MITC (CA EPA, 2002). No sister chromatid exchanges were observed when Chinese hamster V79 cells



were treated with MITC in the absence of presence of metabolic activation (CA EPA, 2002). MITC did not induce unscheduled DNA synthesis (UDS) in rat primary hepatocytes (CA EPA, 2002).

### In Vivo Studies

#### **Dazomet**

The *in vivo* studies conducted on Dazomet are presented below in Table 3. All of the studies show that Dazomet is not mutagenic or genotoxic.

**Table 3: In Vivo Genotoxicity Studies on Dazomet**

Test System	Results*	Reference
Rat bone marrow (chromosomal aberration)	-	ECHA
Rat bone marrow (chromosomal aberration)	-	ECHA
Mouse bone marrow (micronucleus)	-	ECHA
Rat bone marrow (chromosomal aberration)	-	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	ECHA
<i>Drosophila</i> SLRL Test	-	ECHA
Rat liver Unscheduled DNA Synthesis (UDS) Assay	-	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	ECHA
Mouse peripheral blood micronucleus study	-	Vernes and Ballantyne (2002)
Rat liver Unscheduled DNA Synthesis (UDS) Assay	-	Mirsalis <i>et al.</i> (1989)

a+, positive; -, negative

#### **MITC**

CD-1 mice were given by oral gavage 0 or 110 mg/kg MITC. Bone marrow was harvested 24, 48, and 72 hours after dosing. There was no significant increase in micronucleated polychromatic erythrocytes at any dose level (CA EPA, 2002).

### **H. Carcinogenicity**

#### Oral

#### **Dazomet**

Male and female mice were given in their feed 0, 20, 80, or 320 ppm dazomet for 78 weeks. The estimated daily intake is: 0, 4, 16, and 68 mg/kg-day for males; and 0, 6, 22, and 93 mg/kg-day for females. The 320 ppm females had a slightly increased incidence of hepatocellular adenomas. The incidences were 3/50, 0/50, 1/50, and 7/50 for the 0, 20, 80, and 320 ppm dose groups. The 320 ppm females also had significant increased incidence of basophilic foci. Malignant lymphomas at one or more sites in females in all dose groups at an incidence of 3/60. Since the incidence was low, there was no dose-response, and the lymphomas were not observed in males, the malignant lymphomas were not considered to the treatment-related (NRA, 1997).

Male and female rats were given in their feed 0, 5, 20, 80, and 320 ppm dazomet for two years. The estimated daily intakes are: 0, 0.3, 1, 4, and 18 mg/kg-day for males; and 0, 0.3, 1, 6, and 23 mg/kg-day for females. There was no evidence of a carcinogenic effect from dazomet exposure (NRA, 1997).

Male and female rats were given in their diet 0, 5, 20, or 80 ppm. The estimated mean daily intakes were: 0, 0.3, 1, and 4 mg/kg-day for males; and 0, 0.1, 1, and 6 mg/kg-day for females. There was no evidence of a carcinogenic effect from dazomet exposure (NRA, 1997).

Male and female rats were given in their diet 0, 10, 40, 160, or 640 ppm dazomet for two years. There was no evidence of a carcinogenic effect from dazomet exposure (NRA, 1997).

## MITC

Male and female CD rats were given in their drinking water 0, 2, 10, or 50 ppm MITC for two years. The estimated daily intakes were: 0, 0.095, 0.463, and 2.075 mg/kg-day for males; and 0, 0.140, 0.692, and 3.189 mg/kg-day for females. The high-dose males had a 9-12% decrease in water consumption and body weight. The study authors considered the body weight change to be secondary to the reduced water consumption due to the palatability of the test material in the drinking water. An increased incidence in mammary gland tumours (multiple fibroadenomas) was observed in surviving female rats, which achieved statistical significance at the 50 ppm dose level. The incidences were 24%, 40%, 44%, and 48% for the controls, 2, 10, and 50 ppm dose groups, respectively. Mammary gland carcinomas were only observed in the low- and mid-dose groups (1/20 and 2/32, respectively) (CA EPA, 2002).

Male and female ICI-JCR mice were given in their drinking water 0, 5, 20, 80, or 200 ppm MITC for two years. The estimated daily intakes were: 0, 0.68, 2.74, 9.82, and 21.34 mg/kg-day for males; and 0, 0.76, 3.04, 10.81, or 24.09 mg/kg-day for females. There was no treatment-related effect on survival. Of the mice that survived the study, there were no increased incidences of tumours that were considered to be treatment-related (CA EPA, 2002).

## Inhalation

No studies were identified.

## Dermal

No studies were identified.

## I. Reproductive Toxicity

### Dazomet

A two-generation reproductive toxicity study was conducted on dazomet. Rats were given 0, 5, 30, or 180 ppm dazomet in their feed. There were no treatment-related effects on fertility or reproductive performance, as well as reproductive organs and pup development. Effects indicative of liver toxicity was observed in the parental animals in both generations in the 180 ppm group and, to some extent, in the 30 ppm group. The NOAEL for reproductive and developmental toxicity is 180 ppm (calculated to be approximately 18 mg/kg-day). The NOAEL for systemic toxicity is 5 ppm (calculated to be approximately 0.5 mg/kg-day) (NRA, 1997).

### MITC

In a two-generation rat reproductive toxicity study, SD rats were given MITC in their drinking water at concentrations of 0, 2, 10, or 50 ppm. The calculated equivalent doses are: 0, 0.16, 0.7, or 3.49 mg/kg-day for males; and 0, 0.2, 0.94, or 4.49 mg/kg-day for females. Pre-weaning viability was decreased in F1 pups at all dose levels (pre-weaning loss was 6.6%, 17.8%, 17.1%, and 14.4% for the 0, 2, 10, and 50 ppm groups, respectively). This effect was not considered to be a treatment-related effect because there was no dose-response; there was no statistical significance; pup weights indicated that growth was normal; pup deaths did not occur within a discrete window, but appeared to occur randomly; and the

pattern of pre-weaning loss was not repeated in the F2 pups. At 10 and 50 ppm, parental water consumption was significantly decreased in both generations, and decreased body weight gains were reported during various time points of the study. The NOAEL for reproductive toxicity is 50 ppm, which corresponds to 3.49 and 4.49 mg/kg-day for males and females, respectively (CA EPA, 2002).

In a three-generation reproductive toxicity study, CD rats were dosed by oral gavage with 0, 1, 3, or 10 mg/kg-day. The body weights of the >3 mg/kg F0 males were reduced compared to the controls. The 3 mg/kg females weaned fewer F3a progeny than controls. The study authors concluded that there were not treatment-related reproductive effects. Histopathologic examination of the parental animals showed lesions in the non-glandular stomach. The NOAEL for reproductive toxicity was considered to be 10 mg/kg-day (CA EPA, 2002).

## **J. Developmental Toxicity**

### **Dazomet**

Pregnant female rats were given in their feed 0, 3, 10, and 30 mg/kg-day dazomet (GD days not stated). Maternal body weights, feed consumption and uterine weights were reduced at the high-dose and, to a lesser extent, at the mid-dose. A higher incidence of runts was noted in the >10 mg/kg dose groups, but there was no dose-response relationship. There was no evidence of teratogenicity. The NOAEL for maternal and developmental toxicity is 3 mg/kg-day (NRA, 1997).

Pregnant female rabbits were dosed by oral gavage with 0, 25, 50, or 75 mg/kg dazomet (GD days not stated). In the 50 and 75 mg/kg doses, clinical signs of toxicity (severe diarrhoea, apathy and unsteady gait), and reduced body weights and feed consumption was noted. The number of live foetuses was reduced by 80% in the 50 and 75 mg/kg dose groups, which corresponded to a high number of dead implantations. Foetal abnormalities were similar across all groups, but the conclusion is unreliable because of the small numbers of foetuses in the 50 and 75 mg/kg groups. The NOAEL for maternal and developmental toxicity is 25 mg/kg-day (NRA, 1997).

Pregnant female rabbits were dosed by oral gavage with 0, 6.25, 12.5, or 25 mg/kg dazomet (GD days not stated). There is conflicting information about the maternal toxicity in this study. The NRA (1997) state that there was no maternal toxicity. However, the EU (2010) report states that there was marked maternal toxicity, as indicated by one death and clinical signs at the same dose where fetotoxicity was observed. At 25 mg/kg, dead implantations, particularly increased early resorptions were noted, resulting in reduced numbers of live foetuses. There was no evidence of teratogenicity. The NOAELs for maternal and developmental toxicity are 12.5 mg/kg-day (NRA, 1997; EU, 2010).

### **MITC**

Pregnant female SD rats were dosed by oral gavage with 0, 1, 5, or 25 mg/kg MITC on GD 6 to 15. Dams dosed with 25 mg/kg exhibited significant reduction in body weight gain and food consumption during the treatment period, and gross necropsy showed thickening of the stomach lining. Dams dosed with 5 mg/kg had only reduced body weight gain. Mean foetal body weights and mean foetal size were reduced in the 25 mg/kg group compared to controls. The NOAELs for maternal and developmental toxicity is 1 and 5 mg/kg-day, respectively (CA EPA, 2002).

Pregnant NZW rabbits were dosed by oral gavage with 0, 1, 3, or 5 mg/kg MITC on day on GD 7-19. Does in the 5 mg/kg dose group exhibited marginal reductions in body weight gain and feed consumption during the early stages of treatment. Mean foetal weights were reduced in the 5 mg/kg group compared to controls. The NOAEL for maternal and developmental toxicity is 3 mg/kg-day (CA EPA, 2002).

Pregnant female rabbits were given via gelatine capsules 0, 1, 3, or 10 mg/kg MITC on GD 6 to 18. At 10 mg/kg, there was maternal toxicity, embryotoxicity, reduced foetal body weights, and a reduction in Day 1 pup survival. There was possible maternal toxicity also at the 3 mg/kg dose level. The study report stated that prenatal MITC may have increased the incidence of incidental skeletal findings. The NOAELs for maternal and developmental toxicity are 1 and 3 mg/kg-day, respectively (CA EPA, 2002).

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for dazomet 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).

### A. Non-Cancer

#### Oral (Dazomet)

The NOAEL or LOAEL values from key toxicity studies on dazomet are listed in Table 4.

**Table 4: Lowest NOAEL Values from Key Toxicity Studies on Dazomet by the Oral Route**

Species/sex	Study Duration	(L)NOAEL mg/kg-day	Endpoint	Reference
Mice, male	3-month (feed)	9	Increased liver weights	NRA (1997)
Rats, male	3-month (feed)	4.6	Increased liver weights	NRA (1997)
Mice, female	78-month (feed)	1	Splenic hemosiderin deposition; extramedullary hematopoiesis	NRA (1997)
Rats, female	2-year (feed)	1	Liver and RBC toxicity	NRA (1997)
Rats	2-year (feed)	1	Liver effects	NRA (1997)
Rats	2-year (feed)	0.4*	Liver and kidney effects	NRA (1997)
Rats	2-generation (feed)	0.5	Liver effects (parental)	NRA (1997)
Rats	GD not specified	3	Developmental	NRA (1997)
Rabbits	GD not specified	12.5	Developmental	NRA (1997)

Four chronic feeding studies have been conducted on dazomet: a 78-week study in mice and three 2-year studies in rats. The NOAEL for two of the rat chronic studies was 1 mg/kg-day based on RBC effects (indicative of haemolytic anaemia) and/or liver effects. The third rat chronic study, which was considered an “old” study by NRA (1997), showed liver and kidney effects in rats; NRA (1997) concluded that a NOAEL was not established. Unfortunately, NRA (1997) did not provide any information on the incidences and dose levels of the liver and kidney effects in the treated rats, and whether the effects were seen in males, females or both sexes. Furthermore, this is the only study conducted on dazomet in which kidney effects were seen in dazomet-treated rats. Studies in rats and dogs (data not provided in this dossier but summarised in NRA 1997) did not develop kidney effects

from dazomet treatment. While the histopathologic details of the glomerular nephritis were not described in NRA (1997), it is entirely possible it could be chronic progressive nephropathy (CPN), also known as glomerulosclerosis, progressive glomerulonephrosis, or old rat nephropathy. CPN is a spontaneous renal disease seen in aging rats of which there is no counterpart in humans and therefore has no relevance for extrapolation in human risk assessment (Hard and Khan, 2004).

Because of the inconsistency of this “older” rat chronic feeding study with the other two chronic rat feeding studies, along with the lack of details on the study findings and no information in NRA (1997) on the justification of a lack of NOAEL, this study will not be used for the risk assessment of dazomet. Furthermore, there are two chronic feeding studies that reported similar findings for the liver effects; both studies had the same NOAEL of 1 mg/kg-day. Haemolytic anaemia, an effect that has been consistency reported in dazomet-treated rats and mice, was seen in one, but not both, of these two chronic studies. Haemolytic anaemia was observed in males and female rats at 320 ppm; only one study included this dose level. Both studies included a dose level of 80 ppm, and haemolytic anaemia was reported in females in only one of the two studies. The reason for this difference is unclear, but it may represent biological variation or perhaps strains differences; the study summaries provided in NRA (1997) are insufficient for an analysis. Nevertheless, the NOAEL of 1 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

UF<sub>A</sub> (interspecies variability) = 10

UF<sub>H</sub> (intraspecies variability) = 10

UF<sub>L</sub> (LOAEL to NOAEL) = 1

UF<sub>Sub</sub> (subchronic to chronic) = 1

UF<sub>D</sub> (database uncertainty) = 1

$$\text{Oral RfD} = 1 / (10 \times 10 \times 1 \times 1 \times 1) = 1/100 = \underline{0.01 \text{ mg/kg-day}}$$

#### *Drinking water guidance value*

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

Using the oral RfD:

$$\text{Drinking water guidance value} = (\text{oral RfD}) \times (\text{human weight}) \times (\text{proportion of water consumed}) / (\text{volume of water consumed})$$

where:

Human weight = 70 kg (ADWG, 2011)

Proportion of water consumed = 10% (ADWG, 2011)

Volume of water consumed = 2L (ADWG, 2011)

$$\text{Drinking water guidance value} = (0.01 \times 70 \times 0.1) / 2 = \underline{0.04 \text{ mg/L}}$$

#### Oral (MITC)

The NOAEL or LOAEL values from key toxicity studies on MITC are listed below in Table 5.

**Table 6: Lowest NOAEL Values from Key Toxicity Studies on MITC by the Oral Route**

Species/sex	Study Duration	(L)NOAEL mg/kg-day	Endpoint	Reference
Rat	3-month oral gavage	2 (LOAEL)	Liver inflammation, stomach lesions, ovary weight change, spermatogenic disorder	CA EPA, 2002
Mouse	3-month oral gavage	1 (LOAEL)	Liver inflammation, stomach lesions, ovary weight change, spermatogenic disorder	CA EPA, 2002
Mouse	3-month oral gavage	0.7 (NOAEL)	Reduced body weight gain, increased liver weights	CA EPA, 2002
Mouse	3-month oral gavage	5 (NOAEL)	Increased total WBC counts	CA EPA, 2002
Rat	8-month oral gavage	3 (LOAEL)	Forestomach lesions	CA EPA, 2002
Rat	2-yr drinking water	0.46 (NOAEL)	Decreased water consumption, body weights	CA EPA, 2002
Mouse	2-yr drinking water	2.74 (NOAEL)	Clinical signs, decreased water consumption, body weights	CA EPA, 2002
Rat	2-generation oral gavage	3.49 (NOAEL)	None (highest dose tested for reproductive toxicity)	CA EPA, 2002
Rat	3-generation oral gavage	10 (NOAEL)	None (highest dose tested for reproductive toxicity)	CA EPA, 2002
Rat	GD 6-15	5 (NOAEL)	Decreased foetal body weights and size	CA EPA, 2002
Rabbit	GD 7-19	3 (NOAEL)	Decreased foetal body weights	CA EPA, 2002
Rabbit	GD 6-18	3 (NOAEL)	Decreased foetal body weights	CA EPA, 2002

The NOAEL of 0.46 mg/kg-day (rounded off to 0.5) from the two-year rat drinking water study will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

*Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

UF<sub>A</sub> (interspecies variability) = 10

UF<sub>H</sub> (intraspecies variability) = 10

UF<sub>L</sub> (LOAEL to NOAEL) = 1

UF<sub>Sub</sub> (subchronic to chronic) = 1

UF<sub>D</sub> (database uncertainty) = 1

$$\text{Oral RfD} = 0.5 / (10 \times 10 \times 1 \times 1 \times 1) = 0.5 / 100 = 0.005 \text{ mg/kg-day}$$

*Drinking water guidance value*

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

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 =  $(0.005 \times 70 \times 0.1) / 2 = 0.018 \text{ mg/L}$

## B. Cancer

### Dazomet

Dazomet was not carcinogenic to mice or rats in chronic feeding studies. Thus, no cancer reference value was derived.

### MITC

An increased incidence of mammary gland tumours (fibroadenomas) in female rats was reported in the two-year drinking water study. The increase was marginally statistically significant in the highest dose tested (50 ppm). MITC was not carcinogenic in mice when given in drinking water for two years. A cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Dazomet does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

MITC is considered a flammable liquid.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Dazomet exhibits high acute toxicity to aquatic organism, particularly to fish (96-hr  $LC_{50} = 0.16 \text{ mg/L}$ ). This effect, however, is unlikely to be attributed only to dazomet since dazomet is rapidly degraded to MITC in water. MITC exhibits a higher acute toxicity to fish compared to dazomet (96-hr  $LC_{50} = 0.053 \text{ mg/L}$ ). Both dazomet and MITC show moderate toxicity to earthworms. To birds, dazomet is moderately toxic on an acute basis and slightly toxic on a subacute dietary basis.

### B. Aquatic Toxicity

#### Acute Studies

Table 6A and 6B lists the results of acute aquatic toxicity studies conducted on Dazomet and MITC, respectively.



**Table 6A: Acute Aquatic Toxicity Studies on Dazomet**

Test Species	Endpoint	Results (mg/L)	Reference
<i>Lepomis macrochirus</i>	96-hr LC50	0.3	HSDB
<i>Lepomis macrochirus</i>	96-hr LC50	1.3	HSDB
<i>Oncorhynchus mykiss</i>	96-hr LC50	0.48	HSDB
<i>Oncorhynchus mykiss</i>	96-hr LC50	16.2	HSDB
<i>Oncorhynchus mykiss</i>	96-hr LC50	0.16	HSDB
<i>Oncorhynchus mykiss</i>	96-hr LC50	2.4	HSDB
<i>Daphnia magna</i>	48-hr EC50	11.9	HSDB
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.31	HSDB
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.88	HSDB
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.55	HSDB
<i>Pseudokirchneriella subcapitata</i>	72-hr EC <sub>50</sub> NOEC	Biomass: 0.16 Growth rate: 0.59 0.056	EFSA, 2010
<i>Desmodesmus subspicatus</i>	96-hr EC <sub>50</sub>	Biomass: 1.015	EFSA, 2010

**Table 6B: Acute Aquatic Toxicity Studies on MITC**

Test Species	Endpoint	Results (mg/L)	Reference
<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	0.0531	EFSA, 2010
<i>Oncorhynchus mykiss</i>	28-d NOEC (growth)	0.004	EFSA, 2010
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.076	EFSA, 2010
<i>Daphnia magna</i>	21-d NOEC (reproduction)	0.01275	EFSA, 2010
<i>Daphnia magna</i>	21-d NOEC (reproduction)	0.00625	EFSA, 2010
<i>Pseudokirchneriella subcapitata</i>	72-hr EC <sub>50</sub>	Biomass: 0.28 (initial measured) Growth rate: 0.58 (initial measured) Biomass: 0.075 (mean measured) Growth rate: 0.275 (mean measured)	EFSA, 2010

### Terrestrial Toxicity

The terrestrial toxicity studies conducted on dazomet and MITC are presented in Table 7.



**Table 7: Terrestrial Toxicity Studies on Dazomet and MITC**

Test Species (method)	Test Substance	Endpoint	Results (mg/kg soil dw)	Reference
<i>Eisenia fetida</i>	Dazomet	14-day LC <sub>50</sub>	6.7	EU, 2010
<i>Eisenia fetida</i>	MITC	14-day LC <sub>50</sub>	2.79	EU, 2010

Avian toxicity studies have also been conducted on dazomet. The oral LD<sub>50</sub> for dazomet is 424 mg/kg for bobwhite quail. The NOEC is 147 mg/kg with observed effects at higher doses including lethargy, anorexia, and reduced mean body weights and feed consumption (EPA, 2008). The 8-day acute dietary LC<sub>50</sub> values are 2,301 and >5,137 ppm for bobwhite quail and mallard duck, respectively (EPA, 2008).

### C. Calculation of PNEC

The PNEC calculations for dazomet and MITC follow the methodology discussed in DEWHA (2009).

#### PNEC water

##### **Dazomet**

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (0.16 mg/L), *Daphnia* (0.31 mg/L), and algae (0.16 mg/L). No chronic toxicity studies have been conducted on Dazomet. On the basis of the short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 0.16 mg/L for fish and algae. The PNEC<sub>water</sub> is 1.6 x 10<sup>-4</sup> mg/L or 0.16 µg/L.

##### **MITC**

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (0.0531 mg/L), *Daphnia* (0.076 mg/L), and algae (0.275 mg/L). Chronic toxicity values are available for fish (0.004 mg/L) and invertebrates (0.00625 mg/L). On the basis that the data consists of short-term and results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC of 0.004 mg/L for fish. The PNEC<sub>water</sub> is 8 x 10<sup>-5</sup> mg/L or 0.08 µg/L.

#### PNEC sediment

##### **Dazomet**

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 1.05 x 10<sup>-3</sup> mg/kg wet weight or 1.05 µg/kg wet weight.

The calculations are as follows:

$$\begin{aligned}
 \text{PNEC}_{\text{sed}} &= (K_{\text{sed-water}} / \text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\
 &= (8.4/1280) \times 1000 \times 0.00016 \\
 &= 0.00105
 \end{aligned}$$

Where:

K<sub>sed-water</sub> = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)

BD<sub>sed</sub> = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned} K_{\text{sed-water}} &= 0.8 + [(0.2 \times K_{\text{P sed}})/1000 \times \text{BD}_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 15.8)/1000 \times 2400] \\ &= 8.4 \end{aligned}$$

Where:

$K_{\text{p}}$  = solid-water partition coefficient (L/kg).

$\text{BD}_{\text{solid}}$  = bulk density of the solid phase ( $\text{kg}/\text{m}^3$ ) = 2,400 [default]

$$\begin{aligned} K_{\text{p}} &= K_{\text{oc}} \times f_{\text{oc}} \\ &= 394 \times 0.04 \\ &= 15.8 \end{aligned}$$

Where:

$K_{\text{oc}}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{\text{oc}}$  for dazomet in sediment is 394.

$f_{\text{oc}}$  = fraction of organic carbon suspended sediment = 0.04 [default].

## MITC

There are no toxicity data for sediment-dwelling organisms. Therefore, the  $\text{PNEC}_{\text{sed}}$  was calculated using the equilibrium partitioning method. The  $\text{PNEC}_{\text{sed}}$  is  $8.1 \times 10^{-5}$  mg/kg wet weight or 0.081 ug/kg wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (K_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (1.3/1280) \times 1000 \times 0.00008 \\ &= 8.1 \times 10^{-5} \end{aligned}$$

Where:

$K_{\text{sed-water}}$  = suspended matter-water partition coefficient ( $\text{m}^3/\text{m}^3$ )

$\text{BD}_{\text{sed}}$  = bulk density of sediment ( $\text{kg}/\text{m}^3$ ) = 1,280 [default]

$$\begin{aligned} K_{\text{sed-water}} &= 0.8 + [(0.2 \times K_{\text{P sed}})/1000 \times \text{BD}_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 1.1)/1000 \times 2400] \\ &= 1.3 \end{aligned}$$

Where:

$K_{\text{p}}$  = solid-water partition coefficient (L/kg).

$\text{BD}_{\text{solid}}$  = bulk density of the solid phase ( $\text{kg}/\text{m}^3$ ) = 2,400 [default]

$$\begin{aligned} K_{\text{p}} &= K_{\text{oc}} \times f_{\text{oc}} \\ &= 27 \times 0.04 \\ &= 1.1 \end{aligned}$$

Where:

$K_{\text{oc}}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{\text{oc}}$  for MITC in sediment is 27.

$f_{\text{oc}}$  = fraction of organic carbon suspended sediment = 0.04 [default].

## PNEC soil

## Dazomet

Experimental results are available for earthworms, with 14-day LC<sub>50</sub> value of 4.0 mg/kg soil dry weight. On the basis that the data consists of one short-term result from one trophic level, an assessment factor of 1,000 has been applied to LC<sub>50</sub> value of 6.5 mg/kg soil dry weight for earthworms. The PNEC<sub>soil</sub> is 0.004 mg/L or 4.0 ug/L.

## MITC

Experimental results are available for earthworms, with 14-day LC<sub>50</sub> value of 2.79 mg/kg soil dry weight. On the basis that the data consists of one short-term result from one trophic level, an assessment factor of 1,000 has been applied to LC<sub>50</sub> value of 6.5 mg/kg soil dry weight for earthworms. The PNEC<sub>soil</sub> is 0.00279 mg/L or 2.79 ug/L.

## VIII. PBT ASSESSMENT

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).

### Dazomet

There is rapid degradation of dazomet by hydrolysis in the aquatic environment and soil. Therefore, it does not meet the criteria for persistence.

The calculated BCF value for dazomet is 2.39. Therefore, it does not meet the screening criteria for bioaccumulation.

No chronic aquatic toxicity studies are available for dazomet. The lowest acute LC<sub>50</sub> value is >0.1 mg/L. Therefore, dazomet does not meet the criteria for toxicity.

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

## MITC

MITC does not degrade in freshwater by hydrolysis. It is also not readily biodegradable. However, it is expected to be removed rapidly from water by volatilisation. In soil, the degradation half-life is 5-13 days (<6 months). MITC also disappears rapidly in sediment: <2% can be found in sediment after 14 days (EU, 2010). Therefore, MITC does not meet the criteria for persistence.

The calculated BCF value for MITC is 3.16. Therefore, it does not meet the screening criteria for bioaccumulation.

A chronic NOEC value is available for *daphnia*, with the value being <0.1 mg/L. Therefore, MITC meets the screening criteria for toxicity.

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

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Acute Toxicity Category 4 [oral]  
Eye Irritant Category 2  
STOT RE Category 2 [liver]

Note: Dazomet would also have the following classifications for aquatic toxicity: Aquatic Acute Category 1 and Aquatic Chronic Category 1. However, aquatic toxicity classification is not required for Australia GHS.

## **B. Labelling**

Warning

## **C. Pictograms**



## **X. SAFETY AND HANDLING**

Dazomet is used in the drilling mud product DEXTRID® LTE at a concentration of 0.1 to 1%. The safety and handling of dazomet at this concentration in DEXTRID® LTE will be provided in the dossier on starch, which is the major constituent of DEXTRID® LTE.

### Occupational Exposure Standards

No occupational exposure standards have been established for dazomet.

## **D. Transport Information**

Dazomet is used in the drilling mud product DEXTRID® LTE at a concentration of 0.1 to 1%. The transportation information for DEXTRID® LTE will be provided in the dossier on starch, which is the major constituent of DEXTRID® LTE.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

California Environmental Protection Agency (CA EPA) (2002). Evaluation of methyl isothiocyanate as a toxic air contaminant. Part C-Human Health Assessment. California Department of Pesticide Regulation, California Environmental Protection Agency, August 2002. Available at:<http://www.cdpr.ca.gov/docs/emon/pubs/mitc/augfinl02/augpartc.pdf>

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.

enHealth Human Risk Assessment (HHRA) (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

EU (2010). Dazomet Product-type 8 (Wood preservatives) Assessment Report. Directive 98/8/EC concerning the placing biocidal products on the market. Inclusion of active substances in Annex I or IA to Directive 98/8/EC. Annex I – Belgium. 11 march 2010. Available at: <https://circabc.europa.eu/sd/a/4a7d3e6b-1de7-4e2b-a288-8b1b7e4e79dd/Dazomet%20Assessment%20report.pdf>

European Food Safety Authority (EFSA) (2010). Conclusion on the peer review of the pesticide risk assessment of the active substance dazomet. EFSA Journal 8(10): 1833. Available at: [http://www.efsa.europa.eu/sites/default/files/scientific\\_output/files/main\\_documents/1833.pdf](http://www.efsa.europa.eu/sites/default/files/scientific_output/files/main_documents/1833.pdf)

Hard, G.C., Khan, K.N. (2004). A contemporary overview of chronic progressive nephropathy in the laboratory rat, and its significance for human risk assessment. Toxicol Pathol. 32: 171-180.

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.

National Registration Authority for Agricultural and Veterinary Chemicals (NRA) (1997). NRA Special Review of Metham Sodium, Dazomet and Methylisothiocyanate (MITC) Volume II. Commonwealth of Australia. Available at: <http://apvma.gov.au/sites/default/files/publication/14571-methamsodium-review-volume-2.pdf>

United States Environmental Protection Agency [EPA] (2008). Revised Environmental Fate and Ecological Risk Assessment for Dazomet. PC Code: 035602, DP Barcode: 306855. Office of Prevention, Pesticides, and Toxic Substances, USEPA, Washington D.C., April 8, 2008. Available at: [https://www3.epa.gov/pesticides/chem\\_search/cleared\\_reviews/csr\\_PC-035602\\_08-Apr-08\\_a.pdf](https://www3.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-035602_08-Apr-08_a.pdf)

Warin, A.P. (1992). Allergic contact dermatitis from Dazomet. Contact Dermatitis 26: 135-136.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
AICS	Australian Inventory of Chemical Substances
CA EPA	California Environmental Protection Agency
CPN	chronic progressive nephropathy
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EFSA	European Food Safety Authority

EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
Hb	haemoglobin
Hct	haematocrit
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
MCH	mean corpuscular haemoglobin
MCV	mean corpuscular volume
mg/kg-day	milligrams per kilogram-day
mg/L	milligrams per litre
MITC	methylisothiocyanate
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NRA	National Registration Authority for Agricultural and Veterinary Chemicals
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RBC	red blood cell
RfD	oral reference dose
SGOT	serum glutamic-oxaloacetic transaminase
SMILES	simplified molecular-input line-entry system
UDS	unscheduled DNA synthesis
USEPA	United States Environmental Protection Agency

## ETHYLENE OXIDE/PROPYLENE OXIDE COPOLYMER

This dossier on ethylene oxide/propylene oxide copolymer (EO/PO copolymer) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of EO/PO copolymer in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Oxirane, methyl-, polymer with oxirane

**CAS RN:** 9003-11-6

**Molecular formula:**  $(C_3H_6O.C_2H_4O)_x$ -

**Molecular weight:** Variable

**Synonyms:** ethylene oxide, propylene oxide block polymer; poloxalene; poloxamer; polyethylene glycol, propoxylated; polyethylene-polypropylene glycol; polyoxyethylene-oxy-propylene; oxirane, 2-methyl-, polymer with oxirane; oxirane, methyl-, polymer with oxirane

**SMILES:** Not applicable.

The generic CAS RN 9003-11-6 refers to polymers that are synthetic block copolymers of ethylene oxide and propylene oxide. There are over 50 various amphiphilic non-ionic block polymers of hydrophobic propylene oxide (PO) and hydrophilic ethylene oxide (EO) (CIR, 2008). These copolymers consist of a central polyoxypropylene molecule, flanked on both sides by two hydrophilic polyoxyethylene chains.

EO/PO copolymers are also known as Poloxamers.

### II. PHYSICO-CHEMICAL PROPERTIES

The physico-chemical properties of the EO/PO copolymers used in cosmetics are listed in **Table 1**.

**Table 1: Physico-chemical Properties of Selected EO/PO Copolymers (CIR, 2008)**

Properties	Poloxamer 124	Poloxamer 188	Poloxamer 407
Avg. molecular weight	2090-2360	7680-9510	9840-14600
Description	Colorless liquid	White solid	Solid
Wt. % oxyethylene	$46.7 \pm 1.9$	$81.8 \pm 1.9$	$73.2 \pm 1.7$
Melting point (°C)	16	52	56
Solubility	Soluble in water	Soluble in water	Soluble in water

### III. ENVIRONMENTAL FATE PROPERTIES

No studies are available.

The following information is from the Dow Chemical Company's Product Safety Assessment document on their EO/PO copolymer products with CASRN 9003-11-6 and 53637-25-5:

Polyglycol EP Series Polymers are non-volatile (do not evaporate) and vary in water solubility. If released to water or soil, they would tend to remain in and be transported with the surface or ground water to which they are emitted, and will be adsorbed to soil and sediment particles.

Polyglycol EP Series Polymers are unlikely to persist in the environment, as all products are known or expected to be either readily biodegradable (>65% biodegraded in 28 days per OECD 301F test) or inherently biodegradable according to Organisation for Economic and Co-operation and Development (OECD) test guidelines. As such, these products will be efficiently removed during treatment in biological wastewater treatment facilities.

These products are not expected to accumulate in the food chain (low bioconcentration potential).

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

EO/PO polymers are not acutely toxic by the oral route. These polymers are not skin irritants or sensitizers. No systemic toxicity was observed in rats given very high oral doses of EO/PO polymers for up to two years. A slight inflammation response was seen in rats that inhaled a very high concentration of an aerosol or dust of these polymers over a two-week period. Repeated dermal applications of an EO/PO polymer to the skin of rabbits produced a slight irritating response, but no systemic toxicity. An EO/PO polymer was not mutagenic when tested in a bacterial reverse mutation assay. No studies are available to evaluate reproductive or developmental toxicity.

##### B. Acute Toxicity

The oral LD<sub>50</sub> values in rats for Poloxamer 124, 182, 188, and 235 were 5,000, 5,500, >15,000, and 34,600 mg/kg (Leaf, 1967). No acute dermal or inhalation studies were located.

##### C. Irritation

The EO/PO copolymers are not skin irritants to laboratory animals or humans (CIR, 2008).

##### D. Sensitisation

The EO/PO copolymers are not dermal sensitizer (CIR, 2008).

##### E. Repeated Dose Toxicity

###### Oral

Rats were given in their diet 0, 3, or 5% Poloxamer 188 for 6 months. During the study, 2 and 14 animals died in the mid- and high-dose groups, respectively. Deaths were attributed to a combination of infection and inanition. There were no histopathologic effects that were considered to be treatment-related (Leaf, 1967).

Rats were given in their diet Poloxamers 331, 235, or 338 for 90 days. The doses were: 40, 200, or 500 mg/kg Poloxamer 331; 40, 200, or 500 mg/kg Poloxamer 235; 200, 1,000 or 5,000 mg/kg Poloxamer 338. There was no treatment-related mortality. The rats in the 5,000 mg/kg Poloxamer 338 dose group had diarrhoea. No other details were given (Leaf, 1967).

Rats were given in their diet 0, 3, 5, or 7.5% Poloxamer 188 for two years. There was no treatment-related mortality. At the two higher doses, the rats had continuous moderate diarrhoea, but not other adverse reactions. A small decrease in growth was seen in the 7.5% group (no statistical analysis and not information on the amount of change), but there were no treatment-related histopathological effects at any dose level. The NOAEL for this study is 5% in the diet (Leaf, 1967).



Male and female rats were given in their diet 0, 40, 200, or 500 mg/kg Poloxamer 182 for two years. Deaths occurred in all groups of rats due to chronic respiratory infections unrelated to the administration of Poloxamer 182. There were no clinical signs of toxicity, and blood and urine chemistry parameters were comparable across all groups. There were no gross pathological changes noted. It is unclear from the summary in CIR (2008) whether a histopathologic examination was conducted. The NOAEL for this study is 500 mg/kg-day (Leaf, 1967).

#### Inhalation

Male SD rats were exposed by inhalation to 0 or 97 mg/m<sup>3</sup> Poloxamer 101 aerosol for 6 hours/day, 5 days/week over a two-week period. A separate group of rats was exposed for two weeks followed by a two-week recovery period. All animals survived until the end of the study. The only adverse effect observed was slight alveolitis in the Poloxamer 101-exposed rats, which subsided by the end of a two-week recovery (Ulrich et al., 1992).

#### Dermal

New Zealand rabbits were given dermal applications of 0, 100, 300 or 1,000 mg/kg Poloxamer 184 5 days/week for a total of 20 applications. The skin of the treated animals showed slight intradermal inflammatory responses, but no systemic effects (CIR, 2008).

### **F. Genotoxicity**

Poloxamer 407 was not mutagenic to *S. typhimurium* strains TA97, TA98, TA100, TA1535, and TA1537 in the absence and presence of metabolic activation (CIR, 2008).

### **G. Carcinogenicity**

No studies are available.

### **H. Reproductive Toxicity**

No studies are available.

### **I. Developmental Toxicity**

No studies are available.

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for EO/PO copolymer 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).

### **A. Non-Cancer**

#### Oral

EO/PO copolymers have been tested in two chronic rat dietary studies. In the first study, the only effect observed was slightly reduced growth in the rats fed 7.5% EO/PO copolymer; no effects were seen in the 5% and lower dose groups. No statistical analysis was provided on whether the change in body weight gain was statistically significant, or whether the change is of sufficient magnitude to be considered an adverse effect. For the purposes of this risk assessment, the 7.5% and 5% concentrations

in the feed will be considered an LOAEL and NOAEL, respectively. In the second feeding study, there were no effects seen in the rats at oral doses up to 500 mg/kg-day.

The NOAEL of 5% EO/PO copolymer in the diet will be used to derive an oral reference dose (RfD) and a drinking water guidance value.

$$\text{NOAEL (mg/kg-day)} = 50,000 \text{ ppm} \times 0.05 = \underline{2,500 \text{ mg/kg-day}}$$

Where 0.05 is the fraction of body weight that is consumed per day as food for the rat (USEPA).

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 2,500 / (10 \times 10 \times 1 \times 1 \times 1) = 2,500 / 100 = \underline{25 \text{ mg/kg-day}}$$

#### *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)

$$\text{Drinking water guidance value} = (25 \times 70 \times 0.1) / 2 = \underline{88 \text{ mg/L}}$$

## **B. Cancer**

No carcinogenicity studies were located. Thus, a toxicological reference value was not derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

EO/PO copolymer does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Aquatic Toxicity

No studies are available.

The following information is from the Dow Chemical Company's Product Safety Assessment document on their EO/PO copolymer products with CASRN 9003-11-6 and 53637-25-5 (Dow, 2014):

[EO/PO copolymers] are practically non-toxic to aquatic organisms ( $LC_{50}/EC_{50} > 100$  mg/L for the most sensitive species tested) on an acute basis.

### B. Terrestrial Toxicity

No studies are available.

### C. Calculation of PNEC

The PNEC calculations for the EO/PO copolymers follow the methodology discussed in DEWHA (2009).

#### PNEC water

No experimental studies were found. However, Dow Chemical's Product Safety Assessment document on their EO/PO copolymers indicate that acute toxicity testing has been conducted on these copolymers and the  $LC_{50}/EC_{50}$  value for the most sensitive species is  $> 100$  mg/L. On the basis of the short-term results, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 100 mg/L. The  $PNEC_{water}$  is 0.1 mg/L.

#### PNEC sediment

A  $PNEC_{sed}$  was not calculated for EO/PO copolymer. There are no experimental toxicity data on sediment organisms and a Koc value EO/PO copolymer is unavailable for calculating the  $PNEC_{sed}$  using the equilibrium partition method. A Koc value for the EO/PO polymers has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as EO/PO polymers.

#### PNEC soil

A  $PNEC_{soil}$  was not calculated for EO/PO copolymer. There are no experimental toxicity data on soil organisms and a Koc value EO/PO copolymer is unavailable for calculating the  $PNEC_{soil}$  using the equilibrium partition method. A Koc value for the EO/PO polymers has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as EO/PO polymers.

## VIII. PBT ASSESSMENT

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).

EO/PO copolymers are either readily biodegradable or inherently biodegradable; thus, they do not meet the screening criteria for persistence.

EO/PO copolymers are expected to have high molecular weights and are not expected to be bioavailable. Thus, these copolymers do not meet the criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on the EO/PO copolymers. However, the acute E(L)C<sub>50</sub> on these copolymers are >0.1 mg/L in aquatic organisms based on information from Dow Chemical's Product Safety Assessment (Dow, 2014). EO/PO copolymers also have a high molecular weight and are not expected to be bioavailable. Thus, they do not meet the screening criteria for toxicity.

The overall conclusion is that EO/PO copolymers are not PBT substances.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Not classified

### **B. Labelling**

No signal word

### **C. Pictograms**

None

## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) on BARA-DEFOAM® HP (revision date: 03-Jan-2012).

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

### **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS on BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS on BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS on BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Slippery when wet.

### Storage

Store away from oxidizers. Store in a cool, dry location. The product has a shelf life of 36 months.

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for EO/PO copolymers (CAS No. 9003-11-6).

The information below on exposure controls and personal protection was obtained from the Halliburton SDS on BARA-DEFOAM® HP (revision date: 03-Jan-2012).

## Engineering Controls

Use in a well-ventilated area.

## Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves

*Skin Protection:* Normal work coveralls

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None known.

## **F. Transport Information**

EO/PO copolymers are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

Cosmetic Ingredient Review (CIR). (2008). Safety Assessment of Poloxamers 101, 105, 108, 122, 123, 124, 181, 182, 183, 184, 185, 188, 212, 215, 217, 231, 234, 235, 237, 238, 282, 284, 288, 331, 333, 334, 334, 338, 401, 402, 403, and 407, Poloxamer 105 benzoate, and Poloxamer 182 dibenzoate as used in cosmetics. Int. J. Toxicol. 27 (Suppl. 2): 93-128

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.

Dow Chemical Company. (Dow). (2014). Product Safety Assessment from Dow Chemical Company on their Polyglycol EP Series Polymers/FLUENT Brand Polyglycols/SYNALOX™ Fluids, revised June 5, 2014. Available at: [http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh\\_090c/0901b8038090c665.pdf?filepath=productsafety/pdfs/noreg/233-01006.pdf&fromPage=GetDoc](http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh_090c/0901b8038090c665.pdf?filepath=productsafety/pdfs/noreg/233-01006.pdf&fromPage=GetDoc)

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health RiskAssessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

Leaf, C.W. (1967). Toxicology of some non-ionic surfactants. Soap Chem. Spec. 43: 48; cited in CIR (2008).

Ulrich, C.E., Geil, G., Tyler, R.R., Kennedy, G.L., and Birnbaum, H.A. (1992). Two-week aerosol inhalation study in rats of ethylene oxide/propylene oxide copolymers. Drug Chem. Toxicol. 15: 269-270; cited in CIR (2008).

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
CIR	Cosmetic Ingredient Review
DEWHA	Department of the Environment, Water, Heritage and the Arts
Dow	Dow Chemical Company
ECHA	European Chemicals Agency
EO/PO	ethylene oxide/propylene oxide
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
RfD	oral Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system

## GLUTARALDEHYDE

This dossier on glutaraldehyde does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of glutaraldehyde in its use in drilling muds and hydraulic fracturing fluids. The majority of information presented in this dossier was obtained from NICNAS (1994) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** glutaraldehyde

**CAS RN:** 111-30-8

**Molecular formula:** C<sub>7</sub>H<sub>8</sub>O<sub>2</sub>

**Molecular weight:** 100.12

**Synonyms:** Pentanedial; glutaral; glutaric dialdehyde; 1,3-diformylpropane; 1,5-pentanedial; glutaric aldehyde; glutaric acid dialdehyde; dioxopentane; glutardialdehyde; 1,5-pentanedione; Algicide®C

**SMILES:** C(CC=O)CC=O

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-Chemical Properties of Glutaraldehyde**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa*	Sweetish smelling, clear water liquid	1	ECHA
Melting Point*	-33°C	1	ECHA
Boiling Point*	101.5°C @ 987.1 hPa	1	ECHA
Density*	1.13 kg/m <sup>3</sup>	1	ECHA
Vapour Pressure*	30 hPa @ 26.3°C	1	ECHA
Partition Coefficient (log P <sub>ow</sub> )*	-0.36	1	ECHA
Water Solubility*	miscible	2	ECHA
Flash Point*	Not measurable	1	ECHA
Auto flammability*	395°C @ ~1,000hPa	1	ECHA
Viscosity*	12.75 mm <sup>2</sup> /s (static) at 25°C	1	ECHA
Henry's Law Constant	0.011 Pa m <sup>3</sup> /mol at 25°C [QSAR]	2	ECHA

\*ca. 50% glutaraldehyde solution (in water)

1 ppm = 4.095 mg/m<sup>3</sup>

1 mg/m<sup>3</sup> = 0.244 ppm

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Glutaraldehyde is considered to be readily biodegradable. It is also expected to have a low potential for bioaccumulation. The Koc values indicate that glutaraldehyde is expected to have low to adsorption to suspended solids and sediment in water and moderate adsorption to soil. Glutaraldehyde



is not expected to undergo hydrolysis in the environment. Overall, glutaraldehyde shows limited persistence in the environment.

## **B. Abiotic Degradation**

### Hydrolysis

In an OECD TG 111 test (hydrolysis as a function of pH), glutaraldehyde was found to be hydrolytically stable at pH 4 and pH 7, but decomposed at pH 9 (ECHA). [Kl. score = 2]

### Phototransformation in Water

Photolytic degradation of glutaraldehyde occurred in water under sensitised conditions: the half-life was 18 days when equivalent to 36 days of natural sunlight (12 hours/day; sensitised acetone system); and 49 days when equivalent to 34 days of natural sunlight (12 hours/day; sensitised acetonitrile system). There was no photodegradation of glutaraldehyde under darkness or non-sensitised conditions (ECHA). [Kl. score = 2]

## **C. Biodegradation**

Glutaraldehyde was considered readily biodegradable in an OECD 301A (DOC die away test). Degradation was 90-100% in 28 days (ECHA). [Kl. score = 1]

In a simulation test involving aerobic sewage treatment [activated sludge units] (OECD TG 303A), glutaraldehyde degraded 97% after 73 days based on DOC removal (ECHA). [Kl. score = 1]

In an aerobic aquatic metabolism test, [ $^{14}\text{C}$ ]-glutaraldehyde had a half-life of 10.6 hours in the water/sediment system. A minor transformation product was glutaric acid: the maximum yield was 18.9 to 21.5% at 12 hours, which then declined rapidly to 10.1 to 11% by 24 hours; and was not observed at the end of the study period in the aqueous phase (ECHA). [Kl. score = 1]

In an anaerobic aquatic metabolism test, [ $^{14}\text{C}$ ]-glutaraldehyde was rapidly metabolised with the first-order half-life being 7.7 hours. Glutaraldehyde was transformed to 5-hydroxypentanal (ca 37% of applied radioactivity) on day 1; after that, it declined to <10%; it was not detected at all after 30 days. The second stable transformation product was 1,5-pentanediol (35% of radioactivity on Day 1), which accounted for 70% of the radioactivity at the end of the test. A minor transformation product was a compound formed via Aldol condensation, cyclisation and dehydration. This compound accounted for about 10-20% of total radioactivity from day 1 onwards (ECHA). [Kl. score = 1]

In an aerobic soil metabolism test, the half-life of the degradation of [ $^{14}\text{C}$ ]-glutaraldehyde was calculated to be 1.7 days, indicating rapid degradation in soil by microbial biotransformation. Degradation products were measured but not identified. (ECHA). [Kl. score = 1]

## **D. Environmental Distribution**

### Adsorption/desorption

The organic carbon/water partition coefficients ( $K_{oc}$ ) values were determined for sediment and four types of soil. The values are as follows: 120 for sediment; 210 for sandy loam; 500 for silty clay loam; 340 for silt loam; and 460 for loamy sand (ECHA; Leung et al., 2001). [Kl. score = 1]

## Distribution Modelling

No fugacity calculations were performed as glutaraldehyde has limited persistence. Its environmental fate is primarily determined by degradation rather than equilibration between compartments (OECD-SIDS, 1995).

### **E. Bioaccumulation**

Glutaraldehyde is not expected to bioaccumulate. The measured log Pow at pH 5, 7 and 9 are -0.41, -0.36 and -0.80, respectively (ECHA).

## **IV. HUMAN HEALTH HAZARD ASSESSMENT**

### **A. Summary**

Glutaraldehyde is moderate to highly toxic by the oral route, low to moderately toxic by the dermal route, and moderately to highly toxic by the inhalation route. Acute inhalation exposure may cause respiratory irritation. Glutaraldehyde is corrosive to the skin and eyes, and it is a skin and respiratory sensitizer. Repeated oral exposures via drinking water to rats have resulted in general systemic toxicity, but no target organ effects. In contrast, the upper respiratory tract, particularly the nasal cavity, is the target organ in rats and mice from repeated inhalation exposure. Glutaraldehyde may exhibit weak genotoxic effects in some *in vitro* tests, whereas the *in vivo* studies consistently show no genotoxic activity. Glutaraldehyde is not a reproductive toxicant; developmental toxicity can occur at maternally toxic doses, but there is no teratogenicity.

### **B. Toxicokinetics**

#### Dermal Absorption

[1,5-<sup>14</sup>C]-glutaraldehyde was applied to the skin of male and female F344 rats (ECHA). Doses were 0.75% and 7.5%: this corresponds to approximately 6.5 and 63 mg/kg for males; and approximately 8.7 and 102 mg/kg for females. The dermal absorption data are presented below in Table 2. The results indicate that glutaraldehyde has a low rate of absorption by the dermal route.

**Table 2: Dermal Absorption Data in Rats on Glutaraldehyde (ECHA)**

Sex	Absorption rate constant/hr		% of applied dose	
	Low Dose	High Dose	Low Dose	High Dose
Males	1.5	0.7	0.7	1.3
Females	1.8	0.9	0.3	2.1

An *in vitro* percutaneous absorption study was conducted on glutaraldehyde using excised skin from rats, rabbits, mice, guinea pigs, and humans (ECHA; Frantz et al., 1993). The skin samples were placed in a flow-through skin penetration chamber, and [<sup>14</sup>C]-glutaraldehyde was added at doses of 0.75% and 7.5%. The results are presented below in Table 3. Glutaraldehyde did not penetrate any of the skin samples to a significant degree, suggesting that only minimal amounts of glutaraldehyde may be available for systemic uptake and distribution after skin exposure. The results also show that skin absorption was greater for the animal species used in toxicity tests than human skin.

**Table 3: *In vitro* Percutaneous Absorption (mg/cm<sup>2</sup>) of Glutaraldehyde (ECHA; Frantz et al., 1993)**

Species	Low Dose	High Dose
Animal*	0.006	0.08

Human	0.002	0.02
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\*Percutaneous absorption in rats, mice, guinea pigs, mice and rabbits were similar to each and were reported as a single value.

### C. Acute Toxicity

The oral LD<sub>50</sub> values are: 123 to 820 mg/kg in rats; 100 to 352 mg/kg in mice; and 50 mg/kg in guinea pigs (NICNAS, 1994).

The dermal LD<sub>50</sub> values are: 640 to 2,000 mg/kg in rabbits; >2,500 mg/kg in rats; and >4,500 mg/kg in mice (NICNAS, 1994).

The inhalation 4-hour LC<sub>50</sub> values for glutaraldehyde are listed in the table below:

**Table 4: Acute inhalation LC<sub>50</sub> values for Glutaraldehyde**

Test Material	LC <sub>50</sub> (males)	LC <sub>50</sub> (females)	LC <sub>50</sub> (both sexes)	Reference
50% aq. aerosol	0.52 mg/L	0.45 mg/L	-	OECD, 1995
25% aq. aerosol	-	-	0.8 mg/L	OECD, 1995
50% aq. aerosol	0.35 mg/L	0.28 mg/L	-	OECD, 1995
5% soln. vapour	0.096 mg/L	0.164 mg/L	-	OECD, 1995

During the exposure period, the animals showed signs of eye and respiratory irritation, as indicated by laboured and audible breathing, and wetness and encrustation around the nose and eyes.

### D. Irritation

Glutaraldehyde is corrosive to the skin and eyes of rabbits (NICNAS, 1994; ECHA). Signs of irritation occurred at a concentration of 2% for skin and 0.2% for eyes (NICNAS, 1994). In the acute inhalation studies, rats exposed to aerosols or vapours of glutaraldehyde showed signs of eye and respiratory irritation (OECD, 1995).

### E. Sensitisation

Glutaraldehyde is a skin sensitizer to guinea pigs and humans. Information on the individual studies can be found in NICNAS (1994) and in the ECHA REACH database (ECHA).

Asthmatic symptoms, such as wheezing, coughing, chest tightness, breathing difficulties and non-specific hyper-responsiveness have been reported to occur in humans occupationally exposed to glutaraldehyde (NICNAS, 1994). It is unclear whether the asthma is an allergic hypersensitivity response or a result of the aggravation of pre-existing asthma due to the irritating properties of glutaraldehyde. Nevertheless, glutaraldehyde should be considered a respiratory sensitizer, although one of low potency.

### F. Repeated Dose Toxicity

#### Oral

Male and female Wistar rat were given in their drinking water 0, 100, 500 or 2,000 ppm glutaraldehyde for 90 days. The approximate daily intakes were 0, 3, 15 or 53 mg/kg-day for males, and 0, 4, 19 or 72 mg/kg-day for females. There were no signs of neurotoxicity at any dose level. There was slight impairment of food consumption in the 2,000 ppm animals, as well as slight impairment of body weight and body weight gain. Impaired water consumption was seen in the 100

and 500 ppm females. The NOAEL for males is 500 ppm (15 mg/kg-day). The NOAEL for females is 100 ppm (4 mg/kg-day), since the impaired water consumption in the 100 ppm females was considered a palatability problem and not an adverse effect (ECHA). [Kl. score = 1]

Male and female F344 rats were given in their drinking water 0, 50, 250 or 1,000 ppm glutaraldehyde for 13 weeks. Additional groups of animals were given in their drinking water 0 or 1000 ppm glutaraldehyde for 13 weeks followed by a 4-week recovery period. The approximate daily intakes were 0, 5, 25 or 100 mg/kg-day for males; and 0, 7, 35 or 120 mg/kg-day for females. Water consumption was reduced in a dose-dependent manner in the  $\geq 250$  ppm males and 1,000 ppm females, which was attributed to an aversion to the taste and/or odour of glutaraldehyde in the water. There was also a reduction in food consumption in the 1,000 ppm animals with a parallel reduction in body weights. It is unclear whether the reduction in food consumption was related to the decreased water consumption. Urine volume was decreased with an increase in specific gravity, along with a slight increase in protein and ketone concentration, in the  $\geq 250$  ppm animals, which was probably related to the decreased water consumption. There were no treatment-related changes in the haematology parameters measured. Blood urea nitrogen was increased in a dose-related manner in the  $\geq 250$  ppm females at the 6-week time point, but at the 13-week or 17-week time points. Relative kidney weights were increased in a dose-related manner in the  $\geq 250$  ppm males and females, and increased absolute kidney weights in the females. Histopathological examination showed no treatment-related effects. The NOAEL is 50 ppm (5 and 7 mg/kg-day for males and females, respectively) based on dose-related increase in kidney weights at  $\geq 250$  ppm (ECHA). [Kl. score = 2]

Male and female Wistar rats were given in their drinking water 0, 100, 500 or 2000 ppm glutaraldehyde for 12 months. The approximate daily intakes were: 0, 6.4, 30.5 or 116.6 mg/kg-day for males; and 0, 9.6, 46 or 153 mg/kg-day for females. There was no treatment-related mortality. At 2,000 ppm, treatment-related effects included respiratory sounds (both sexes), decrease in body weight (males), decrease in body weight gain (both sexes), decrease in food consumption (both sexes), reduced water consumption (both sexes), lesions within the glandular stomach (both sexes showed erosion/ulceration of the glandular stomach), increased incidence of clear cell foci in the liver (males), and a single case of slight diffuse squamous metaplasia in the epithelium of the larynx (male). At 500 ppm, water consumption was reduced in males which was considered to be a palatability (bad taste) problem and not an adverse effect. No effects were seen in the 100 ppm animals. The NOAEL for this study is 500 ppm, which corresponds to 30.5 and 46 mg/kg-day for males and females, respectively (ECHA). [Kl. score = 1]

Male and female Fischer 344 rats were given in their drinking water 0, 50, 250 or 1000 ppm glutaraldehyde for 104 weeks. The mean glutaraldehyde consumption was 0, 4, 17 and 64 mg/kg-day for males and 0, 6, 25 and 86 mg/kg-day for females. There were no treatment-related mortalities or clinical symptoms of toxicity. In the 250 and 1,000 ppm groups, there was reduction in body weight and body weight gain; reduction in food and water consumption; increased statistically significant incidence of nucleated erythrocytes and of large monocytes; decreases in alanine aminotransferase (ALT), aspartate aminotransferase (AST), and glutamate dehydrogenase; dose-related decrease in urine volume accompanied by a dose-related increase in osmolality; changes in absolute and relative kidney weight; gastric irritation; increases in bone marrow hyperplasia; and increased incidence of renal tubular pigmentation. The decreased water consumption was considered to be due to the bad taste, smell and/or irritancy of the test substance in the drinking water; Therefore, it is of no toxicological relevance. As a result of reduced water intake, there are renal physiological adaptation, such as decreased urine, increased osmolality and changes in kidney weight. The haematological and clinical chemistry parameter changes were marginal and were considered to be of not toxicological relevance. The main haematological finding seen at the end of the study and which consisted of the appearance of nucleated erythrocytes and large monocytes in all treated groups (statistically significant for the  $\geq 250$  ppm males) was related to the incidence of large granular lymphocytic leukaemia (LGLL) in the spleen. The bone marrow hyperplasia and renal tubular pigmentation are related to the occurrence/incidence of LGLL, and were considered by the authors of the study as being

secondary to a low grade haemolytic anaemia in animals with LGLL. The NOAEL for this study is 50 ppm which corresponds to 4 and 6 mg/kg-day for males and females, respectively (Van Miller *et al.* 2002). [Kl. score = 2]

### Inhalation

Male and female F344 rats were exposed by inhalation to 0, 0.0625, 0.125, 0.25, 0.5 or 1.0 ppm (0, 0.26, 0.5, 1, 2, or 4.1 mg/m<sup>3</sup>) glutaraldehyde for 6.5 hours/day, 5 days/week for 13 weeks. The study focused on the respiratory tract, using histopathology and epithelial cell labelling index as end points. Histopathological lesions in the nasal passages and turbinates were seen at  $\geq 0.25$  ppm. Treatment-related effects were primarily the respiratory mucosa (nasal cavity and tips of the turbinates) and the olfactory epithelium (dorsal meatus). Hyperplasia, squamous metaplasia, olfactory degeneration, squamous exfoliation (accumulation of keratin, cell debris and bacteria in the lumen of the nasal vestibule) and focal erosions were reported for both sexes, and the severity and incidence of the findings increased with increasing concentration of glutaraldehyde. The NOAEL for this study is 0.125 ppm (Gross *et al.*, 1994). [Kl. score = 1]

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0, 0.0625, 0.125, 0.25, 0.5 or 1.0 ppm (0, 0.26, 0.5, 1, 2, or 4.1 mg/m<sup>3</sup>) glutaraldehyde for 6.5 hours/day, 5 days/week for 13 weeks. The study focused on the respiratory tract, using histopathology and epithelial cell labelling index as end points. Histopathologic lesions in the nasal passages and turbinates were seen at all exposure concentrations ( $\geq 0.0625$  ppm). Treatment-related lesions were primarily the respiratory mucosa (nasal cavity and tips of the turbinates) and the olfactory epithelium (dorsal meatus). Hyperplasia, squamous metaplasia, olfactory degeneration, squamous exfoliation (accumulation of keratin, cell debris and bacteria in the lumen of the nasal vestibule) and focal erosions were reported for both sexes, and the severity and incidence of the findings increased with increasing test concentration. Furthermore, neutrophilic inflammation was seen at  $\geq 0.062$  ppm, and squamous metaplasia as well as necrosis were seen in the larynx at 1 ppm). The LOAEL for this study is 0.0625 ppm; a NOAEL was not established (Gross *et al.*, 1994). [Kl. score = 1]

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0 or 0.1 ppm (0 or 0.41 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for 52 and 78 weeks. Survival was similar between treated and control groups. Hyperplasia of the squamous epithelium lining of the dorsal wall of the nasal passages and the lateral aspect of the atrioturbinate was seen in a greater number of exposed females than in controls. Epidermal erosion and ulceration as well as squamous and inflammatory exfoliation were also seen in the nasal lumens. All of these changes were dependent on the length of glutaraldehyde exposure. The authors concluded that, since the induced lesions occurred in the more anterior part of the nasal passages, that they were likely the result of an irritation mechanism (Zissu *et al.*, 1998). [Kl. score = 2]

Male and female Fischer 344 rats were exposed by inhalation to 0, 0.25, 0.5, or 0.75 ppm (0, 1, 2, or 3.1 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival in the mid- and high-dose females was statistically significantly decreased compared to controls. Mean body weights of all exposed males and the mid- and high-dose females were generally less than those of the controls. Non-neoplastic lesions were limited primarily to the most anterior region of the nasal cavity. Effects included hyperplasia and inflammation of the squamous epithelium; hyperplasia, goblet cell hyperplasia, inflammation, and squamous metaplasia of the respiratory epithelium; and hyaline degeneration of the olfactory epithelium. The LOAEL for this study is 0.25 ppm based on hyperplasia and inflammation of the squamous epithelium of the nose in both sexes. A NOAEL was not established (van Birgelen *et al.*, 2000). [Kl. score = 2]

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0, 0.0625, 0.125, or 0.25 ppm (0, 0.26, 0.5, or 1 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival of the treated animals was similar to controls. Mean body weights of the high-dose females were generally lower

than the controls. Non-neoplastic lesions were limited primarily to the anterior region of the nasal cavity; the effects were qualitatively similar to those seen in the rats (see accompanying summary on the two-year rat study by van Birgelen et al., 2000). Squamous metaplasia of the respiratory epithelium was observed in both sexes of mice while female mice also had inflammation and hyaline degeneration of the respiratory epithelium. The incidence and severity grade (in parentheses) of the hyaline degeneration were: 16/50 (1.4), 35/49 (1.4), 32/50 (1.3), and 30/50 (1.1) for the 0, 0.0625, 0.125, and 0.25 ppm dose groups, respectively. The LOAEL for this study is 0.0625 ppm based on hyaline degeneration of the respiratory epithelium in female mice. A NOAEL was not established (van Birgelen et al., 2000). [Kl. score = 2]

### Dermal

Applications of a 50% solution of glutaraldehyde was applied to the skin of male and female SD rats for 13 weeks. The doses were 0, 50, 100, and 150 mg/kg glutaraldehyde. At the application site, there were signs of irritation (scabs, desquamation and very slight or well-defined erythema). There was no treatment-related mortality, clinical signs, body weights, feed consumption, and ophthalmoscopic effects. There were no changes in the haematology and clinical chemistry parameters that were considered to be biologically or toxicologically relevant. Organ weights were similar between treated and control animals. Histopathological examination showed a treatment-related effects in the skin associated with chronic irritation; no other changes were noted that were considered to be treatment-related. The NOAEL for this study is 150 mg/kg, the highest dose tested (ECHA). [Kl. score = 1]

## **G. Genotoxicity**

### In Vitro Studies

Glutaraldehyde may exhibit weak genotoxic effects in some *in vitro* tests. The bacterial reverse mutation assays have been the most consistent. Variable results have been reported for the forward gene mutation tests; and for sister chromatid exchange (SCE), chromosomal aberration and Unscheduled DNA Synthesis (UDS) tests (Vergnes and Ballantyne, 2002).

### In Vivo Studies

The *in vivo* studies conducted on glutaraldehyde are presented below in Table 5. All of the studies show that glutaraldehyde is not mutagenic or genotoxic.

**Table 5: *In Vivo* Genotoxicity Studies on Glutaraldehyde**

Test System	Results*	Klimisch Score	Reference
Rat bone marrow (chromosomal aberration)	-	1	ECHA
Rat bone marrow (chromosomal aberration)	-	2	ECHA
Mouse bone marrow (micronucleus)	-	1	ECHA
Rat bone marrow (chromosomal aberration)	-	2	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	2	ECHA
Drosophila SLRL Test	-	2	ECHA
Rat liver UDS Assay	-	1	ECHA
Rat germ cell cytogenetic assay (alkaline elution)	-	2	ECHA
Mouse peripheral blood micronucleus study	-	2	Vernes and Ballantyne (2002)
Rat liver UDS Assay	-	2	Mirsalis <i>et al.</i> (1989)



a+, positive; -, negative

## H. Carcinogenicity

### Oral

Male and female Fischer 344 rats were given in their drinking water 0, 50, 250 or 1,000 ppm glutaraldehyde for 104 weeks. The mean glutaraldehyde consumption was 0, 4, 17 and 64 mg/kg-day for males and 0, 6, 25 and 86 mg/kg-day for females. Mortality rates were 25-30% and 19-23% for males and females, respectively, with no dose-related increase. The major cause of death in all dose groups including the controls was LGLL. There was an increased incidence of LGLL in the liver and spleen in all treated females ( $\geq 50$  ppm). The incidence of LGLL was not significantly increased in the treated males compared to the controls. No other treatment-related increased incidence of tumours was seen (Van Miller et al., 2002). [Kl. score = 2]

Male and female Wistar rats were given in their drinking water 0, 100, 500 or 2,000 ppm glutaraldehyde for two years. The mean daily intake of glutaraldehyde was as follows: 0, 6.1, 31.9, and 120.7 mg/kg-day for males; and 0, 10.5, 48.5 and 176.4 mg/kg-day for females. In the high-dose animals, there was mortality (2 males and 9 females) from asphyxia, and mean terminal body weights were significantly decreased compared to the controls. There were no treatment-related neoplastic effects (ECHA). [Kl. score = 1]

### Inhalation

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0 or 0.1 ppm (0 or 0.4 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for 52 and 78 weeks. No exposure-related neoplastic lesions were observed in either males or females (Zissu et al., 1998). [Kl. score = 2]

Male and female Fischer 344 rats were exposed by inhalation to 0, 0.25, 0.5, or 0.75 ppm (0, 1, 2, or 3.1 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival in the mid- and high-dose females was statistically significantly decreased compared to controls. Survival of the treated males was similar to controls. No exposure-related neoplastic lesions were observed in either males or females (van Birgelen et al., 2000). [Kl. score = 2]

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0, 0.0625, 0.125, or 0.25 ppm (0, 0.26, 0.5, or 1 mg/m<sup>3</sup>) glutaraldehyde for 6 hours/day, 5 days/week for two years. Survival of the treated animals was similar to controls. No exposure-related neoplastic lesions were observed in either males or females (van Birgelen et al., 2000). [Kl. score = 2]

## I. Reproductive Toxicity

A two-generation reproductive toxicity study was conducted in Wistar rats given 0, 100, 500 and 2000 ppm glutaraldehyde in their drinking water. The approximately mean daily intake is 0, 12, 58 and 199 mg/kg-day for the parental males and females of the F<sub>0</sub> and F<sub>1</sub> generation during premating. There were no adverse effects on reproductive performance or fertility. Oestrous cycle data, mating behaviour, conception, gestation, parturition, lactation and weaning as well as sperm parameters, sexual organ weights, gross and histopathological findings of these organs were similar between treated and control groups. In the high-dose animals, there was decreased water and/or food consumption; and decreased body weights and/or reduced body weight gains during the premating periods in the F<sub>0</sub> and F<sub>1</sub> parental females during premating, gestation and/or lactation. The high-dose F<sub>1</sub> parental females also had increased the number of erosions/ulcers with microscopic erosion(s) or inflammatory oedema in the mucosa/submucosa of the glandular stomach. There were no adverse effects in the 500 ppm animals except for slight decreases in water consumption due to a palatability (bad taste) problem. Treatment-related signs of developmental toxicity were seen in the progeny of

the high-dose F<sub>0</sub> and F<sub>1</sub> parental generation, and included impairment in body weight and consequently in organ weights in the respective F<sub>1</sub> and F<sub>2</sub> pups. The NOAEL for reproductive toxicity is 2,000 ppm (199 mg/kg-day), the highest dose tested. The NOAEL for parental systemic toxicity is 500 ppm (58 mg/kg-day). The NOAEL for developmental toxicity is 500 ppm or 58 mg/kg-day (ECHA). [Kl. score = 1]

A two-generation reproductive toxicity study was conducted in Crj: CD(SD) rats given 0, 50, 250 and 1,000 ppm glutaraldehyde in their drinking water. Mean daily intake was not calculated. Parental body weights and body weight gains were significantly reduced at 1,000 ppm at some periods, particularly during pre-mating. Food consumption was significantly reduced at 1,000 ppm for the F<sub>0</sub> and F<sub>1</sub> parental animals during pre-mating and gestation, and F<sub>1</sub> females during lactation. Water consumption was reduced throughout the pre-mating period for the F<sub>0</sub> and F<sub>1</sub> 250 and 1,000 ppm parental animals. There was no indication of adverse effects on reproductive performance or fertility at any dose level. For the F<sub>1</sub> 1,000 ppm offspring, body weights were reduced from lactation days 21-28. The NOAEL for reproductive toxicity is 1,000 ppm, the highest dose tested. The NOAEL for parental systemic toxicity is 50 ppm. The NOAEL for developmental toxicity is 250 ppm (Neeper-Bradley and Ballantyne, 2000). [Kl. score = 2]

## **J. Developmental Toxicity**

Pregnant Wistar rats were given in their drinking water 0, 50, 250 or 750 ppm (0, 5, 26 or 68 mg/kg) glutaraldehyde from GD 6 to 16. Water consumption was reduced in a dose-related manner in the  $\geq 250$  ppm dams, and was considered not to be a toxic response, but due to the palatability (bad taste) of the drinking test solution. No other maternal effects were seen in the study. There were no significant differences between treated and controls in the sex distribution, placental weights, fetal weights, malformations or variations. The NOAELs for maternal and developmental toxicity in this study are 68 mg/kg-day, respectively (ECHA). [Kl. score = 1]

Pregnant Wistar rats were dosed by oral gavage with 0, 25, 50, or 100 mg/kg glutaraldehyde on GD 6 to 15. Mortality was significantly increased in the high-dose group (5/26); there were 2/21 deaths in the mid-dose group. Clinical signs (piloerection) occurred in all treated groups in a dose-dependent manner. Maternal body weight gain and feed consumption were significantly reduced in the high-dose dams, but not at the lower doses. The necropsy findings showed evidence of stomach irritation in almost all of the animals that died during the study and in 12/21 of the surviving dams in the high-dose group. The number of implantation per litter, resorptions and dead fetuses per litter, live fetuses per litter, and incidence of post-implantation loss per litter was similar across all groups. The mean foetal body weights for male and female fetuses were significantly reduced in the high-dose group; this was attributed to the reduced food consumption of the dams during gestation rather than a direct effect of treatment. There was no evidence of a treatment-related teratogenic effect. The NOAELs for maternal and developmental toxicity are 50 mg/kg-day, respectively (Ema et al., 1992). [Kl. score = 2]

Pregnant Himalayan rabbits were dosed by oral gavage with 0, 5, 15 or 45 mg/kg glutaraldehyde on GD 7 to 19. In the high-dose group, 5/15 died on GD 9-11. Food consumption and body weight gain were also significantly reduced in the high-dose group. Clinical observations in 12/15 high-dose does included soft faces, diarrhoea, and blood in the bedding. The mean gravid uterus weight was significantly reduced in the high-dose group. Post-implantation loss was greatly increased (94.3%) in the high-dose group: no viable fetuses in 9/15 of the high-dose does, only early resorptions; only one female gave 4 alive fetuses on the scheduled date. There were reduced placental and foetal body weights in the only four fetuses. No significant maternal or developmental effects were seen in the mid- and low-dose groups. The NOAELs for maternal and developmental toxicity in this study are 15 mg/kg-day (ECHA). [Kl. Score = 2]



## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for glutaraldehyde 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).

### A. Non-Cancer

#### Oral

The lowest NOAEL values from key toxicity studies on glutaraldehyde are listed below in Table 6.

**Table 6: Lowest NOAEL Values from Key Toxicity Studies on Glutaraldehyde by the Oral Route**

Species/Sex	Study Duration	mg/kg-day	Endpoint	Reference
Rats, female	90-days	4	Decreased body weights, food and water consumption	ECHA
Rats, male	13-wk (drinking water)	5	Increased kidney weights	ECHA
Rats, male	12-months (drinking water)	30.5	Clinical signs; decreased body weights and food consumption; increased clear cell foci in liver	ECHA
Rats, male	2-yr (drinking water)	4	Reduced body weight, body-weight gain, and food consumption	Van Miller <i>et al.</i> (2002)
Rats	2-generation (drinking water)	58	Systemic toxicity	ECHA
Rats	GD 6-16 (drinking water)	68	Developmental toxicity	ECHA
Rats	GD 6-15 (oral gavage)	50	Developmental toxicity	Ema <i>et al.</i> (1992)
Rabbits	GD 7-19 (oral gavage)	15	Developmental toxicity	ECHA

The lowest NOAEL from these studies is 4 mg/kg-day based on reduced body weights, body weight gain, and feed consumption in male rats from the two-year drinking water study (Van Miller *et al.*, 2002). The NOAEL of 4 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

UF<sub>A</sub> (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

$$\text{Oral RfD} = 4 / (10 \times 10 \times 1 \times 1 \times 1) = 4 / 100 = \underline{0.04 \text{ mg/kg-day}}$$

#### *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 = 2 L (ADWG, 2011)

Drinking water guidance value =  $(0.04 \times 70 \times 0.1) / 2 = \underline{0.14 \text{ mg/L}}$

## **B. Cancer**

Increased incidence of large granular cell lymphatic leukaemia (LGLL) was observed in all groups of male and female Fischer 344 rats given glutaraldehyde in their drinking water, including the controls (Van Miller *et al.* 2002). For the males, the incidence of LGLL was not statistically significantly increased. However, for the females, the incidence of LGLL was significantly increased in all treated females ( $\geq 50$  ppm). Inhalation exposure of Fischer 344 rats to glutaraldehyde did not result in an increased incidence of tumours, including LGLL.

LGLL, also known as mononuclear cell leukaemia, is an extremely common spontaneous neoplastic disease of the ageing F344 rat (Stromberg 1985, Ward *et al.* 1990; Thomas *et al.* 2007). Consistent features are splenomegaly, anaemia, thrombocytopenia and leukemic infiltration of the spleen, liver lung, and in an advanced stage, of several other organs. The incidence is variable but has been increasing progressively with time and can exceed 70% in controls in some studies. This compares with background incidence of less than 1% in other strains of commonly used laboratory rats (Haseman *et al.*, 1998; Thomas *et al.*, 2007). The incidence in F344 rats is modulated by a variety of factors not clearly related to carcinogenicity. Corn oil gavage, for example, has been shown consistently to reduce the incidence of MCL in male, but not female, controls (reviewed in Thomas *et al.*, 2007).

The neoplastic mononuclear cells appear to be derived from large granular lymphocytes (LULs) (reviewed in Thomas *et al.*, 2007). The tumour cell is of the NK type in most, if not all, cases. LGL leukaemia, although uncommon, does occur in humans. There are two types: T-LGL leukaemia which has a chronic course characterised by neutropenia, recurrent infections, splenomegaly and accompanying rheumatoid arthritis, and the much rarer NK-LGL leukaemia which has an acute course, more pronounced splenomegaly, and thrombocytopenia. The latter type appears to resemble more closely the disease in the F344 rat than the former. The aetiology of human LGL leukaemia is unknown. There is some evidence that viral infection may play a role but no evidence that a chemically-related increased of LGLL in the F344 rat is indicative of the potential to induce LGL leukaemia in humans.

To extrapolate results from an animal model that has a clear predisposition (high spontaneous rates) to a tumour type to humans, of which this is not the case, seems inappropriate if the mechanism(s) for LGLL formation in that strain is not understood. Although that rat strain may be useful for understanding the disease process in humans, it does not seem reasonable to use the results from that rat strain for risk assessment purposes. There should be confirmation of a putative leukemogenic effect in the F344 rat in another strain before any conclusions are made about the use of this tumour type for human health risk assessment purposes.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Glutaraldehyde does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Glutaraldehyde is slight to moderately toxic to fish and invertebrates, and moderately to highly toxic to algae. It is of low toxic concern to terrestrial invertebrates and plants. To birds, glutaraldehyde is moderately toxic on an acute basis and slightly toxic on a subacute dietary basis.

### B. Aquatic Toxicity

#### Acute Studies

Table 7 lists the results of acute aquatic toxicity studies conducted on glutaraldehyde.

**Table 7: Acute Aquatic Toxicity Studies on Glutaraldehyde**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill sunfish	96-hr LC <sub>50</sub>	13	2	ECHA
<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	10	2	ECHA
<i>Daphnia magna</i>	48-hr LC <sub>50</sub>	14.87	2	ECHA
<i>Daphnia magna</i>	48-hr LC <sub>50</sub>	14	2	ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub>	0.375 (biomass) 0.6 (growth rate) 0.025 (NOEC)	1	ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub>	0.92 (growth rate) 0.61 (biomass) 0.33 (NOEC)	2	ECHA; Leung et al., 2001
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub>	0.61 (growth rate)	2	ECHA

#### Chronic Studies

The chronic aquatic toxicity studies conducted on glutaraldehyde are listed in Table 8.

**Table 8: Chronic Aquatic Toxicity Studies on Glutaraldehyde**

Test Species	Endpoint	Results (mg/L)	Kl. score	Reference
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<i>Oncorhynchus mykiss</i>	97-day (OECD 210)	LOEC = 5 NOEC = 1.6	1	ECHA
<i>Daphnia magna</i>	21-day	NOEC = 5	1	ECHA

### C. Terrestrial Toxicity

Table 9 lists the results of toxicity studies conducted on glutaraldehyde with earthworms, soil microorganisms, and birds.

**Table 9: Terrestrial Toxicity Studies on Glutaraldehyde**

Test Species (method)	Endpoint	Results	Kl. score	Reference
Earthworm <i>Eisenia fetida</i> (OECD 207)	14-d LC <sub>50</sub>	>500 mg/kg soil dw	1	ECHA
Soil microorganisms* (OECD 216)	28-d EC <sub>50</sub> 28-d EC <sub>10</sub>	360 mg/kg soil dw 11.5 mg/kg soil dw	1	ECHA
Soil microorganisms* (OECD 217)	28-d EC <sub>50</sub> 28-d EC <sub>10</sub>	>593 mg/kg soil dw 1.5 mg/kg soil dw	1	ECHA
Mallard ducks	Single-dose (oral gavage) LC <sub>50</sub>	206 mg/kg	2	ECHA
Mallard ducks	5-d (dietary) NOEC	>2,500 ppm	1	ECHA

\*organic carbon content of soil = 1.34% dry weight

Glutaraldehyde has also been evaluated in a terrestrial plants test: seedling emergence and seedling growth test (OECD TG 208). The test material contained 48.9% glutaraldehyde. The results are as follows:

*Avena sativa* (oats): 19-day EC<sub>50</sub> value is >1,000 mg/kg soil dry weight based on emergence rate, dry weight and shoot length. The NOECs for *Avena sativa* (oats) were ≥1,000 mg/kg dry weight on all three parameters tested

*Brassica napus* (rapeseed): 19-day EC<sub>50</sub> is >1,000 mg/kg soil dry weight based on emergence rate and shoot length and 994 mg/kg soil dry weight based on dry weight. The NOECs were ≥1,000, 500, and 250 mg/kg soil dry weight for emergence rate, dry matter, and shoot length, respectively.

*Vicia sativa* (vetch): 19-day EC<sub>50</sub> is >1,000 mg/kg soil dry weight based on emergence rate and shoot length, and 901 mg/kg soil dry weight based on dry weight. The NOECs were ≥1,000, 125, and 125 mg/kg soil dry weight for emergence rate, dry matter, and shoot length, respectively (ECHA). [Kl. score = 1]

### D. Calculation of PNEC

The PNEC calculations for glutaraldehyde follow the methodology discussed in DEWHA (2009).

#### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (10 mg/L), *Daphnia* (14 mg/L), and algae (0.375 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 0.025 mg/L for algae. 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 0.025 mg/L for algae. The  $PNEC_{water}$  is 0.0025 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the  $PNEC_{sed}$  was calculated using the equilibrium partitioning method. The  $PNEC_{sed}$  is 0.006 mg/kg wet weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{sed} &= (K_{sed-water}/BD_{sed}) \times 1000 \times PNEC_{water} \\ &= (3.1/1280) \times 1000 \times 0.0025 \\ &= 0.006 \end{aligned}$$

Where:

$K_{sed-water}$  = suspended matter-water partition coefficient ( $m^3/m^3$ )  
 $BD_{sed}$  = bulk density of sediment ( $kg/m^3$ ) = 1,280 [default]

$$\begin{aligned} K_{sed-water} &= 0.8 + [(0.2 \times K_{p_{sed}})/1000 \times BD_{solid}] \\ &= 0.8 + [(0.2 \times 4.8)/1000 \times 2400] \\ &= 3.1 \end{aligned}$$

Where:

$K_{p_{sed}}$  = solid-water partition coefficient (L/kg).  
 $BD_{solid}$  = bulk density of the solid phase ( $kg/m^3$ ) = 2,400 [default]

$$\begin{aligned} K_{p_{sed}} &= K_{oc} \times f_{oc} \\ &= 120 \times 0.04 \\ &= 4.8 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for glutaraldehyde in sediment is 120.  
 $f_{oc}$  = fraction of organic carbon suspended sediment = 0.04 [default].

### PNEC soil

Experimental results are available for three trophic level. An acute  $LC_{50}$  value is available for earthworms (>500 mg/kg). Results from long-term studies are available for two trophic levels, with the lowest NOEC or  $EC_{10}$  being 1.5 mg/kg soil dry weight for soil organisms.

The  $EC_{10}$  value is corrected for bioavailability of glutaraldehyde in soil by normalising the organic carbon content in the soil using the following equation:

$$EC_{10(std)} = EC_{10(exp)} \times Fom_{soil(std)}/Fom_{soil(exp)}$$

Where:

$Fom_{soil(std)}$  = 1% ([www.scew.gov.au/node/941](http://www.scew.gov.au/node/941))  
 $Fom_{soil(exp)}$  = 1.34% (see Table 9)

$$EC_{10(std)} = 1.5 \text{ mg/kg} \times 1/1.34 = 1.12 \text{ mg/kg}$$

On the basis that the data consists of one short-term from one trophic level and two long-term results from two additional levels, an assessment factor of 50 has been applied to the lowest reported long-term  $EC_{10}$  of 1.12 mg/kg soil dry weight [corrected for organic carbon content] for soil organisms. The  $PNEC_{soil}$  is 0.02 mg/kg soil dry weight.

## VIII. PBT ASSESSMENT

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).

Glutaraldehyde is readily biodegradable and Therefore does not meet the screening criteria for persistence.

The  $\log P_{ow}$  for glutaraldehyde at different pH values ranges from -0.36 to -0.80. Therefore, glutaraldehyde does not meet the screening criteria for bioaccumulation.

Chronic NOECs for fish, daphnia and algae are available for glutaraldehyde, and the NOEC values are  $>0.01$  mg/L. Therefore, glutaraldehyde does not meet the screening criteria for toxic.

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

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Acute Toxicity Category 3 [oral]  
Acute Toxicity Category 2 [inhalation]  
Skin Corrosion Category 1B  
Eye Damage Category 1  
Respiratory Sensitiser 1A  
Skin Sensitiser 1A  
STOT Single Exposure Category 3 [respiratory irritation]

The appropriate hazard statements corresponding the GHS classifications are to be added to the SDS, including the non-GHS hazard statement “AUH071: Corrosive to the Respiratory Tract”.

Note: Glutaraldehyde would also have the following classifications for aquatic toxicity: Aquatic Acute Category 1 and Aquatic Chronic Category 2. However, aquatic toxicity classification is not required for Australia GHS.

### B. Labelling

Danger

### C. Pictograms



## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the ECHA REACH database (ECHA).

#### Eye Contact

Wash immediately and continuously with flowing water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Obtain prompt medical consultation, preferably from an ophthalmologist. Eye wash fountain should be located in immediate work area.

#### Skin Contact

Take off contaminated clothing. Wash skin with soap and plenty of water for 15-20 minutes. Call a poison control centre or doctor for treatment advice. Wash clothing before reuse. Shoes and other leather items which cannot be decontaminated should be disposed of properly. Safety shower should be located in immediate work area.

#### Inhalation

Move person to fresh air. If a person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc.). Call a poison control centre or doctor for treatment advice. If breathing is difficult, oxygen should be administered by qualified personnel.

#### Ingestion

If the person is fully alert and cooperative, have the person rinse mouth with plenty of water. In cases of ingestion have the person drink 4 to 10 ounces (120-300 mL) of water. Do not induce vomiting. Do not attempt mouth rinse if the person has respiratory distress, altered mental status, or nausea and vomiting. Call a physician and/or transport to an emergency facility immediately. See Note to Physician. Seek medical attention immediately.

#### Notes to Physician

Maintain adequate ventilation and oxygenation of the patient. May cause asthma-like (reactive airways) symptoms. Bronchodilators, expectorants, antitussives and corticosteroids may be of help. Glutaraldehyde may transiently worsen reversible airways obstruction including asthma or reactive airways disease. Chemical eye burns may require extended irrigation. Obtain prompt consultation, preferably from an ophthalmologist. If the burn is present, treat as any thermal burn, after decontamination. Due to irritant properties, swallowing may result in burns/ulceration of mouth, stomach and lower gastrointestinal tract with subsequent stricture. Aspiration of vomitus may cause lung injury. Suggest endotracheal/oesophageal control if lavage is done. Probable mucosal damage may contraindicate the use of gastric lavage. Inhalation of vapours may result in skin sensitization. In sensitised individuals, re-exposure to very small amounts of vapour, mist, or liquid may cause a severe allergic skin reaction. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the Safety Data Sheet, and if available, the product container or label with you when calling a poison control centre or doctor, or going for treatment.

### Medical Conditions Aggravated by Exposure

Excessive exposure may aggravate pre-existing asthma and other respiratory disorders (e.g. emphysema, bronchitis, reactive airways dysfunction syndrome).

### Emergency Personnel Protection

First Aid responders should pay attention to self-protection and use the recommended protective clothing (chemical resistant gloves, splash protection). If the potential for exposure exists, refer to Section 8 of the Safety Data Sheet for specific personal protective equipment.

## **B. Fire Fighting Information**

Firefighting information was obtained from the ECHA REACH database (ECHA).

### Extinguishing Media

Use water fog, carbon dioxide, dry chemical or foam to extinguish combustible residues of this product

### Specific Exposure Hazards

This material will not burn until the water has evaporated. Residue can burn. Some components of this product may decompose under fire conditions. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include and are not limited to carbon monoxide and carbon dioxide.

### Special Protective Equipment for Firefighters

Wear positive-pressure self-contained breathing apparatus (SCBA) and protective firefighting clothing (includes firefighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during firefighting operations. If contact is likely, change to full chemical resistant firefighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight the fire from a remote location.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the ECHA REACH database (ECHA).

### Personal Precautions

Use appropriate safety equipment. Evacuate area. Keep upwind of the spill. Ventilate area of leak or spill. Only trained and properly protected personnel must be involved in clean-up operations.

### Environmental Precautions

Spills or discharge to natural waterways is likely to kill aquatic organisms. Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.



### Steps to be Taken if Material is Released or Spilt

Avoid making contact with spilt material; glutaraldehyde will be absorbed by most shoes. Always wear the correct protective equipment, consisting of splash-proof mono-goggles, or both safety glasses with side shields and a wraparound full-face shield, appropriate gloves and protective clothing. A self-contained breathing apparatus or respirator and absorbents may be necessary, depending on the size of the spill and the adequacy of ventilation. Small spills: Wear the correct protective equipment and cover the liquid with absorbent material. Collect and seal the material and the dirt that has absorbed the spilt material in polyethylene bags and place in a drum for transit to an approved disposal site. Rinse away the remaining spilt material with water to reduce odour, and discharge the rinsate into a municipal or industrial sewer. Large spills: In the case of nasal and respiratory irritation, vacate the room immediately. Personnel cleaning up should be trained and equipped with a self-contained breathing apparatus, or an officially approved or certified full-face respirator equipped with an organic vapour cartridge, gloves, and clothing impervious to glutaraldehyde, including rubber boots or shoe protection. Deactivate with sodium bisulphite (2-3 parts [by weight] per part of active substance glutaraldehyde), collect the neutralised liquid and place in a drum for transit to an approved disposal site.

### **D. Storage and Handling**

Information on storage and handling was obtained from the ECHA REACH database (ECHA).

#### General Handling

Do not get in eyes, on skin, on clothing. Avoid breathing vapour. Do not swallow. Keep container closed. Use with adequate ventilation. Wear goggles, protective clothing and butyl or nitrile gloves. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

#### Other Handling Precautions

Do not spray or aerosolize the undiluted form of the product. Full personal protective equipment (including skin covering and full-face SCBA respirator) is required for dilutions or mixtures of the product used in a spray application.

#### Storage

Do not store in: Aluminium. Carbon steel. Copper. Mild steel. Iron. Shelf life: Use within 12 Months.

### **E. Exposure Controls / Personal Protection**

#### Occupational Exposure Standards

The workplace exposure standard for glutaraldehyde in Australia is 0.1 ppm (0.41 mg/m<sup>3</sup>) as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

The information below on exposure controls and personal protection was obtained from the Halliburton Safety Data Sheet (SDS) on ALDACIDE® G ANTIMICROBIAL (revision date: 11-Dec-2014).

## Engineering Controls

Use in a well-ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation. If vapours are strong enough to be irritating to the nose or eyes, the TLV is probably being exceeded, and special ventilation or respiratory protection may be required.

## Personal Protection Equipment

*Respiratory Protection:* If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear an NIOSH-certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional. Full Facepiece Respirator with Organic vapour cartridge with particulate pre-filter.

*Hand Protection:* Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480-minute permeation time as per EN 374): Butyl rubber gloves. ( $\geq 0.7$  mm thickness) This information is based on literature references and on information provided by glove manufacturers or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g. temperature). If signs of wear and tear are noticed, then the gloves should be replaced. Manufacturer's directions for use should be observed because of the great diversity of types.

*Skin Protection:* Butyl coated apron or clothing.

*Eye protection:* Splash proof chemical mono-goggles or safety glasses with side shield in conjunction with a face shield. Do NOT wear contact lenses.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

For aqueous glutaraldehyde solutions at a concentration that is corrosive (i.e., 30% and higher):

### Australia Dangerous Goods

UN3265, Corrosive Liquid, Acidic, Organic, N.O.S. (Contains Glutaraldehyde)

Class 8

Packing Group III

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

### XIII. REFERENCES

- ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.
- 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: <http://echa.europa.eu/information-on-chemicals/registered-substances>
- Ema, M., Itami, T., and Kawasaki, H. (1992). Teratological assessment of glutaraldehyde in rats by gastric intubation. *Toxicol. Lett.* 63: 147-153.
- enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Frantz, S.W., Beskitt, J.L., Tallant, M.J., Futrell, J.W., and Ballantyne, B. (1993). Glutaraldehyde: species comparisons of in vitro skin penetrations. *J. Toxicol.-Cut. & Ocular Toxicol.* 12: 349-361.
- Gross, E.A., Mellick, P.W., Kari, F.W., Miller, F.J., and Morgan, K.T. (1994). Histopathology and cell replication responses in the respiratory tract of rats and mice exposed by inhalation to glutaraldehyde for up to 13 weeks. *Fundam. Appl. Toxicol.* 23: 348-362.
- Haseman, J.K., Hailey, J.R., and Morris, R.W. (1998). Spontaneous neoplasm incidences in Fischer 344 rats and B6C3F<sub>1</sub> mice in two-year carcinogenicity studies: A National Toxicology Program update. *Toxicol. Pathol.* 26: 428-441.
- Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. *Regulatory Toxicology and Pharmacology* 25:1-5.
- Leung, H.-W. (2001). Ecotoxicology of glutaraldehyde: review of environmental fate and effects studies. *Ecotoxicol. Environ. Safety* 49: 26-39.
- Mirsalis, J.S., Tyson, C.K., Steinmetz, K.L., Loh, E.K., Hamilton, C.M., Bakke, J.P., and Spalding, J.W. (1989). Measurement of unscheduled DNA synthesis and S-phase synthesis in rodent hepatocytes following in vivo treatment: testing of 24 compounds. *Environ. Mol. Mutagen.* 14: 155-164.
- Neeper-Bradley, T.L., and Ballantyne, B. (2000). Two-generation reproduction study by dosing with glutaraldehyde in the drinking water of CD rats. *J. Toxicol. Environ. Health A* 61: 107-129.
- NICNAS (1994). Glutaraldehyde – Full Public Report. National Industrial Chemicals Notification and Assessment Scheme (NICNAS), AGPS, Canberra, Australia.

- OECD (1995). OECD-SIDS document on Glutaraldehyde, CAS No. 111-30-8, UNEP Publications. Accessed at: [http://webnet.oecd.org/hpv/ui/SIDS\\_Details.aspx?id=b13f2e48-0425-4a8a-b7b8-c04cfaab06e8](http://webnet.oecd.org/hpv/ui/SIDS_Details.aspx?id=b13f2e48-0425-4a8a-b7b8-c04cfaab06e8)
- Stromberg, P.C. (1985). Large granular lymphocyte leukaemia in F344 rats: Model for human T lymphoma, a malignant histiocytosis and T-cell chronic lymphocytic leukaemia. *Am. J. Pathol.* 119: 517-519.
- Thomas, J., Haseman, J.K., Goodman, J.I., Ward, J.M., Loughran, Jr., T.P., and Spencer, P.J. (2007). A review of large granular lymphocytic leukaemia in Fischer 344 rats as an initial step toward evaluating the implication of the endpoint to human cancer risk assessment. *Toxicol. Sci.* 99: 3-19.
- Van Birgelen, A.P.J.M., Chou, B.J., Renne, R.A., Grumbein, S.L., Roycroft, J.H., Hailey, J.R., and Bucher, J.R. (2000). Effects of glutaraldehyde in a 2-year inhalation study in rats and mice. *Toxicol. Sci.* 55: 195-205.
- Van Miller, J.P., Hermansky, S.J., Losco, P.E., and Ballantyne, B. (2002). Chronic toxicity and oncogenicity study with glutaraldehyde dosed in the drinking water of Fischer 344 rats. *Toxicol.* 175: 177-189.
- Vergnes, J.S., and Ballantyne, B. (2002). Genetic toxicology studies with glutaraldehyde. *J. Appl. Toxicol.* 22: 45-60.
- Ward, J.M., Rehm, S., and Reynolds, C.W. (1990). Tumours of the haematopoietic system. In: *Pathology of Tumours in Laboratory Animals*, Vol. 1, Second Edition (Turusov, V.S., and Mohr, U., Eds.), pp. 625-657, International Agency for Research on Cancer, Lyon, France.
- Zissu, D., Bonnet, P., and Binet, S. (1998). Histopathological study in B6C3F1 mice chronically exposed by inhalation to glutaraldehyde. *Toxicol. Lett.* 95: 131-139.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
ALT	alanine aminotransferase
AST	aspartate aminotransferase
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
kg/m <sup>3</sup>	kilogrammes per cubic metre
LGLL	large granular lymphocytic leukaemia
LOAEL	lowest observed adverse effect level
LULs	large granular lymphocytes
mg/kg	milligrams per kilogram

mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SCE	sister chromatid exchange
SDS	Material Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system
UDS	Unscheduled DNA Synthesis
UVCB	unknown or variable composition, complex reaction product, or biological origin

## GLYOXAL

This dossier on glyoxal does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of glyoxal in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on glyoxal (OECD, 2005) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Oxalaldehyde

**CAS RN:** 107-22-2

**Molecular formula:** C<sub>2</sub>H<sub>2</sub>O<sub>2</sub>

**Molecular weight:** 58.04

**Synonyms:** 1,2-ethanedial, biformal, biformal, ethanedial (9CI), ethandione, glyoxal, glyoxal aldehyde, oxal,

**SMILES:** C(=O)C=O

Glyoxal is commonly supplied in the form of an aqueous solution at 40% (w/w) (OECD, 2005).

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-Chemical Properties of Glyoxal**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa*	Clear, slightly viscous liquid	1	ECHA
Melting Point*	-25°C -15°C	1 2	ECHA
Boiling Point*	103.6°C @ 1,013 hPa	1	ECHA
Density*	1.27 @ 20°C	1	ECHA
Vapour Pressure*	20.2 hPa @ 20°C 23 hPa @ 23.9°C	1 2	ECHA
Partition Coefficient (log Pow)*	-1.15 @ 23°C (pH 7) -1 @ 23°C (pH 5) -1.62 @ 23°C (pH 9)	1	ECHA
Water Solubility*	Miscible at pH 5-9	1	ECHA
Flash Point*	Not measurable	2	ECHA
Auto flammability	285°C @ 1013 hPa	2	ECHA
Viscosity	At 20°C: 6.6 mm <sup>2</sup> /s (static), 8.37 mPa s (dynamic). At 40°C: 3.38 mm <sup>2</sup> /s (static), 4.25 mPa s (dynamic).	1	ECHA
Henry's Law Constant	<0 Pa m <sup>3</sup> /mol at 20°C and 1013 hPa	2	ECHA

40% glyoxal in water

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Glyoxal is readily biodegradable. Glyoxal is mobile in soil, and it has a low potential for accumulation in soil. It is also not expected to bioaccumulate based on the octanol-water partition coefficient.

#### B. Abiotic Degradation

##### Hydrolysis

Anhydrous glyoxal immediately reacts with water to form ethane bis-gemdiol, which is stable in water. Polymerisation to acetals-semiacetals is possible, depending on concentration and pH (OECD, 2005).

#### C. Biodegradation

The results from biodegradation studies are shown below in Table 2. Glyoxal is readily biodegradable.

**Table 2: Biodegradation Studies on Glyoxal**

Test Method	Results	Klimisch score	Reference
OECD 301A	>90% after 19 days	1	ECHA
OECD 301C	65% (BOD/ThOD), 98% (TOC removal) after 14 days	2	ECHA
OECD 301D	90% after 28 days	2	ECHA

#### D. Environmental Distribution

##### Adsorption/desorption

An experimental Koc of a 40% aqueous solution of glyoxal was determined to be 2.1 L/kg from an OECD TG121 test (OECD, 2005; ECHA). [Kl. score = 1]

##### Distribution Modelling

According to a MacKay Level I fugacity model, all (100%) of the released glyoxal would be in the water compartment (OECD, 2005). A MacKay level III fugacity model gave the following results: air (0.1%), water (45.6%), sediment (0.1%), and soil (54.2%). If released to air, glyoxal would rapidly partition to soil and water; if released to soil and water, glyoxal would mostly remain in those compartments and degradation would prevent partitioning from one compartment to the other (OECD, 2005).

#### E. Bioaccumulation

No experimental studies on glyoxal were identified. The octanol-water partition coefficient is -1.15 at pH 7 (ECHA), indicating a low potential for bioaccumulation.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Glyoxal exhibits low acute toxicity by the oral and dermal routes; it has moderate acute toxicity by the inhalation route. Glyoxal is an irritant to the skin and eyes and is a skin sensitiser. Repeated oral exposure to glyoxal induces liver effects in rats; these effects are of questionable toxicological

significance. Stomach lesions were observed in female rats given glyoxal feed for two years. Glyoxal has shown mutagenic or genotoxic effects in a variety of in vitro assays; in vivo studies indicate that glyoxal is genotoxic in organs at the point of entry (the stomach) and immediately downstream (the liver), but not in more remote organs. Glyoxal was not carcinogenic to rats or mice in chronic feeding studies. There was no evidence of reproductive or developmental toxicity in rats or rabbits when given glyoxal in the diet.

## **B. Metabolism**

Male Wistar rats were given a single oral dose of 1,2-[<sup>14</sup>C]glyoxal, as well as [<sup>13</sup>C]glyoxal. The doses were 25 and 250 mg/kg. Glyoxal was extensively metabolised, with no glyoxal detected in urine, feces, tissues, or plasma. The metabolites were identified as organic acids (*i.e.*, oxalate, citrate, and succinate), indicating that glyoxal metabolism in the rat results in incorporation of glyoxal residues into endogenous metabolic pathways (ECHA). [Kl. score 1]

## **C. Acute Toxicity**

The oral LD<sub>50</sub> of a 40% aq. solution of glyoxal in male and female rats is 3,300 mg/kg. Clinical symptoms indicative of toxicity were seen in all animals in all dose groups. These included: decreased spontaneous activity, decreased respiration rate, increased water consumption, uncoordinated gait, squatting position, and retracted abdomen and flanks. At the higher doses, there were some symptoms indicative of acute neurotoxicity (ECHA). [Kl. score = 1]

The dermal LD<sub>50</sub> of a 40% aq. solution of glyoxal is >2,000 mg/kg in rats (ECHA). [Kl. score = 1]

The 4-hour inhalation LC<sub>50</sub> value of a 40% aq. solution of glyoxal in male and female rats is 2.44 mg/L as an aerosol. The respirable fraction (*i.e.*, 3µm) was 80% (ECHA). [Kl. score = 1]. Another study reported a 4-hour LC<sub>50</sub> value of >1.3 mg/L for glyoxal dust (80% purity) in rats exposed nose-only. There was no mortality, and the respirable fraction was about 5%, with the remaining 95% of particles being larger than the respirable fraction (ECHA). [Kl. score = 1]

## **D. Irritation**

Overall, rabbit studies show that glyoxal is irritating to the skin and eye (OECD, 2005; ECHA). [Kl. scores 1 and 2]

## **E. Sensitisation**

Several guinea pig studies have shown that glyoxal is a skin sensitiser (OECD, 2005; ECHA). [Kl. scores 1 and 2]. When tested in a mouse local lymph node assay (LLNA), glyoxal produced a sensitising response at test concentrations of 5, 10, and 24% with T:C ratios of 18.1, 13.6, and 12.2, respectively (Basketter et al., 1994; ECHA). [Kl. score = 2]

Gloxyal (as a 10% solution) was a skin sensitiser in a human maximisation test, with positive skin reactions appeared in 24 of 24 patients (Kligman, 1966).

## **F. Repeated Dose Toxicity**

### Oral

Male and female CrI CD(SD)BR rats were given in their drinking water 0, 100, 300 or 1000 mg/kg glyoxal for 28 days. There was no deaths and body weight gain was slightly reduced in the 300 mg/kg dose group and significantly reduced in the 1,000 mg/kg dose group. The reduced body weight coincided with a decreased food consumption. Water consumption was decreased in the >100 mg/kg and >300 mg/kg males and females, respectively, in a dose-dependent manner. A slight increase in



erythrocyte count in the 1,000 mg/kg male rats was considered to be a secondary effect of the reduced water consumption. Various organ weight changes in the 1,000 mg/kg were attributed to the reduced body weight. There were no changes haematological and biochemical parameters and of the urinary status that were considered to be treatment-related. Neither were there any macroscopic or histopathological effects that were considered treatment-related. The NOAEL for this study was considered to be 100 mg/kg-day (OECD, 2005; ECHA). [Kl. score = 1]

Male and female Wistar rats were given in their drinking water 0, 200, 1,000 or 5,000 ppm glyoxal for 90 days. In the 5,000 ppm group, there was a significant reduction in body weights and body weight gain. Changes in clinical chemistry consisted of decreased alanine aminotransferase (ALT) values in rats of both sexes, increased urea values in rats of both sexes, decreased globulin and total protein values in females, increased inorganic phosphate levels in males, increased incidences of higher urine ketone body and urobilinogen levels in males, and increased incidences of higher urine protein levels in females. There were no treatment-related effects on the functional observation battery (FOB), motor activity measurements, organ weights, gross or histopathological effects. The LOAEL for this study is 5,000 ppm, corresponding to 290 and 351.7 mg/kg-day for males and females, respectively. The NOAEL is 1,000 ppm, corresponding to 72 and 92.6 mg/kg-day for males and females, respectively (ECHA). [K. score = 1]

Male and female C57BL mice were given in their drinking water 0, 200, 1,000 or 2,000 ppm glyoxal (40% aq. solution) for 90 days. There were no adverse clinical signs, and body weight gain and food consumption were similar between treated and control animals. In the high-dose group, water consumption was reduced in males and females throughout the study with few exceptions. Although treatment-related, the decreased water consumption was considered to be palatability problem and not toxicologically relevant. In both, the mid and the low dose groups, changes in water consumption were incidental and not treatment-related. No treatment-related changes in haematological parameters were observed. Albumin and globulin and subsequently the total protein levels were statistically significantly decreased in the 5000 ppm males compared to controls, as well as cholesterol levels. In the 5,000 ppm females, urea and magnesium levels were statistically significantly decreased compared to control. There were no gross or histopathological effects that were considered to be treatment-related. The 5,000 ppm animals (both sexes) showed changes in mean absolute and relative kidney and heart weights. No histopathological correlation was found in the kidneys of the high-dose animals that could explain the statistically significant increase in the absolute weight (males and females), as well as of the relative weight (males only) of the kidneys. The statistically significant decrease of the heart weight in the females (absolute weight decrease in the >200 ppm groups; relative weight decrease in the >1000 ppm groups) was considered to be incidental, as no histopathological correlation was found in the 5000 ppm animals; there was also an absence of a clear treatment-related dose relationship. The LOAEL for this study is 5,000 ppm, corresponding to 683.5 and 933 mg/kg-day for males and females, respectively. The NOAEL for this study is 1,000 ppm, corresponding to 159.6 and 211.7 mg/kg-day for males and females, respectively (ECHA). [Kl. score = 1]

Male and female Harlan-Wistar rats were given in their diet 0, 31.25, 62.5, 125, 250 mg/kg-day glyoxal for 90 days. The actual ingested concentrations were: 0, 32.7, 63.2, 132 or 253 mg/kg-day for males; and 0, 32, 63.2, 127 or 271 mg/kg-day for females. There were no treatment-related effects on mortality and food consumption. The 250 mg/kg males showed a significant reduction in body weight gain during the first two weeks of the study; after that there were no significant differences between controls. Relative liver weights were significantly increased in the 250 mg/kg males. No other treatment-related effects were observed. The NOAEL for this study is approximately 125 mg/kg-day (OECD, 2005; ECHA). [Kl. score = 2]

Male Sprague-Dawley rats were given in their drinking water 0, 2,000, 4,000, or 6,000 mg/L glyoxal (98.7% purity) for 90 days. The corresponding average intakes were 0, 107, 234 or 315 mg/kg-day. Food and water consumption were decreased in a dose-dependent manner, with the mid- and high-dose groups significantly different from controls, which correlated with a reduction in body weight gain.

Water consumption was also significantly reduced in the low-dose group, with no change in body weight gain. Absolute organs, excluding the weights of the testes and brain, were significantly decreased in all dose groups in a dose-dependent manner. Relative kidney weights in the high-dose group were significantly increased compared to the controls. In the mid- and high-dose groups, decreased activities of alanine and aspartate aminotransferase as well as lactate dehydrogenase and reduced albumin and total protein values were observed. Decreased alanine aminotransferase activity and a reduced total protein value also occurred in the low-dose group. After 30 days of exposure, there was a significantly increased glyoxalase I and II activity in the liver and in the erythrocytes in the mid- and/or high-dose animals, as well glyoxalase I activity in the kidneys in the high-dose animals. However, there was no effect of treatment on glyoxalase I and II activity after 60 and 90 days of exposure. Glutathione levels and synthesis of 2-thiobarbituric acid active substances were not affected in the liver, kidney or erythrocytes. There were no treatment-related histopathological effects noted. The LOAEL is 2,000 mg/L (corresponding to 107 mg/kg-day) based on the decrease in serum protein levels seen at this dose; an NOAEL was not identified (Ueno et al., 1991a; OECD, 2005). [Kl. score = 2]

In a follow-up study, male Sprague-Dawley rats were given in their drinking water 6,000 mg/L glyoxal (100%) for 90 or 180 days. In addition to one control group fed the diet ad libitum, a control group was included which obtained the same amount of diet as the treated group (pair-fed control group). The daily substance intake in the 90- and 180-day groups corresponded to 315 and 298 mg/kg-day. The reduction in body weight retardation after 180 days was greater than that in the pair-fed control group, therefore indicating that the reductions in body weight gain seen in the first study probably reflected a systemic toxicity effect due to glyoxal treatment. With the exception of those of the brain and testes, the absolute weights of the weighted organs were below those of the controls. The relative weights of the liver, kidneys and heart were increased compared to the pair-fed control group at both the 90- and 180-day terminations. The total protein level was significantly lower in the treated group after 180 days, when compared to both control groups; the albumin-to-globulin ratio also was significantly decreased. The AST also was significantly decreased whereas the remaining parameters (ALT, LDH) were similar to control values. Necropsy showed haemorrhage or polyps in the glandular stomach of 2 animals of the treated group after 180 days; the finding, however, was considered not to be necessarily related to the treatment. The only treatment-related finding revealed by histopathological examination consisted of a slight swelling of papillary epithelial cells in the kidneys, which was accompanied by papillary interstitial oedema and lymph congestion. These lesions were found in 4/5 high-dose treated animals at both termination time points. The LOAELs for the 90-day and 180-day studies are 315 and 298 mg/kg-day, the only dose tested (Ueno et al., 1991a; OECD, 2005). [Kl. score = 2]

An additional assay was undertaken for examination of possible effects of glyoxal on the protein synthesis in liver, kidneys, and spleen because of the observed reduction in serum protein levels seen in the 90-day rat study, which the authors attributed to glyoxal. A group of 4 rats was administered 0 or 150 mg/kg glyoxal intravenously or 0 or 1000 mg/kg orally. After 4 hours, the animals were given an intraperitoneal injection of radiolabelled [4,5-<sup>3</sup>H]-leucine and were sacrificed 2 hours after injection. The liver, kidneys, and spleen were removed and prepared for measurement of leucine incorporation into tissue protein by means of liquid scintillation counting. The incorporation of radiolabelled leucine in tissue protein was decreased in liver and spleen when glyoxal was administered orally, and in the liver when glyoxal was administered intravenously. Therefore, a glyoxal-related decrease in protein synthesis could be demonstrated (Ueno et al., 1991a; OECD, 2005). [Kl. score = 3]

Male and female Wistar rats were given in their drinking water 0, 25, 75, or 300 mg/kg glyoxal for 24 months. There was no treatment-related mortality. Final body weights were lower in the high-dose males (-11%) and females (-12%) compared to the controls. Water consumption was lower in the high-dose animals and was considered to be due to the palatability of the water. The high-dose animals showed decreased serum ALT activity; there were no changes in liver weights and no other clinical chemistry changes to indicate a microsomal enzyme induction. Lower cholesterol and globulin values were seen in the high-dose animals and in the mid-dose males. The study authors thought that these

changes may be due to a dysregulation of metabolism in liver cells or decreased intestinal absorption of cholesterol combined with a lower synthesis of transport globulins. There were no treatment-related organ weight changes. Gross necropsy and histopathological examination showed an increase of erosions/ulcers in the glandular stomach of females. The incidence of these lesions in the histopathological examination were: 0, 1, 6, and 9 for the 0, 25, 75, and 300 mg/kg dose groups. The single erosion/ulcer seen in the low-dose group was considered incidental since it is within the historical control range. No other histopathological changes were noted. The NOAEL for this study is 25 mg/kg-day (ECHA). [Kl. score = 1]

### Inhalation

Male and female Wistar rats were exposed by inhalation (nose-only) to 0, 0.4, 2, or 10 mg/m<sup>3</sup> glyoxal (40% aq. solution) aerosol, for 6 hours/day, 5 days/week for 29 days (20 exposure days). The aerosol was respirable (99.7% particles were 3µm) for all three exposure groups. There was no mortality or clinical signs of toxicity. Body weight, body weight gain, food consumption, and water consumption were similar across all groups. There were no treatment-related changes in the haematology, clinical chemistry, or urinalysis parameters measured. Organ weights were similar across all groups. Histopathological examination showed minimal squamous metaplasia of the cuboidal epithelium of the epiglottis in the larynx in all high-dose animals, as well as some of the mid-dose animals. Some animals showed submucosal infiltration with lymphoid cells. These effects in the respiratory tract were considered to be localised effects due to the irritating nature of the test material. The NOAEL for systemic effects is 10 mg/m<sup>3</sup>, the highest exposure concentration tested. The NOAEL for localised effects is 0.4 mg/m<sup>3</sup> (OECD, 2005; ECHA). [Kl. score = 1]

### Dermal

No adequate studies were identified.

## **G. Genotoxicity**

### In Vitro Studies

Glyoxal has been tested in several bacterial reverse mutation assays. It was mutagenic to some of the *S. typhimurium* strains and to *E. coli* in the absence and/or presence of metabolic activation (OECD, 2005; ECHA). Glyoxal also showed mutagenic or genotoxic activity in a variety of other in vitro tests, as shown in Table 3.

**Table 3: In vitro Genotoxicity Studies on Glyoxal**

Test System	Results <sup>a</sup>		Klimisch Score	Reference
	-S9	+S9		
Mouse lymphoma assay	+	-	1	ECHA
Rat liver Unscheduled DNA Synthesis (UDS) assay	N/A	+	2	ECHA
Cytogenetics study in CHO cells (SCE)	+	+	2	ECHA
Cytogenetics study in CHO cells (chromosomal aberration)	+	+	1	ECHA
Cytogenetics study in V79 cells (chromosomal aberrations)	+	+	2	ECHA

<sup>a</sup>+, positive; -, negative

### In Vivo Studies

The in vivo studies conducted on glyoxal are presented in Table 5.

**Table 5: In Vivo Genotoxicity Studies on Glyoxal**

Test System	Results*	Klimisch Score	Reference
Mouse bone marrow micronucleus assay (gavage)	-	1	ECHA
Mouse bone marrow micronucleus assay (i.p.)	-	2	ECHA
Mouse bone marrow micronucleus assay (i.p.)	-	1	ECHA
Drosophila SRLR test	-	2	ECHA
Drosophila SRLR test	-	2	ECHA
Rat Liver Unscheduled DNA Synthesis (UDS) Assay (OECD 486/GLP study)	-	1	ECHA
Rat Stomach Unscheduled UDS Assay	+	2	Furihata et al. (1985); ECHA
Rat Stomach UDS Assay	+	2	ECHA
Rat Alkaline Elution Assay (stomach)	+	2	Furihata et al. (1989)
Rat Alkaline Elution Assay (liver, kidney, spleen, pancreas, lung)	+ (liver); - (other tissues)	2	Ueno et al. (1991b); ECHA

a+, positive; -, negative

The findings from the *in vivo* studies indicate that glyoxal reacts at the point of entry (the stomach) and immediately downstream (the liver), but not in more remote organs (OECD, 2005; ECHA).

## H. Carcinogenicity

### Oral

Male and female Wistar rats were given in their drinking water 0, 25, 75, or 300 mg/kg glyoxal for 24 months. There was no treatment-related mortality. Final body weights were lower in the high-dose males (-11%) and females (-12%) compared to the controls. Water consumption was lower in the high-dose animals and was considered to be due to the palatability of the water. There were no increases in the tumour incidences that were considered treatment-related (ECHA). [Kl. score = 1]

### Inhalation

No studies were identified.

### Dermal

Female CD-1 mice were administered two applications week of 0.1 ml glyoxal (37-40% aq. solution) onto the shaven skin of the back for five weeks (initiation phase). A week later, the mice were given applications of 12-O-tetra- decanoylphorbol-13-acetate (TPA) as a promoter for 47 weeks. The total initiation dose was 500 µmol glyoxal/mouse (corresponding to 30 mg/mouse). All animals survived the entire 53-week test period. In the glyoxal-treated group, 2 of 20 mice showed papillomas. No tumours were found in the DMSO (control) group. In the positive control group (DMBA/TPA), all 20 mice had a total of 134 skin tumours (99 of which were papillomas and 31 squamous cell carcinomas). Therefore, glyoxal does not appear to be a tumour initiator in this study (Miyakawa et al., 1991). [Kl. score = 2]

## **I. Reproductive Toxicity**

A two-generation reproductive toxicity study was conducted in Wistar rats given 0, 25, 100, or 400 mg/kg glyoxal in their drinking water. Final body weights of the high-dose males in both generations were significantly lower than the controls. The mid- and high-dose animals in both generations showed decreased serum ALT activity; there were no changes in liver weights and no other clinical chemistry changes to indicate a microsomal enzyme induction. There were no treatment-related effects on fertility or reproductive performance; nor was there any indications of developmental toxicity. The NOAEL for reproductive and developmental toxicity is 400 mg/kg-day. The NOAEL for parental toxicity is 25 mg/kg-day (ECHA). [Kl. score = 1]

## **J. Developmental Toxicity**

Pregnant Wistar rats were dosed by oral gavage with 0, 5, 25 and 125 mg/kg glyoxal on GD 6 to 19. Maternal toxicity was observed in the 125 mg/kg dose group only, as indicated by transient and sporadically occurring salivation immediately after dosing, significantly reduced food consumption, and significantly lower corrected body weight gain. There was no treatment-related developmental effects or teratogenicity at any dose level. The maternal and developmental NOAELs for this study are 25 and 125 mg/kg/day, respectively (OECD, 2005; ECHA). [K. score = 1]

Two other toxicity studies have been conducted in rats and rabbits with glyoxal trimeric dihydrate, which is the oligomeric form of glyoxal and which would be in equilibrium with the monomer in water.

Pregnant rats were dosed by oral gavage with 0, 50, 150 or 300 mg/kg glyoxal trimeric dehydrate (100%) on gestational days 6 through 15. A slight reduction was seen in maternal body weight and food consumption in the high-dose dams during the treatment period. No developmental toxicity was observed at any dose level. The maternal and developmental NOAELs for this study are 150 and 300 mg/kg/day, respectively (NTP, 1994; ECHA). [Kl. score = 1]

Pregnant New Zealand rabbits were dosed by oral gavage with 0 and 50 mg/kg glyoxal trimeric dehydrate (100%) on GD 6 through 19. A statistically significant, but transient, reduction in maternal body weight was seen in the treated animals during GD 6-9. Food consumption was also decreased at various intervals in the study. There was no evidence of developmental toxicity. The maternal and developmental NOAELs for this study are <50 and 50 mg/kg-day, respectively (NTP, 1993; ECHA). [Kl. score = 1]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for glyoxal 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).

### **A. Non-Cancer**

#### Oral

The lowest NOAEL values from key toxicity studies on glyoxal are listed below in Table 5.

**Table 5: Lowest NOAEL Values from Key Toxicity Studies on Glyoxal by the Oral Route**

Species/Sex	Study Duration	mg/kg-day	Endpoint	Reference
Rats, male	90-day (drinking water)	72	Decreased body weights; clinical chemistry changes	ECHA
Mice, male	90-day (drinking water)	160	Clinical chemistry changes	ECHA
Rats	90-day (feeding)	125	Decreased body weights; increased liver weights	OECD, 2005; ECHA
Rats	90-day (drinking water)	107*	Decreased serum protein levels	Ueno et al., 1991a
Rats, female	2-yr (drinking water)	25	Decreased serum ALT activity; stomach lesions	ECHA
Rats	2-generation (drinking water)	25	Decreased serum ALT activity	ECHA
Rats, female	GD 6-19 (oral gavage)	125	Developmental toxicity	ECHA
Rats, female	GD 6-19 (oral gavage)	50	Developmental toxicity	NTP, 1993

The lowest NOAEL from these studies is 25 mg/kg-day from a two-year drinking water study in rats and from a two-generation reproductive toxicity study in rats. (ECHA). Both studies showed decreased serum ALT activity at higher doses (>75 and >100 mg/kg-day, respectively), with the two-year drinking water study also showing stomach lesions in female rats at >75 mg/kg-day. The 90-day drinking water study by Ueno et al. (1991a) also reported an LOAEL of 107 mg/kg-day based on decreased serum protein levels. Additional 90-day and 180-day drinking water studies by Ueno et al. (1991a) used a single higher dose of glyoxal, so it is not possible to identify an NOAEL from the Ueno et al. (1991a) studies.

The NOAEL of 25 mg/kg-day from the two-year drinking water study will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value for glyoxal.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 25 / (10 \times 10 \times 1 \times 1 \times 1) = 25 / 100 = \underline{0.25 \text{ mg/kg-day}}$$

#### *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 = 2 L (ADWG, 2011)

Drinking water guidance value =  $(0.25 \times 70 \times 0.1)/2 = \underline{0.88 \text{ mg/L}}$

## B. Cancer

Glyoxal was not carcinogenic to rats in a chronic drinking water study. Therefore, no cancer reference value was derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Glyoxal does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Glyoxal exhibits a low concern for toxicity to aquatic organisms, as well as to terrestrial invertebrates and plants.

### B. Aquatic Toxicity

#### Acute Studies

Table 6 lists the results of acute aquatic toxicity studies conducted on glyoxal.

**Table 6: Acute Aquatic Toxicity Studies on Glyoxal**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Golden orfe	96-hr LC <sub>50</sub>	186 - 272	2	ECHA
Common carp	96-hr LC <sub>50</sub>	>200	2	ECHA
<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	215	2	ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	101	2	ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub> 72-hr NOEC	>200 >100	2	ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub> 72-hr NOEC	>100 3.13	1	ECHA

#### Chronic Studies

The chronic aquatic toxicity studies conducted on glyoxal are listed below:

**Table 7: Chronic Aquatic Toxicity Studies on Glyoxal**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Fathead minnow	34-d NOEC	112	1	ECHA
<i>Daphnia magna</i>	21-d NOEC	3.19	1	ECHA

### C. Terrestrial Toxicity

Table 8 lists the results of toxicity studies conducted on glyoxal with earthworms, soil microorganisms, and birds.

**Table 8: Terrestrial Toxicity Studies on Glyoxal**

Test Species (method)	Endpoint	Results (mg/L)	Klimisch score	Reference
Earthworm <i>Eisenia fetida</i> (OECD 207)	14-d LC <sub>50</sub>	>398	1	ECHA
Soil microorganisms* (OECD 216)	28-d EC <sub>50</sub>	>400	1	ECHA
	28-d EC <sub>10</sub>	>400		
Soil microorganisms* (OECD 217)	28-d EC <sub>50</sub>	>400	1	ECHA
	28-d EC <sub>10</sub>	240		

\*organic carbon content of soil = 1.34% dry weight

Glyoxal has also been evaluated in a terrestrial plants test: seedling emergence and seedling growth test (OECD TG 208). The test material contained 40% glyoxal. The results are as follows (expressed as active ingredient):

*Avena sativa* (oats): 19-day EC<sub>50</sub> value is >400 mg/kg soil dry weight based on emergence rate, fresh matter, dry matter, and shoot length. The NOECs were >400 mg/kg soil dry weight on tested parameters.

*Brassica napus* (rapeseed): 19-day EC<sub>50</sub> is >400 mg/kg soil dry weight based on emergence rate, fresh matter, dry matter, and shoot length. The NOEC was >400 mg/kg soil dry weight for seedling emergence and 503 mg/kg soil dry weight for dry matter, fresh matter, and shoot length.

*Vicia sativa* (vetch): 19-day EC<sub>50</sub> is >400 mg/kg soil dry weight based on emergence rate, fresh matter, dry matter, and shoot length. The NOEC was >400 mg/kg soil dry weight for seedling emergence and 203 mg/kg soil dry weight for fresh matter and dry matter (ECHA). [Kl. score = 1]

### D. Calculation of PNEC

The PNEC calculations for glyoxal follow the methodology discussed in DEWHA (2009).

#### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (>186 mg/L), invertebrates (101 mg/L), and plants (>100 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 3.19 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 3.19 mg/L for invertebrates. The PNEC<sub>water</sub> is 0.319 mg/L.



### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the  $PNEC_{sed}$  was calculated using the equilibrium partitioning method. The  $PNEC_{sed}$  is 0.21 mg/kg wet weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{sed} &= (K_{sed-water}/BD_{sed}) \times 1000 \times PNEC_{water} \\ &= (0.84/1280) \times 1000 \times 0.319 \\ &= 0.21 \end{aligned}$$

Where:

$K_{sed-water}$  = suspended matter-water partition coefficient ( $m^3/m^3$ )

$BD_{sed}$  = bulk density of sediment ( $kg/m^3$ ) = 1,280 [default]

$$\begin{aligned} K_{sed-water} &= 0.8 + (0.2 \times Kp_{sed})/1000 \times BD_{solid} \\ &= 0.8 + (0.2 \times 0.084)/1000 \times 2400 \\ &= 0.84 \end{aligned}$$

Where:

$Kp$  = solid-water partition coefficient (L/kg).

$BD_{solid}$  = bulk density of the solid phase ( $kg/m^3$ ) = 2,400 [default]

$$\begin{aligned} Kp &= K_{oc} \times f_{oc} \\ &= 2.1 \times 0.04 \\ &= 0.084 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for glyoxal in sediment is 2.1.

$f_{oc}$  = fraction of organic carbon suspended sediment = 0.04 [default].

### PNEC soil

Experimental results are available for three trophic levels. An acute  $LC_{50}$  value is available for earthworms (>398 mg/kg soil dry weight). Results from long-term studies are available for two trophic levels, with the lowest NOEC or  $EC_{10}$  being 203 mg/kg soil dry weight for plants (*Vicia sativa*). On the basis that the data consists of a short-term test and long-term tests from two trophic levels, an assessment factor of 50 has been applied to the lowest reported long-term NOEC of 203 mg/kg soil dry weight. The  $PNEC_{soil}$  is 4.06 mg/kg soil dry weight.

## **VIII. PBT ASSESSMENT**

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).

Glyoxal is readily biodegradable; Therefore, it does not meet the screening criteria for persistence.

The estimated  $\log K_{ow}$  value for glyoxal is -1.15. Therefore, glyoxal does not meet the screening criteria for bioaccumulation.

Chronic NOECs for fish, invertebrates, and algae are available for glyoxal, and the NOEC values are >0.01 mg/L. Therefore, glyoxal does not meet the screening criteria for toxicity.

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

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Acute Toxicity Category 4 [inhalation]  
Skin Irritation Category 2  
Eye Irritation Category 2  
Skin Sensitisation Category 1B  
Mutagen Category 2  
STOT SE Category 3 [respiratory irritation]

### **B. Labelling**

Warning

### **C. Pictograms**



## **X. SAFETY AND HANDLING**

Glyoxal is used in the drilling mud product PAC<sup>TM</sup>-L at a concentration of ~0.1%. The safety and handling of glyoxal at this concentration in PAC<sup>TM</sup>-L will be provided in the dossier on sodium carboxymethylcellulose, the major constituent of PAC<sup>TM</sup>-L.

### Occupational Exposure Standards

Workplace Australia does not have an occupational exposure standard for glyoxal. The ACGIH TLV for glyoxal is 0.1 mg/m<sup>3</sup> as a TWA, with a skin sensitisation notation.

### **A. Transport Information**

Glyoxal is used in the drilling mud product PAC<sup>TM</sup>-L at a concentration of ~0.1%. The transportation information for PAC<sup>TM</sup>-L will be provided in the dossier on sodium carboxymethylcellulose, the major constituent of PAC<sup>TM</sup>-L.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

### XIII. REFERENCES

- ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.
- Basketter, D.A., Scholes, E.W., Kimber, I. (1994). The performance of the local lymph node assay with chemicals identified as contact allergens in the human maximisation test. *Fd. Chem. Toxicol.* 32: 543-547.
- 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: <http://echa.europa.eu/information-on-chemicals/registered-substances>
- enHealth Human Risk Assessment (HHRA) (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency (ECHA) (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Furihata, C., Yoshida, S., and Matsushima, T. (1985). Potential initiating and promoting activities of diacetyl and glyoxal in rat stomach mucosa. *Jpn. J. Cancer Res (Gann)* 76: 809-814.
- Furihata, C., Hatta, A., Sato, Y., and Matsushima, T. (1989). Elution of DNA from stomach pyloric mucosa of rats treated with glyoxal. *Mutat. Res.* 213: 227-231.
- Kligman, A.M. (1966). The identification of contact allergens by human assay. III. The maximisation test: a procedure for screening and rating contact dermatitis. *J. Invest. Dermatol.* 47: 393-409.
- 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.
- Miyakawa, Y., Nishi, Y., Kato, K., Sato, H., Takahashi, M., Hayashi, Y. (1991). Initiating activity of eight pyrolysates of carbohydrates in a two-stage mouse skin tumorigenesis model. *Carcinogenesis* 12: 1169-1173.
- National Toxicology Program (NTP). (1993). Final report of the developmental toxicity of glyoxal trimeric dihydrate (CAS No. 4405-13-4) in New Zealand White (NZW) rabbits. TER92121. NTIS PB94-104064.
- National Toxicology Program (NTP). (1994). Final report of the developmental toxicity of glyoxal trimeric dihydrate (CAS No. 4405-13-4) in Sprague-Dawley (CD) rats. NTIS PB94-151974.
- OECD (2005). SIDS Initial Assessment Profile and Report for Glyoxal (CAS No. 107-22-2), UNEP Publication. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=84452AF1-8EC7-4B1B-85BF-BB77012F6FBC](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=84452AF1-8EC7-4B1B-85BF-BB77012F6FBC)

Ueno, H., Segawa, T., Hasegawa, T., Nakamuro, K., Maeda, H., Hiramatsu, Y., Okada, S., and Sayato, Y. (1991a). Subchronic oral toxicity of glyoxal via drinking water in rats. *Fund. Appl. Toxicol.* 16: 763-772.

Ueno, H., Nakamuro, K., Sayato, Y., and Okada, S. (1991b). DNA lesions in rat hepatocytes induced by in vitro and in vivo exposure to glyoxal. *Mutat. Res.* 260: 115-119.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
ACGIH	Association Advancing Occupational and Environmental Health
ALT	alanine aminotransferase
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
FOB	functional observation battery
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
kg/m <sup>3</sup>	kilogrammes per cubic metre
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
NPT	National Toxicology Program
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference dose
SMILES	simplified molecular-input line-entry system
TLV	threshold limit value
UDS	Unscheduled DNA Synthesis

## METHANOL

This dossier on methanol does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of methanol in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on methanol (OECD, 2004a, b) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Methanol

**CAS RN:** 67-56-1

**Molecular formula:** CH<sub>4</sub>O

**Molecular weight:** 32.04

**Synonyms:** Methyl alcohol, carbinol, wood spirits, wood alcohol, methylol, wood, columbian spirits, colonial spirit, columbian spirit, methyl hydroxide, monohydroxymethane, pyroxylic spirit, wood naphtha.

**SMILES:** CO

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-Chemical Properties of Methanol**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colorless liquid	2	ECHA
Melting Point	-97.8°C	2	ECHA
Boiling Point	64.7°C	2	ECHA
Density	0.79 g/cm <sup>3</sup>	2	ECHA
Vapour Pressure	169.27 hPa	2	ECHA
Partition Coefficient (log Pow)	-0.77	2	ECHA
Water Solubility	>1,000 g/L [miscible]	2	ECHA
Flash Point	9.7°C	2	ECHA
Auto flammability	455°C @ 1013 hPa	2	ECHA
Viscosity	0.544 – 0.59 mPa s (dynamic)	2	ECHA
Henry's Law Constant	0.461 Pa m <sup>3</sup> /mol	2	ECHA

Methanol is a highly flammable liquid.

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Methanol is readily bioavailable. It has a low adsorptive capacity on soils and low potential to bioaccumulate.

## B. Biodegradation

The adsorption of methanol was investigated in three different soil types at 6°C (Lokke, 1984; ECHA). Only slight methanol adsorption occurred with the sandy soils tested (percentage organic matter of 0.09% and 0.1% in the samples) and with the clay soil (percentage organic matter was 0.22%). Methanol solutions of concentrations of 0.1, 1.0, 9, and 90 mg/L were used in one-hour exposure adsorption studies; adsorption coefficients of between 0.13 and 0.61 were measured for all soil types and at all concentrations.

## C. Environmental Distribution

### Adsorption/desorption

The adsorption of methanol was investigated in three different soil types at 6°C (Lokke, 1984; ECHA). Only slight methanol adsorption occurred with the sandy soils tested (percentage organic matter of 0.09% and 0.1% in the samples) and with the clay soil (percentage organic matter was 0.22%). Methanol solutions of concentrations of 0.1, 1.0, 9, and 90 mg/L were used in one-hour exposure adsorption studies; adsorption coefficients of between 0.13 and 0.61 were measured for all soil types and at all concentrations.

### Distribution Modelling

Using data reported in the U.S. Toxics Release Inventory (TRI) for 2001, a distribution calculation was performed using the MacKay Level III fugacity model.

## D. Bioaccumulation

The BCF of methanol in *Cyprinus carpio* was determined to be 1 (Gluth et al. 1985); in *Leuciscus idus*, the BCF was <10 (Hansch and Leo, 1985; Freitag et al. 1985).

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

Methanol has a low order of acute toxicity (as measured by lethality) by the oral, dermal, and inhalation routes of exposure, as measured by lethality. Sublethal doses, however, have been shown to produce central nervous system (CNS) effects and ocular injury that may result in blindness. This effect has been seen in primates but not in rodents and has been contributed to the differences in blood levels of the metabolites. Acute toxicity in humans is characterised by a well-defined pattern; that includes CNS effects, ocular symptoms, and acidosis. Methanol is not irritating to the skin, but it is slightly irritating to the eyes. Repeated exposures by the oral and inhalation routes have not resulted in any systemic toxicity to rodents. Methanol was not carcinogenic to rats or mice in chronic inhalation studies. Increased tumours from methanol in drinking water were reported by Soffritti et al. (2002); however, there are methodological problems with this study and questions have been raised about the validity of the results. Methanol is inactive in a variety of in-vitro and in vivo genotoxicity studies. Conflicting results have been obtained concerning the effect of methanol on testicular hormones in rats; nevertheless, methanol does not appear to a male reproductive toxicant. The primate data indicates that methanol is unlikely to be a reproductive hazard in females. Methanol causes developmental effects at very high exposure levels in both rats ( $\geq 10,000$  ppm) and mice ( $\geq 2000$  ppm); there is also some evidence that it is a developmental neurotoxicant in rodents, but not in primates.

## B. Toxicokinetics and Metabolism

Several reviews on the metabolism and pharmacokinetics of methanol are available (Kavet and Nauss, 1990; Liesivuori and Savolainen, 1991; Tephly, 1991; IPCS, 1997; OECD, 2004a, b). Methanol is first oxidised to formaldehyde. This initial metabolic step involves different enzymes in rats than in primates and humans, although the rates are similar. A catalase–peroxidase system is primarily responsible for the initial step in rats, whereas alcohol dehydrogenase plays a major role in humans and monkeys. Methanol oxidation can also occur via hepatic microsomal oxidation involving the cytochrome P450 system.

Formaldehyde is converted to formic acid, which is converted to formate and a hydrogen ion. Conversion to formic acid is a two-step process; the second step is irreversible. In the first reaction, formaldehyde combines with reduced glutathione (GSH) to form S-formylglutathione. This is mediated by an NAD-dependent formaldehyde dehydrogenase. In the second reaction, thiolase catalyses the hydrolysis of S-formylglutathione to form formic acid and GSH. A folate-dependent pathway in the liver is responsible for formate metabolism in both rats and primates. Formate first forms a complex with tetrahydrofolate (THF) that is sequentially converted to 10-formyl-THF (by formyl-THF synthetase) and then to CO<sub>2</sub> (by formyl-THF dehydrogenase). THF is derived from folic acid in the diet and is also regenerated in the folate pathway. Although the folate pathway metabolises formate in both rats and monkeys, rats use the pathway more efficiently.

The dermal uptake rate of liquid methanol applied to the forearm of human volunteers was 11.5 mg/cm<sup>2</sup>/hr (Dutkiewicz et al., 1980). The dermal flux for methanol in human skin (epidermis) in vitro is 8.29 mg/cm<sup>2</sup>/hr (Schueplein and Blank, 1971). When 12 human volunteers immersed one hand into a vessel containing neat methanol for up to 16 min, the maximum methanol concentration in blood was reached 1.9 + 1.0 hr after exposure. Delivery rates from the skin into blood lagged exposure by 0.5 hr, and methanol continued to enter the blood for 4 hr following exposure. The average derived dermal absorption rate was 8.1 + 3.7 mg/cm<sup>2</sup>/hr. The authors calculated that the maximum concentration of methanol in blood following immersion of one hand in methanol for approximately 20 min is comparable to that reached following inhalation exposures to 200 ppm methanol (Batterman and Franzblau, 1997).

## C. Acute Toxicity

The acute oral LD<sub>50</sub> for rats range from 6,200 to 13,000 mg/kg (Kimura et al., 1971; Welch and Slocum, 1943; Deichman and Mergard, 1948; Smyth et al., 1941). The acute dermal LD<sub>50</sub> for rabbits was reported to be 20 mL/kg (Rowe and McCollister 1982). The acute inhalation 4- and 6-hour LC<sub>50</sub> values in rats are 128.2 and 87.5 mg/L, respectively (BASF, 1980a, b). Sublethal doses, however, produce CNS effects and ocular injury that may result in blindness. This effect has been seen in primates, but not in rodents, and has been attributed to the differences in blood levels of the metabolite, formic acid.

Methanol is metabolised to formate, which is considered to be the ultimate toxicant in acute methanol intoxication in humans. Acute methanol toxicity in humans is characterised by CNS depression, followed by acidosis and ocular injury. Generally, transient CNS effects appear above methanol levels of 200 mg/L and serious ocular symptoms appear above 500 mg/L (OECD, 2004). This blood concentration can transiently be achieved in an adult person (70 kg) by ingestion of 0.4 mL methanol/kg (approximately 0.32 mg/kg). The minimal acute methanol dose to humans that can result in death is considered to be 300 to 1,000 mg/kg by ingestion, and fatalities have occurred in untreated patients with initial methanol blood levels in the range of 1500–2000 mg/L (OECD, 2004). However, such high blood methanol levels able to cause death are not likely to be achieved through inhalation exposure.



## **D. Irritation**

Methanol is not irritating to the skin of rabbits (BASF, 1975), but it is slightly irritating to the eyes of rabbits (BASF, 1975).

## **E. Sensitization**

Methanol was not considered a skin sensitizer to guinea pigs (BASF, 1979).

## **F. Repeated Dose Toxicity**

### Oral

Male and female Sprague–Dawley rats were dosed by oral gavage with 0, 100, 500, or 2,500 mg/kg of methanol for 90 days. There were no differences in body weight gain and food consumption between treated and control animals. Brain weights were decreased in both sexes in the 2,500 mg/kg dose group. Elevated serum glutamic pyruvate transaminase and alkaline phosphatase were noted in the 2,500 mg/kg dose group, but there were no adverse treatment-related effects in the gross pathology and histopathological evaluation. The NOAEL is 500 mg/kg-day (USEPA, 1986).

Sprague-Dawley rats were given in their drinking water 0, 500, 5,000 or 20,000 ppm methanol for 104 weeks, and then the animals were maintained until natural death. The study was conducted by the Ramazzini Foundation which uses their own testing guideline for carcinogenicity studies and not an internationally accepted guideline. Treatment with methanol did not decrease survival. However, there was considerable early mortality; by 18 months, 30% of the male controls had died. In females, there were no differences in survival between controls and treated groups. There was still more early mortality in the females than expected, but it was less pronounced than the males. There was no obvious effect of methanol exposure on water consumption. The 20,000 ppm males and females weighed more than the controls (up to 14% and 7%, respectively) throughout the study. The 5,000 ppm females also weighed more (4%) than the controls at 24 months, but not at earlier time points. There were no body weight differences between the remaining treatment groups and the controls. The calculated methanol doses based on water intake were: 0, 55, 542, and 1,840 mg/kg-day for males; and 0, 67, 630, and 2,250 mg/kg-day for females. Nearly all rats in all dose groups had some pathology in the lung. The finding of lung pathology was consistent regardless of the age at death (not an old age response). The lung pathology included inflammation, dysplasia, or tumours). Lung pathology was present in 70-100% of the first 10% of deaths in each group, including controls (70, 80, 80, 100% in males; and 90, 90, 100, 100% in females at 0, 500, 5,000, and 20,000 ppm). The degree of inflammation in the lungs is difficult to assess because no other lung information was recorded for the rats when a neoplasm in the lung was recorded (Soffritti et al., 2002; Cruzan, 2009; USEPA, 2013a). [Kl. score = 3]

### Inhalation

Cynomolgus monkeys or Sprague–Dawley rats were exposed by inhalation to 0, 500, 2,000, or 5,000 ppm (0, 660, 2,620, or 6,552 mg/m<sup>3</sup>) methanol for 6 h/day, 5 days/ week for 4 weeks. There was no mortality and no clinical signs of toxicity among the monkeys, but there a few signs of eye and nose irritation in the rats. No differences were seen between treated and control groups in body weight gain and organ weights, with the exception being decreased absolute adrenal weight in the 5,000 ppm female monkeys and increased relative spleen weights in the 2,000 ppm female rats. These changes were not considered by the authors to be of biological significance. There were no treatment-related effects on the ophthalmoscopy, gross pathology or histopathology. The NOAEL for this study is 5,000 ppm (6,552 mg/m<sup>3</sup>) (Andrews et al., 1987). [Kl. score = 4]

Groups of four male rats were exposed by inhalation to 0, 200, 2000, or 10,000 ppm (0, 262, 2,621, or 13,104 mg/m<sup>3</sup>) methanol for 6 hours/day, 5 days/week for 1, 2, 4, or 6 weeks. Additional groups of



animals were exposed for 6 weeks followed by a 6-week recovery period. Evaluation of a number of parameters including lung weights, surfactant levels, and enzyme activities did not reveal any adverse effects on the lung. No histopathological examinations were performed (White et al. 1983). [Kl. score = 2]

Male and female F344 rats were exposed by inhalation to 0, 10, 100, or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 104 weeks. The average methanol doses were: 0, 3.7, 37, and 369 mg/kg-day in males; and 0, 5.9, 60, and 599 mg/kg-day for females. There were no treatment-related clinical signs and no effect on survival or food consumption. Lower body weights were seen in the 1,000 ppm females beginning around day 259, but after day 574, there was no difference from controls. Body weights in males were similar across all groups. There were no treatment-related effects on urinalysis, hematology, or clinical biochemistry. Nor was there any treatment-related effects on organ weights or gross lesions. Histopathologic examination showed no statistically significant differences between treated and control animals (NEDO, 1985a). [Kl. score = 2]

Male and female B6C3F1 mice were exposed by inhalation to 0, 10, 100, or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 78 weeks. The average methanol doses were: 0, 9.8, 95, and 947 mg/kg-day in males; and 0, 8.1, 106, and 1,071 mg/kg-day for females. There were no treatment-related clinical signs and no effect on survival or body weight. Food consumption was decreased slightly between months 7 and 12 in the 1,000 ppm females. Urinalysis, hematology, and clinical biochemistry were similar across all groups. No differences were seen in organ weights, gross lesions, or histopathology between treated and control mice. (NEDO, 1985b). [Kl. score = 2]

### Dermal

No studies were identified.

## **G. Genotoxicity**

### In Vitro Studies

Methanol was not mutagenic to *Salmonella* strains TA97, TA98, TA100, TA1535, TA1537, and TA1538 in in vitro bacterial mutation assays with or without metabolic activation (De Flora et al., 1984a, b; Florin et al., 1980; Gocke et al., 1981). Equivocal results were obtained with *Salmonella* strain TA102 in the presence of metabolic activation (De Flora et al. 1984b). Methanol was not mutagenic in a DNA-repair test using various strains of *Escherichia coli* WP2 (De Flora et al. 1984a) and in a forward mutation assay using *Schizosaccharomyces pombe* (Abbondandolo et al. 1980).

Methanol did not induce micronuclei in Chinese hamster lung V79 cells in vitro (Lasne et al., 1984). Methanol was mutagenic in the mouse lymphoma assay in the presence of metabolic activation (McGregor et al., 1985), but it was not mutagenic in a Basc test or in a *Drosophila*, sex-linked, recessive lethal mutation assay (Gocke et al., 1981). Treatment of primary cultures of Syrian golden hamster embryo cells with methanol did not lead to cell transformation (Heidelberger et al., 1983).

### In Vivo Studies

Male C57BL/6J mice were exposed by inhalation 0, 800 or 4,000 ppm methanol, 6 hours/day for five days. There were no increased frequencies of micronuclei in blood cells; sister chromatid exchanges, chromosomal aberrations, or micronuclei in lung cells; or synaptosomal complex damage in spermatocytes (Campbell et al., 1991).

Normal or folate-deficient mice were given four daily intraperitoneal injections of up to 2,500 mg/kg of methanol. There was no increase in micronucleated erythrocytes in the treated mice compared to the controls (O'Loughlin et al., 1992).

Male and female NMRI mice were given a single intraperitoneal injection of 0, 1,920, 3,200, or 4,480 mg/kg methanol. There was no increase in micronuclei was observed in the bone marrow at any dose level (Gocke et al., 1981).

## **H. Carcinogenicity**

The carcinogenicity studies conducted on methanol were reviewed by Cruzan (2009) and by the USEPA (2013).

### Oral

Male and female SD rats were given in their drinking water 0, 500, 5,000, or 20,000 ppm methanol for 104 weeks. This study was conducted by the Ramazzini Foundation, which uses a unique methodology and not the standardised international testing guidelines. There was excessive early mortality, and lung pathology (inflammation, dysplasia, or tumours) was present in 87 to 94% of those dying anytime during the study. An increase in lympho-immunoblastic lymphomas was reported (Soffritti et al., 2002; Cruzan, 2009; USEPA, 2013). [Kl. score = 3]

### Inhalation

Male and female F344 rats were exposed by inhalation to 0, 10, 100, or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 104 weeks. The average methanol doses were: 0, 3.7, 37, and 369 mg/kg-day in males; and 0, 5.9, 60, and 599 mg/kg-day for females. There was no increase in tumours in the methanol-exposed rats and mice (NEDO, 1985a). [Kl. score = 2]

Male and female B6C3F1 mice were exposed by inhalation to 0, 10, 100, or 1,000 ppm methanol 19.5 hours/day, 7 days/week for 78 weeks. The average methanol doses were: 0, 9.8, 95, and 947 mg/kg-day in males; and 0, 8.1, 106, and 1,071 mg/kg-day for females. There was no increase in tumours in the methanol-exposed mice (NEDO, 1985b). [Kl. score = 2]

## **I. Reproductive Toxicity**

The reproductive and developmental toxicity studies were reviewed by the NTP Centre for Evaluation of Risks to Human Reproduction (NTP-CERHR, 2003). Conflicting results have been obtained concerning the effect of methanol on testicular hormones in rats; nevertheless, methanol does not appear to a male reproductive toxicant. The primate data indicates that methanol is unlikely to be a reproductive hazard in females. Methanol causes developmental effects at very high exposure levels in both rats ( $\geq 10,000$  ppm) and mice ( $\geq 2000$  ppm); there is also some evidence that it is a developmental neurotoxicant in rodents, but not in primates.

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for methanol 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).

### **A. Non-Cancer**

#### Oral

In 2013, the USEPA changed the oral Reference Dose (RfD) for methanol from 0.5 mg/kg-day to 2 mg/kg-day (USEPA, 2013a, b).

The 2 mg/kg-day was derived using data from the mouse developmental toxicity study by Rogers et al. (1993). In this study, pregnant female CD-1 mice were exposed to 0, 1,000, 2,000, 5,000, 7,500, 10,000, or 15,000 ppm methanol vapours for 7 hours/day on GD 6 to 15 and sacrificed on GD 17. There was no effect on clinical signs of toxicity or maternal body weight gain. Cervical ribs/litter were statistically significantly increased in the 2,000, 5,000 and 15,000 ppm groups. At >5,000 ppm, the incidences of cleft palates/litter and exencephaly/litter were increased significantly at all concentrations, with exception of exencephaly which did not increase significantly at 7,500 ppm. Live pups/litter were significantly reduced at >7,500 ppm, with a significant increase in fully resorbed litters at >10,000 ppm.

The incidence in cervical ribs/litter reported in this study was used to derive the oral RfD, using Benchmark dose (BMD) and physiologically-based pharmacokinetic (PBPK) modelling. The details of the derivation of the oral RfD can be found in the USEPA IRIS database (USEPA 2013a,b).

#### *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 = 2 L (ADWG, 2011)

Drinking water guidance value =  $(2 \times 70 \times 0.1)/2 = 7 \text{ mg/L}$

### **B. Cancer**

Methanol was not carcinogenic to rats or mice in chronic inhalation studies. Increased tumours from methanol in drinking water were reported by Soffritti et al. (2002); however, there are methodological problems with this study and questions have been raised about the validity of the results. No cancer reference value was derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Methanol is a highly flammable liquid.

It does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Methanol exhibits a low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants.

## B. Aquatic Toxicity

### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on methanol.

**Table 2: Acute Aquatic Toxicity Studies on Methanol**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill	96-hr LC <sub>50</sub>	15,400	1	Poirer et al. 1986
<i>Salmo gairdneri</i>	96-hr LC <sub>50</sub>	20,100	1	Call et al., 1983
<i>Pimphales promelas</i>	96-hr LC <sub>50</sub>	28,100	1	Call et al., 1983
<i>Daphnia magna</i>	96-hr EC <sub>50</sub>	18,260	2	Dorn et al., 2012; ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>10,000	2	Kuehn et al., 1989
<i>Selenastrum capricornutum</i>	96-hr EC <sub>50</sub>	~22,000	2	Cho et al., 2008; ECHA
<i>Chlorella pyrenoidosa</i>	10-14 d EC <sub>50</sub>	28,400	2	Stratton and Smith, 1988

### Chronic Studies

No adequate chronic studies were identified.

## C. Terrestrial Toxicity

The terrestrial toxicity studies on methanol are listed below in Table 3.

**Table 3: Terrestrial Toxicity Studies on Methanol**

Test Species (Method)	Endpoint	Results (mg/kg soil dw)	Klimisch score	Reference
Earthworm <i>Eisenia fetida</i> (OECD 222)	35-d EC <sub>50</sub> 63-d EC <sub>50</sub>	17,199 26,646	2	ECHA
<i>Folsomia candida</i> (OECD 232)	28-d EC <sub>25</sub> 28-d NOEC* (reproduction)	2,842 1,000	1	ECHA
<i>Hordeum vulgare</i> (OECD 208)	14-d EC <sub>50</sub> 14-d NOEC* (seedling emergence)	15,492 12,000	1	ECHA
	14-d EC <sub>25</sub> 14-d NOEC* (shoot dry mass)	2,538 1,555		
	14-d EC <sub>25</sub> 14-d NOEC* (root dry mass)	2,823 2,592		
	14-d EC <sub>25</sub> 14-d NOEC* (shoot length)	4,885 2,592		
	14-d EC <sub>25</sub> 14-d NOEC* (root length)	5,752 4,320		

\* Since only EC<sub>25</sub> values were available from the test results, NOECs were derived graphically from the representing treatment means.

#### D. Calculation of PNEC

The PNEC calculations for methanol follow the methodology discussed in DEWHA (2009).

##### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (15,400 mg/L), *Daphnia* (>10,000 mg/L), and algae (22,000 mg/L). There are no well-conducted long-term studies on methanol. Therefore, an assessment of 1,000 has been applied to the lowest reported effect concentration of 10,000 mg/L for *Daphnia*. The PNEC<sub>water</sub> is 10 mg/L.

##### PNEC sediment

There are no adequate toxicity studies on sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 6.3 mg/kg wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (K_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (0.81/1280) \times 1000 \times 10 \\ &= 6.3 \end{aligned}$$

Where:

$K_{\text{sed-water}}$  = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)

$\text{BD}_{\text{sed}}$  = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned} K_{\text{sed-water}} &= 0.8 + (0.2 \times K_{\text{P}_{\text{sed}}})/1000 \times \text{BD}_{\text{soilid}} \\ &= 0.8 + (0.2 \times 0.02)/1000 \times 2400 \\ &= 0.81 \end{aligned}$$

Where:

$K_{\text{p}}$  = solid-water partition coefficient (L/kg).

$\text{BD}_{\text{soilid}}$  = bulk density of the solid phase (kg/m<sup>3</sup>) = 2,400 [default]

$$\begin{aligned} K_{\text{p}} &= K_{\text{oc}} \times f_{\text{oc}} \\ &= 0.61 \times 0.04 \\ &= 0.02 \end{aligned}$$

Where:

$K_{\text{oc}}$  = organic carbon normalized distribution coefficient (L/kg). The  $K_{\text{oc}}$  for methanol in sediment is 0.61.

$f_{\text{oc}}$  = fraction of organic carbon suspended sediment = 0.04 [default].

##### PNEC soil

Experimental results from chronic studies are available for three trophic levels. The lowest NOEC is 1,000 mg/kg soil dry weight for the arthropod *Folsomia candida*. On the basis that the data consists of long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported long-term NOEC of 1,000 mg/kg soil dry weight. The PNEC<sub>soil</sub> is 100 mg/kg soil dry weight.

## VIII. PBT ASSESSMENT

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).

Methanol is readily biodegradable; therefore, it does not meet the screening criteria for persistence.

Based on experimental BCF of <10 in fish, methanol does not meet the criteria for bioaccumulation.

There are no adequate chronic toxicity studies on methanol. The acute E(L)C<sub>50</sub> of methanol is >0.1 mg/L in fish, invertebrates and algae; therefore, it does not meet the screening criteria for toxicity.

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

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Flammable Liquid Category 2  
Acute Toxicity Category 3 [Oral]  
Acute Toxicity Category 3 [dermal]  
Acute Toxicity Category 3 [inhalation]  
STOT SE Category 1 [optic nerve, central nervous system]

In the EU, there are concentration limits for the STOT SE classification of methanol. This may or may not apply to GHS classifications for Australian SDS.

Concentration range (%):

>10	STOT SE Category 1
>3 and <10	STOT SE Category 2

### B. Labelling

Danger

### C. Pictograms



The health hazard pictogram is omitted if the STOT SE classification for methanol does not apply. (i.e., concentration of methanol is below the concentration limits).

## X. SAFETY AND HANDLING

Methanol is used in the drilling mud product ALDACIDE® G ANTIMICROBIAL at a concentration of 0.1% to 1%. The safety and handling of methanol at this concentration in ALDACIDE® G

ANTIMICROBIAL will be provided in the dossier on glutaraldehyde, the major constituent of ALDACIDE® G ANTIMICROBIAL.

### Occupational Exposure Standards

The workplace exposure standard for methanol in Australia is 200 ppm (262 mg/m<sup>3</sup> as an 8-hr TWA and 250 ppm (328 mg/m<sup>3</sup>) as a 15-min STEL. There is also a skin notation indicating that absorption through the skin may be a significant source of exposure.

### **A. Transport Information**

Methanol is used drilling mud product ALDACIDE® G ANTIMICROBIAL at a concentration of 0.1 to 1%. The transportation information for ALDACIDE® G ANTIMICROBIAL will be provided in the dossier on glutaraldehyde, the major constituent of ALDACIDE® G ANTIMICROBIAL.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

Abbondandolo, A. et al. (1980). *Mutat. Res.* 79: 141 – 150.

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Andrews, L.S., Clary, J.J., Terrill, J.B., and Bolte, H.F. (1987). Subchronic inhalation toxicity of methanol. *J. Toxicol. Environ. Health* 20: 117-124.

BASF AG (1975). Unpublished data, (XXIV 436), 03 July 1975; cited in OECD-SIDS SIAR on Methanol.

BASF AG (1979). Unpublished data, (78/333), 11 April / 11 July 1979; cited in OECD-SIDS SIAR on Methanol.

BASF AG (1980a). Unpublished report, (80/158), 07 Aug. 1980; cited in OECD-SIDS SIAR on Methanol.

BASF AG (1980b). Unpublished report, (80/158), 20 Nov. 1980; cited in OECD-SIDS SIAR on Methanol.

Batterman, S.A., and Franzblau, A. (1997). Time-resolved cutaneous absorption and permeation rates of methanol in human volunteers. *Int. Arch. Occup. Environ. Health* 70: 341-351.

Call, D.J. et al. (1983). Toxicity and metabolism studies with EPA priority pollutants and related chemicals in freshwater organisms, EPA-600/3-83-095, PB83-263665.

- Campbell, J.A., Howard, D.R., Backer, L.C., Allen, J.W. (1991). Evidence that methanol does not induce chromosome damage in mice. *Mutat. Res.* 260 : 257-264.
- Cho, C.-W. et al. (2008). The ecotoxicity of ionic liquids and traditional organic solvents on microalga *Selenastrum capricornutum*. *Ecotoxicol. Environ. Saf.* 71: 166-171.
- Cruzan, G. (2009). Assessment of the cancer potential of methanol. *Crit. Rev. Toxicol.* 39: 347-363.
- 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.
- Deichman, W.B., and Mergard, E.G. (1948). *J. Ind. Hyg. Toxicol.* 30: 373 – 378.
- Dorn, N. et al. (2012). Discrepancies in the acute versus chronic toxicity of compounds with a designated narcotic mechanism. *Chemosphere* 87: 742-749.
- Dutkiewicz, B., Korczalik, H., and Karwacki, W. (1980). *Int. Arch. Occup. Environ. Health* 47: 81-88.
- ECHA. ECHA REACH database: <http://echa.europa.eu/information-on-chemicals/registered-substances>
- enHealth Human Risk Assessment (HHRA). (2012). Environmental Health RiskAssessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- De Flora, S. et al. (1984a). *Mutat. Res.* 133 : 161 – 198.
- De Flora, S. et al. (1984b). *Mutat. Res.* 134 : 159 – 165.
- Florin, I. et al. (1980). *Toxicol.* 18 : 219 – 232.
- Freitag, D., Lay, P. and Korte, F. (1985). Environmental Hazard Profile of Organic Chemicals: An experimental method for the assessment of the behaviour of organic chemicals in the ecosphere by means of simple laboratory tests with <sup>14</sup>C labelled chemicals. *Chemosphere*, 14: 1589-1616.
- Gluth, G. et al. (1985). Accumulation of pollutants in fish. *Comp. Biochem. Physiol.*, 81C: 273 – 277.
- Gocke, E et al. (1981). Mutagenicity of cosmetic ingredients licensed by the European Community. *Mutat. Res.* 90: 91 – 109.
- Hansch, C. and Leo, A.J. (1985). *Medchem. Project Issue No.26*, Claremont CA, Pomona College.
- Heidelberger, C. et al. (1983). *Mutat. Res.* 114 : 283 – 385.
- IPCS (1997). Environmental Health Criteria on Methanol 196, WHO, Geneva.



- Kavet, R., and Nauss, K.M. (1990). The toxicity of inhaled methanol vapors. *CRC Crit. Rev. Toxicol.* 20: 21 – 50.
- Kimura, E.T., Ebert, D.M., and Dodge, P.W. (1971). *Toxicol. Appl. Pharmacol.* 19: 699 – 703.
- 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.
- Kuehn, R. et al. (1989). *Water Research*, 23: 495-499.
- Lasne, C. et al. (1984.) *Mutat. Res.* 130: 273 – 282.
- Liesivuori, J., and Savolainen, H. (1991). *Pharmacol. Toxicol.* 69: 157 – 163.
- Lokke, H. (1984). Leaching of ethylene glycol and ethanol in subsoils. *Water, Air, and Soil Pollution* 22: 373-387.
- Malcolm Pirnie, Inc. (1999). Evaluation of the fate and transport of methanol in the environment, prepared for the American Methanol Institute, January; in OECD (2004a,b).
- McGregor, D.B et al. (1985). *Environ. Mutagen.* 7(Suppl. 3), A10.
- NEDO (1985a). 24-month inhalation carcinogenicity study on methanol in Fischer 344 rats (test no.: 5A-268), Report dated September 30, 1985, 10 volumes. Mitsubishi Kasei Institute for Toxicological and Environmental Sciences, Tokyo.
- NED( (1985b). 18-month inhalation carcinogenicity study on methanol in B6C3F1 mice (test no.: 4A-223), Report dated March 30, 1985, 9 volumes. Mitsubishi Kasei Institute for Toxicological and Environmental Sciences, Tokyo.
- NTP-CERHR (2003). NTP-CERHR Monograph on the Potential Human Reproductive and Developmental Effects of Methanol, Center for the Evaluation of Risks to Human Reproduction, National Toxicology Program, U.S. Department of Health and Human Services, NIH Publication, No. 03-4478.
- OECD (2004a). IUCLID Data Set for Methanol (CAS No. 67-56-1). Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89)
- OECD (2004b). Screening Information Dataset (SIDS) Initial Assessment Report for Methanol (CAS No. 67-56-1). Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=39B5D34A-2F5D-4D53-B000-E497B3A3EE89)
- O'Loughlin, K. et al. (1992). *Environ. Mutagen Soc.* 47 (Abstr.).
- Poirer S.H., Knuth, L.M., Anderson-Buchou, C.D. et al. (1986). Comparative toxicity of methanol and N,N-dimethylformamide to freshwater fish. *Bull. Environ. Contam. Toxicol.*, 37: 615-621.
- Rogers, J.M., Mole, M.L., Chernoff, N., Barbee, B.D., Turner, C.I., Logsdon, T.R., and Kavlock, R.J. (1993). The developmental toxicity of inhaled methanol in the CD-1 mouse, with quantitative dose-response modeling for estimation of benchmark doses. *Teratol.* 47: 175-188.

- Rowe, K., and McCollister, S.B. (1982). In: Patty's Industrial Hygiene and Toxicology, 3rd rev. ed. (G. D. Clayton and F. E. Clayton, eds.), pp. 4527-4708, Wiley, New York.
- Schuelplein, R.J., and Blank, I.H. (1971). *Physiol. Rev.* 51: 702-747.
- Smyth, H.F., Seaton, J., and Fisher, L. (1941). *J. Ind. Hyg. Toxicol.* 23: 259 – 268.
- Soffritti, M., Belpoggi, F., Cevolani, D., Guarino, M., Padovani, M., and Maltoni, C. (2002). Results of long-term experimental studies on the carcinogenicity of methyl alcohol and ethyl alcohol in rats. In: M.A. Mehlman (Ed.), *Carcinogenesis bioassays and protecting public health: commemorating the lifework of Cesare Maltoni and colleagues*, pp. 46-69, Bologna, Italy: Ann. N.Y. Acad. Sci.
- Stratton, G.W., and Smith, T.M. (1988). Interaction of organic solvents with the green alga *Chlorella pyrenoidosa*, *Bull. Environ. Contam. Toxicol.*, 40: 736-742.
- Tephly, T.R. (1991). The toxicity of methanol. *Life Sci.* 48: 1031 – 1041.
- USEPA. (1986). Rat Oral Subchronic Study on Methanol, U.S. Environmental Protection Agency, Washington, DC. Cited in the U.S. Integrated Risk Information System (IRIS) database for methanol (<https://www.epa.gov/iris>).
- USEPA. (2013a). Toxicological Review of Methanol (Noncancer) (CAS No. 67-56-1) in Support of Summary Information on the Integrated Risk Information System (IRIS). EPA/635/R-11/00FA U.S. Environmental Protection Agency, Washington, DC. Available at: [https://cfpub.epa.gov/ncea/iris/iris\\_documents/documents/toxreviews/0305tr.pdf](https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0305tr.pdf)
- USEPA. (2013b). Integrated Risk Information System (IRIS) Chemical Assessment Summary: Methanol (CASRN 67-56-1). Available at: [https://cfpub.epa.gov/ncea/iris/iris\\_documents/documents/subst/0305\\_summary.pdf](https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0305_summary.pdf)
- Wagner, R. (1976). *Vom Wasser* 47, 241-265.
- Welch, H., and Slocum, G.G. (1943). *J. Lab. Chem. Med.* 28: 1440.
- White, L.R., Marthinsen, A.B.L., Ricchard, R.J., Eik-Nes, K.B., and Nilsen, O.G. (1983). Biochemical and cytological studies of rat lung after inhalation of methanol vapor. *Toxicol. Lett.* 17: 1-5.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
BMD	benchmark dose
CERHR	Centre for Evaluation of Risks to Human Reproduction
CNS	central nervous system
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
FOB	functional observation battery
GHS	Globally Harmonised System of Classification and Labelling of Chemicals

HHRA	enHealth Human Risk Assessment
IRIS	Integrated Risk Information System
IUPAC	International Union of Pure and Applied Chemistry
kg/m <sup>3</sup>	kilogrammes per cubic metre
LOAEL	lowest observed adverse effect level
mg/cm <sup>2</sup> /hr	milligrams per square centimetre per hour
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
NPT	National Toxicology Program
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system
STOT SE	Specific Target Organ Toxicity - Single Exposure
THF	tetrahydrofolate
TLV	threshold limit value
USEPA	United States Environmental Protection Agency

## POLYALKYLENE

### [Polyalkylene Glycol Monobutyl Ether]

This dossier on polyalkylene or more specifically, polyalkylene glycol monobutyl ether, does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyalkylene glycol monobutyl ether in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

#### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Oxirane, methyl, polymer and oxibane, butyl ether

**CAS RN:** 9038-95-3

**Molecular formula:**  $C_4H_{10}O.(C_3H_6O.C_2H_4O)_x-$

**Molecular weight:** variable

**Synonyms:** Methyloxirane polymer with oxirane monobutyl ester; methyloxirane, polymer with oxirane, monobutyl ether; propylene oxide ethylene oxide polymer, monobutyl ether; polyalkylene glycol monobutyl ether; Tergitol nonionic XD; Tergitol XD (nonionic); Ucon 50-HB-2000; Ucon 50-HV-260; Ucon 50-HB-5100, Ucon fluid LB-285

**SMILES:** Not applicable

The Dow Chemical products that are polyalkylene glycol monobutyl ethers (CAS No. 9038-95-3) are the UCON™ 50-HB and SYNALOX™ branded products (Dow, 2014, Dow, 2015).

#### II. PHYSICO-CHEMICAL PROPERTIES

No information is available.

#### III. ENVIRONMENTAL FATE PROPERTIES

No studies are available.

The following information is from the Dow Chemical Company's Product Safety Assessment document on their lower molecular weight polyalkylene glycol monobutyl ether (CASRN 9038-95-3) branded products (Dow, 2014):

SYNALOX and UCON Butanol-Propylene Oxide-Ethylene Oxide Based Polyglycols are nonvolatile (do not readily evaporate). These products have varying degrees of water solubility, from partial soluble to 100% miscible. If released to the environment, they would migrate toward or remain in water and adsorb on soil, sediment, and suspended solids. These products have varying degrees of biodegradability, from slowly biodegradable to readily biodegradable. For the slowly biodegradable products in this family, they would likely degrade slowly in the environment, including degradation by physical action or upon exposure to sunlight. For the products that are readily biodegradable, they would be rapidly biodegradable in various environmental media. These products are expected to be removed by waste-treatment facilities by adsorption to biosolids or biodegradation. Because of their relatively high molecular weight, and/or high water solubility, SYNALOX and UCON Butanol-Propylene Oxide-Ethylene Oxide Based Polyglycols are not likely to accumulate in the food chain (bioconcentration is low)".

The following information is from the Dow Chemical Company's Product Safety Assessment document on their high molecular weight polyalkylene glycol monobutyl ether (CASRN 9038-95-3) branded products (Dow, 2015).

UCON™ 50-HB lubricants have low volatility (do not evaporate easily). Because they are water-soluble at room temperature, these lubricants will have the tendency to remain in water with minimal tendency to bind to soil or sediment. UCON™ 50-HB lubricants are unlikely to persist in the environment. These compounds are moderately biodegradable which suggests they will be removed from water and soil environments, including biological wastewater treatment plants. UCON™ 50-HB lubricants are not likely to accumulate in the food chain (their bioconcentration potential is low).

#### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

##### **A. Summary**

Polyalkylene glycol monobutyl ethers have low acute toxicity by the oral and inhalation routes. No irritation or sensitization studies are available for these polymers. No systemic toxicity or carcinogenicity was observed in rats given high oral doses of polyalkylene glycol monobutyl ether polymers for up to two years. Respiratory effects indicative of irritation and inflammation were seen in rats that inhaled a high concentration of an aerosol or dust of these polymers over a two-week period. No studies are available to evaluate genotoxicity, reproductive or developmental toxicity.

##### **B. Acute Toxicity**

The oral LD<sub>50</sub> values for UCON® 50-HB-260 were: 7,070 mg/kg for a 90-120 g male rat; 5,950 mg/kg for a 120-170 g male rat; 8,570 mg/kg for a 90-120 g female rat; 4,490 for a 300-400 g female rat; 7,460 mg/kg for a 23-36 g female mouse; and 1,770 mg/kg for a 2,200-2900 g male rabbit (Smyth et al., 1970).

The oral LD<sub>50</sub> values for UCON® 50-HB-5100 were: >64,000 mg/kg in male rats; 45,200 mg/kg in female rats; 49,400 mg/kg in female mice; and 15,800 mg/kg in male rabbits (Smyth et al., 1970).

The oral LD<sub>50</sub> values for UCON® 50-H-2005 were: 14,100 mg/kg in male rats; 35,900 mg/kg in female rats; 22,600 mg/kg in female mice; and 35,600 mg/kg in male rabbits (Smyth et al., 1970).

The oral LD<sub>50</sub> values for UCON® 75-H-1400 were: >64,000 mg/kg in male rats; >16,000 mg/kg in female rats; 45,200 mg/kg in female mice; and 35,400 mg/kg in male rabbits (Smyth et al., 1970).

Rats, mice, guinea pigs, and hamsters were exposed by inhalation to 0, 50, 100, 200, or 500 mg/m<sup>3</sup> UCON-50-HB-5100 [polyalkylene glycol monobutyl ether] for 4 hours. Exposures resulted in the death of mice and rats exposed at  $\geq 100$  mg/m<sup>3</sup>. Guinea pigs died at  $\geq$  mg/m<sup>3</sup>, while hamsters died only at 500 mg/m<sup>3</sup>. The exposures resulted in some delayed mortalities in rodents, apparently the result of pulmonary congestion, oedema, haemorrhage, and inflammation; these were considered to be the major factors causing the deaths of the animals. The most sensitive species appeared to be mice and rats, followed in descending order by guinea pigs, and hamsters. Median lethal concentrations were 147 mg/m<sup>3</sup> for rats, 174 mg/m<sup>3</sup> for mice, 293 mg/m<sup>3</sup> for guinea-pigs, and 511 mg/m<sup>3</sup> for hamsters (Hoffman et al., 1991).

##### **C. Irritation**

No studies are available.

**D. Sensitisation**

No studies are available.

**E. Repeated Dose Toxicity**Oral

A two-year rat dietary study was conducted on four different water-soluble UCON® fluids (polyalkylene glycol monobutyl ethers). The UCON® fluids and doses were: 4, 20, 100, and 500 mg/kg 50-HB-260; 20, 100, and 500 mg/kg 50-HB-5100; 20, 100, and 500 mg/kg 25-H-2005; 100 and 500 mg/kg 75-H-1400. Female rats consuming 500 mg/kg 25-H-2005 grew less than did the controls. Other than this effect, there were no statistically significant differences between treated and control animals for behaviour, feed consumption, mortality, life span, the incidence of infections, final liver and kidney relative to body weights, body weight gain, haematocrit, total RBC count, and histopathology. The overall NOAEL for these UCON® fluids (polyalkylene glycol monobutyl ethers) is 500 mg/kg-day (Smyth et al., 1970).

Inhalation

SD rats were exposed by inhalation to 0 or 100 mg/m<sup>3</sup> UCON-50-HB-2000 or UCON-50-HB-5100 6 hours/day, 5 days/week over a two-week period. Separate groups of rats were exposed for two weeks followed by a two-week recovery period. A mortality rate of >50% was seen in rats exposed to UCON-50-HB-2000 or UCON-5-HB-5100. The UCON-50-HB-2000 exposed animals had decreased body weights, lethargy, soft stools, and prolapsed penises. Alveolar inflammation and prefibrotic changes were seen in the UCON-50-HB-5100 and UCON-50-HB-2000 exposed animals; there were also a few cases of laryngeal oedema and laryngeal epithelial hyperplasia. The treatment-related deaths were attributed to alveolitis with pulmonary oedema (Ulrich et al., 1992).

Dermal

No studies are available.

**F. Genotoxicity**

No studies are available.

**G. Carcinogenicity**Oral

A two-year rat dietary study was conducted on four different water-soluble UCON® fluids (polyalkylene glycol monobutyl ethers). The UCON® fluids and doses were: 4, 20, 100, and 500 mg/kg 50-HB-260; 20, 100, and 500 mg/kg 50-HB-5100; 20, 100, and 500 mg/kg 25-H-2005; 100 and 500 mg/kg 75-H-1400. There was no increased incidence of tumours in the treated rats compared to the controls (Smyth et al., 1970).

**H. Reproductive Toxicity**

No studies are available.

**I. Developmental Toxicity**

No studies are available.

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for the polyalkylene glycol monobutyl ether 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).

### A. Non-Cancer

#### Oral

Smyth et al., (1970) conducted two-year dietary studies on five different polyalkylene glycol monobutyl ether polymers. Although the composition and physico-chemical properties of the polymers were not provided in the published paper, it can be assumed that the polymers cover a range of molecular weights. Of these five polymers, the only effect noted was that the female rats fed 500 mg/kg-day 25-H-2005 (the highest dose) grew less than the controls. The amount of reduced growth was not provided in the paper; this effect was not seen in females fed the equivalent dose for the other polyalkylene glycol monobutyl ethers, nor in any of the treated males. It is likely that the reduced growth in the high-dose females fed 25-H-2005 is a spurious finding and not reflective of oral exposure to polyalkylene glycol monobutyl ethers in general. Thus, the overall NOAEL for this group of studies is 500 mg/kg-day. The NOAEL of 500 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 4 / (10 \times 10 \times 1 \times 1 \times 1) = 500 / 100 = \underline{5 \text{ mg/kg-day}}$$

#### *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 = 2 L (ADWG, 2011)

Drinking water guidance value =  $(5 \times 70 \times 0.1) / 2 = \underline{18 \text{ mg/L}}$



## B. Cancer

The polyalkylene glycol monobutyl ethers were not carcinogenic to rats in chronic dietary studies. Therefore, no cancer reference value was derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Polyalkylene glycol monobutyl ethers do not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

No studies are available. These products are practically nontoxic ( $EC_{50}/LC_{50} > 100$  mg/L in the most sensitive species tested) to aquatic organisms on an acute basis.

### B. Aquatic Toxicity

#### Acute Studies

No studies are available. The following information is from the Dow Chemical Company's Product Safety Assessment document on their low molecular weight polyalkylene glycol monobutyl ether (CASRN 9038-95-3) branded products (Dow, 2014); it also applies to their high molecular weight branded products (Dow, 2015):

[Polyalkylene glycol monobutyl ethers] are practically non-toxic to aquatic organisms ( $LC_{50}/EC_{50} > 100$  mg/L for the most sensitive species tested) on an acute basis.

### C. Terrestrial Toxicity

No studies are available.

### D. Calculation of PNEC

The PNEC calculations for the polyalkylene glycol monobutyl ethers follow the methodology discussed in DEWHA (2009).

#### PNEC water

No experimental studies were found. However, Dow Chemical's Product Safety Assessment document on their polyalkylene glycol monobutyl ethers indicate that acute toxicity testing has been conducted on these products and the  $LC_{50}/EC_{50}$  value for the most sensitive species is  $> 100$  mg/L. On the basis of the short-term results, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 100 mg/L. The  $PNEC_{water}$  is 0.1 mg/L.

#### PNEC sediment

A  $PNEC_{sed}$  was not calculated for the polyalkylene glycol monobutyl ethers. There are no experimental toxicity data on sediment organisms, and a  $K_{oc}$  value for polyalkylene glycol monobutyl ethers is unavailable for calculating the  $PNEC_{sed}$  using the equilibrium partition method. A  $K_{oc}$  value for the



polyalkylene glycol monobutyl ethers has not been determined experimentally, and QSAR models are invalid for these high molecular weight polymers.

#### PNEC soil

A PNEC<sub>soil</sub> was not calculated for the polyalkylene glycol monobutyl ethers. There are no experimental toxicity data on soil organisms, and a K<sub>oc</sub> value for polyalkylene glycol monobutyl ethers is unavailable for calculating the PNEC<sub>soil</sub> using the equilibrium partition method. A K<sub>oc</sub> value for the polyalkylene glycol monobutyl ethers has not been determined experimentally, and QSAR models are invalid for these high molecular weight polymers.

### **VIII. PBT ASSESSMENT**

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).

The polyalkylene glycol monobutyl ethers can range from readily biodegradable to slowly biodegradable; thus, some of the polymers will not meet the screening criteria for persistence.

The polyalkylene glycol monobutyl ethers are expected to have high molecular weights and are not expected to be bioavailable. Thus, these polymers do not meet the criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on the polyalkylene glycol monobutyl ethers. However, the acute E(L)C<sub>50</sub> on these polymers are >0.1 mg/L in aquatic organisms based on Dow Chemical's Product Safety Assessment (Dow, 2014; 2015). The polyalkylene glycol monobutyl ethers also have a high molecular weight and are not expected to be bioavailable. Thus, they do not meet the screening criteria for toxicity.

The overall conclusion is that polyalkylene glycol monobutyl ethers are not PBT substances.

### **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

#### **A. Classification**

Not classified.

#### **B. Labelling**

No signal word.

#### **C. Pictograms**

None.

### **X. SAFETY AND HANDLING**

#### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) on GEM™ CP (revision date 07-Feb-2013).

### Eye Contact

In the case of contact or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Does not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS on GEM™ CP (revision date 07-Feb-2013).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS on GEM™ CP (revision date 07-Feb-2013).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS on GEM™ CP (revision date 07-Feb-2013).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Slippery when wet.

### Storage

Information on storage and handling was obtained from the Halliburton SDS on GEM™ CP (revision date 07-Feb-2013).

## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for polyalkylene glycol monobutyl ether (CAS No. 9038-95-3).

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None known.

## **F. Transport Information**

Polyalkylene glycol monobutyl ethers are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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.

Dow Chemical Company (Dow). (2014). SYNALOX™ and UCON™ Butanol-Propylene Oxide-Ethylene Oxide Based Polyglycols, created August 8, 2014. Available at: [http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh\\_091c/0901b8038091cfda.pdf?filepath=productsafety/pdfs/noreg/233-01179.pdf&fromPage=GetDoc](http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh_091c/0901b8038091cfda.pdf?filepath=productsafety/pdfs/noreg/233-01179.pdf&fromPage=GetDoc)

Dow. (2015). UCON™ Lubricants (High Molecular Weight) UCON™ Lubricants 50-HB-2000, -3520, -5100, revised December 17, 2015. Available at: [http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh\\_094e/0901b8038094e66e.pdf?filepath=productsafety/pdfs/noreg/233-00320.pdf&fromPage=GetDoc](http://SDSsearch.dow.com/PublishedLiteratureDOWCOM/dh_094e/0901b8038094e66e.pdf?filepath=productsafety/pdfs/noreg/233-00320.pdf&fromPage=GetDoc)

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

Hoffman, G.M., Newton, P.E., Thomas, W.C., Birnbaum, H.A., and Kennedy, G.L., Jr. (1991). Acute inhalation toxicity studies in several animal species of an ethylene oxide propylene oxide copolymer UCON 50-HV-1500. *Drug Chem. Toxicol.* 14: 243-256.

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.

Smyth, H.F., Jr., Weil, C.S., King, J.M., Knaak, J.B., Sullivan, L.J., and Carpenter, C.P. (1970). Oral toxicity and excretion of four commercial polyoxyalkylene glycol compounds. *Toxicol. Appl. Pharmacol.* 16: 675-680.

Ulrich, C.E., Geil, G., Tyler, R.R., Kennedy, G.L., and Birnbaum, H.A. (1992). Two-week aerosol inhalation study in rats of ethylene oxide/propylene oxide copolymers. *Drug Chem. Toxicol.* 15: 269-270.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
Dow	Dow Chemical Company
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system

## POLYPROPYLENE GLYCOL

This dossier on polypropylene glycol does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polypropylene glycol in its use in drilling muds and hydraulic fracturing fluids. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA) and on a Cosmetics Ingredient Review (CIR) on polypropylene glycol (Andersen, 1994). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Propane-1,2-diol, propoxylated

**CAS RN:** 25322-69-4

**Molecular formula:**  $(C_3H_6O)_n \cdot H_2O$

**Molecular weight:** Variable

**Synonyms:** Propane-1,2-diol propoxylated; polyoxypropylene; oxirane, methyl-, homopolymer; propylene oxide homopolymer; propylene oxide, propylene glycol polymer; poly[oxy(methyl-1,2-ethanediyl)], alpha.-hydro.-omega.-hydroxy-; alpha-hydro-omega-hydroxypoly(oxy(methyl-1,2-ethanediyl)); alpha-hydro-omega-hydroxypoly(oxypropylene)

Polypropylene glycol is a polymer of propylene oxide, with a minimal of three propylene oxide units.

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-chemical Properties of Selected Polypropylene Glycols**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear, colourless, viscous liquid	4	ECHA
Melting Point*	< -150°C	1	ECHA
Boiling Point*	287°C	1	ECHA
Density*	1.012 @ 20°C	1	ECHA
Vapour Pressure**	8.39 x 10 <sup>-4</sup> @ 20°C 1.35 x 10 <sup>-3</sup> @ 25°C	1	ECHA
Partition Coefficient (log Pow)***	<0.3 to 0.9 (measured)	1	ECHA
Water Solubility*	miscible	1	ECHA
Flash Point*	151°C	1	ECHA
Auto flammability*	305°C	1	ECHA
Viscosity**	78.34 mPa s @ 20°C 27.37 mPa s @ 20°C	1	ECHA
Henry's Law Constant	-	-	-

\*Polypropylene glycol (MW 260)

\*\*Polypropylene glycol (MW 250)

### **III. ENVIRONMENTAL FATE PROPERTIES**

#### **A. Biodegradation**

In an OECD 301F test, polypropylene glycol (identified as Polyol PD 230, MW 260) was degraded 2.1% after 7 days; 60.6% after 14 days; and 86.6% after 28 days. It is considered readily biodegradable (ECHA). [Kl. score = 1]

#### **B. Environmental Distribution**

##### Adsorption/desorption

In an OECD TG 121 test, the Koc of polypropylene glycol (identified as Polyol PD 230, MW 260) was determined to be <17.8. The test material showed weak surface-active properties; it is also a UVCB mixture of homologous components. So, the analytical method may have produced results that are confounded by these properties (ECHA). [Kl. score = 2]

#### **C. Bioaccumulation**

No experimental studies are available. Based on the octanol-water partition coefficient (Pow) of <0.3 to 0.9, polypropylene glycols are not expected to be bioaccumulative.

### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

#### **D. Summary**

The acute oral toxicity of polypropylene glycols varies from moderately to non-toxic, depending on the molecular (toxicity decreases with increasing molecular weight). These substances are non-toxic by the dermal route. Polypropylene glycols are not skin and eye irritants; nor are they skin sensitizers. Repeated dose toxicity studies showed minimal systemic toxicity in rats given oral doses or rabbits given dermal applications of polypropylene glycols. These substances are not genotoxic. In a screening study, no reproductive or developmental effects were seen in rats dosed orally with a substance that is structurally related to polypropylene glycols.

#### **E. Acute Toxicity**

Acute oral toxicity studies on PPGs of various molecular weights (300 to 3,900) have indicated LD50 values (rats) ranging from 500 to >40,000 mg/kg (Andersen, 1994).

In acute dermal toxicity studies, doses of PPG 1025 (20 mL/kg) and PPG 2025 (20 mL/kg) did not cause death to rabbits. Two of five rabbits dosed with 20 mL/kg PPG 425 and one of five dosed with 10 mL/kg PPG 425 died (Andersen, 1994).

No acute inhalation studies on polypropylene glycol were identified.

#### **F. Irritation**

Skin irritation was not noted after PPG 425, PPG 1025, or PPG 2025 was applied once to the skin of rabbits or when applied a total of eight times to the same area within 4 hours (Andersen, 1994).

PPGs 425, 1025, and 2025 were classified as harmless agents in rabbits in another ocular irritation study; PPG 1200 induced slight, transient ocular irritation in an albino rabbit (Andersen, 1994).

## G. Sensitisation

Polypropylene glycol (MW 260) was considered a non-sensitiser in a mouse local lymph node assay (LLNA) (ECHA). Neither skin irritation nor sensitization reactions were observed in 300 human subjects who received continuous and repeated dermal applications of undiluted PPG 2000.

## H. Repeated Dose Toxicity

### Oral

PPG 2000 was administered to rats over a period of 100 days. Concentrations of 0.1, 0.3, 1.0, and 3.0% were administered in oral doses of 50 to 1,500 mg/kg-day. There were no adverse effects noted at concentrations of 0.1 to 1.0%. Slight decreases in growth were observed after the administration of 3% PPG 2000. The NOAEL is 1% (500 mg/kg-day) in the diet (Andersen, 1994).

In a 90-day study, PPG 2000 was administered orally to rats in doses ranging from 275 to 501 mg/kg-day. There was no evidence of adverse histopathologic, hematologic, or clinical chemistry effects in any of the animals tested. Body weight effects (not specified) were noted at the highest dose tested. The NOAEL is ~500 mg/kg-day (Andersen, 1994).

PPG 750 was administered to rats over a period of 100 days. Concentrations of 0.1 and 1% were administered at doses of 50 and 500 mg/kg-day. PPG 750 (0.1%) did not induce any adverse effects. However, in the group dosed with 1% PPG 750, there was a slight increase in liver and kidney weights; there were no histological changes. Neither of the doses resulted in a central nervous system stimulatory effect. The NOAEL is 500 mg/kg-day (Andersen, 1994).

A rat 28-day oral gavage study was conducted on triethanolamine, propoxylated (CAS No. 37208-53-0), a structurally related substance to polypropylene glycol. Male and female Wistar rats were dosed with 0, 100, 300, or 1,000 mg/kg-day. There were no treatment-related deaths and no clinical signs of toxicity. Haematological and clinical chemistry parameters measured in the study were similar across all groups. There were no gross necropsy or histopathological changes that were considered to be treatment-related. The NOAEL for this study is 1,000 mg/kg-day (ECHA). [Kl. score = 1]

### Inhalation

No studies are available.

### Dermal

PPG-2000, at doses of 1, 5, or 10 ml/kg, was applied to the skin of rabbits 24 hours/day, 5 days/week for three months. It was reported that there was a slight reduction in growth in the 5 and 10 ml/kg groups; no effects were seen at 1 ml/kg (Andersen, 1994).

## I. Genotoxicity

### In Vitro Studies

Polypropylene glycol (MW 260) was not mutagenic to *S. typhimurium* strains TA1535, TA1537, TA102, TA98, and TA100 in the absence or presence of metabolic activation (ECHA).

### In Vivo Studies

No studies are available.



## J. Reproductive/Developmental Toxicity

No studies are available on polypropylene glycol.

A reproductive and developmental screening toxicity study (OECD 421) was conducted on triethanolamine, propoxylated (CAS No. 37208-53-0), a structurally related substance to polypropylene glycol. Male and female Wistar rats were dosed by oral gavage with doses of 0, 100, 300, or 1,000 mg/kg-day. Transient salivation was noted in the high-dose parental animals. There were marginal body weight gains in females in all dose groups during the pre-mating period, and a slight body weight loss in the high-dose females during lactation. There were no reproductive or developmental effects that were considered treatment-related. The NOAEL for reproductive and developmental toxicity is 1,000 mg/kg-day (ECHA). [Kl. score = 1]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for polypropylene glycol 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).

### A. Non-Cancer

#### Oral

Several rat subchronic toxicity studies conducted on polypropylene glycol showed an NOAEL of 1% polypropylene glycol in the diet (500 mg/kg-day). In one study, it was reported that there was a slight increase in liver and kidney weights, but no data was provided to determine if the change in organ weights were statistically significant. Nevertheless, these organ weight changes may not be considered adverse since there were no accompanying histopathologic changes. No adverse effects were seen in rats given oral doses of up to 1,000 mg/kg-day for four weeks of a substance that is structurally similar to polypropylene glycol.

The NOAEL of 500 mg/kg-day from the polypropylene glycol studies will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 500 / (10 \times 10 \times 1 \times 1 \times 1) = 500 / 100 = \underline{0.5 \text{ mg/kg-day}}$$

#### *Drinking water guidance value*

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

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 =  $(0.5 \times 70 \times 0.1) / 2 = 2 \text{ mg/L}$

## B. Cancer

No carcinogenicity studies were located. Therefore, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Polypropylene glycol does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Polypropylene glycol is low toxicity concern to aquatic organisms.

### B. Aquatic Toxicity

Table 2 lists the results of acute aquatic toxicity studies conducted on polypropylene glycol.

**Table 2: Acute Aquatic Toxicity Studies on Polypropylene Glycol**

Test Species	Endpoint	Results (mg/L)	Kl. score	Reference
<i>Danio rerio</i>	96-hr LC <sub>50</sub>	>100	1	ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	105.8	1	ECHA
<i>Desmodesmus subspicatus</i>	72-hour EC <sub>50</sub>	>100	1	ECHA

### Chronic Studies

No studies on polypropylene glycol are available.

There is a chronic *Daphnia* reproduction study on D-glucitol, propoxylated (CAS No. 52625-13-5), with an MW of 600. The 21-day NOEC from this study is >10 mg/L (ECHA).

### C. Terrestrial Toxicity

No studies are available.

## D. Calculation of PNEC

The PNEC calculations for polypropylene glycol follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute  $E(L)C_{50}$  values are available for fish ( $>100$  mg/L), *Daphnia* (105.8 mg/L), and algae ( $>100$  mg/L). The only chronic toxicity study on polypropylene glycol is an algal study. However, a chronic *Daphnia* study has been conducted on D-glucitol, propoxylated (CAS No. 52625-13-5), a structurally similar substance to polypropylene. On the basis of the short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported effect concentration of 10 mg/L for invertebrates. The  $PNEC_{water}$  is 0.2 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the  $PNEC_{sed}$  was calculated using the equilibrium partitioning method. The  $PNEC_{sed}$  is 0.18 mg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{sed} &= (K_{sed-water}/BD_{sed}) \times 1000 \times PNEC_{water} \\ &= (1.14/1280) \times 1000 \times 0.2 \\ &= 0.18 \end{aligned}$$

Where:

$K_{sed-water}$  = suspended matter-water partition coefficient ( $m^3/m^3$ )

$BD_{sed}$  = bulk density of sediment ( $kg/m^3$ ) = 1,280 [default]

$$\begin{aligned} K_{sed-water} &= 0.8 + (0.2 \times K_{psed})/1000 \times BD_{solid} \\ &= 0.8 + (0.2 \times 0.71/1000 \times 2400) \\ &= 1.14 \end{aligned}$$

Where:

$K_{psed}$  = solid-water partition coefficient (L/kg).

$BD_{solid}$  = bulk density of the solid phase ( $kg/m^3$ ) = 2,400 [default]

$$\begin{aligned} K_{psed} &= K_{oc} \times f_{oc} \\ &= 17.8 \times 0.04 \\ &= 0.71 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for polypropylene glycol is 17.8.

$f_{oc}$  = fraction of organic carbon in sediment = 0.04 [default].

### PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the  $PNEC_{soil}$  was calculated using the equilibrium partitioning method. The  $PNEC_{soil}$  is 0.05 mg/kg soil dry weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{soil} &= (K_{psoil}/BD_{soil}) \times 1000 \times PNEC_{water} \\ &= (0.36/1500) \times 1000 \times 0.2 \\ &= 0.05 \end{aligned}$$

Where:

$K_{p_{soil}}$  = soil-water partition coefficient ( $m^3/m^3$ )

$BD_{soil}$  = bulk density of soil ( $kg/m^3$ ) = 1,500 [default]

$$K_{p_{soil}} = K_{oc} \times f_{oc}$$

$$= 17.8 \times 0.02$$

$$= 0.36$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for polypropylene glycol is 17.8.

$f_{oc}$  = fraction of organic carbon in soil = 0.02 [default].

## VIII. PBT ASSESSMENT

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).

Polypropylene glycol is readily biodegradable; therefore, it does not meet the screening criteria for persistence.

Based on octanol-water partition coefficient ( $\log Pow$ ) of <0.3 to 0.9, polypropylene glycol does not meet the screening criteria for bioaccumulation.

There are no chronic toxicity studies on polypropylene glycol. The acute  $E(L)C_{50}$  of polypropylene glycol is >0.1 mg/L in fish, invertebrates, and algae. Also, an NOEC from the structurally similar substance (D-glucitol, propoxylated) is >0.1 mg/L. Therefore, it does not meet the screening criteria for toxicity.

The overall conclusion is that polypropylene glycol is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Not classified.

### B. Labelling

No signal word.

### C. Pictograms

None.

## X. SAFETY AND HANDLING

### A. First Aid

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) for BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Fire Fighting Information**

Firefighting information was obtained from the Halliburton SDS for BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS for BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS for BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid breathing mist. Avoid breathing vapours.

### Storage

Store away from oxidizers. Store away from acids. Store away from alkalis. Keep container closed when not in use. Product has a shelf life of 60 months

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for polypropylene glycol

The information below on exposure controls and personal protection was obtained from the Halliburton SDS for BARA-DEFOAM® HP (revision date: 03-Jan-2012).

### Engineering Controls

Use in a well-ventilated area. Local exhaust ventilation should be used in areas without good cross ventilation.

### Personal Protection Equipment

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended. Organic vapour respirator with a dust/mist filter.

*Hand Protection:* Impervious rubber gloves. Polyvinyl chloride gloves. Neoprene gloves.

*Skin Protection:* Rubber apron.

*Eye Protection:* Chemical goggles; also wear a face shield if splashing hazard exists.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

Polypropylene glycol is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Andersen F.A. (1994) Final report on the safety assessment of propylene glycol and polypropylene glycols. *Int. J. Toxicol.* 13: 437- 491.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

## **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
CIR	Cosmetics Ingredient Review
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LLNA	local lymph node assay
mg/kg	milligrams per kilogram

mg/L	milligrammes per litre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
RfD	oral Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
UVCB	unknown or variable composition, complex reaction product, or biological origin



## POTASSIUM CHLORIDE

This dossier on potassium chloride does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of potassium chloride in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on potassium chloride (OECD, 2001a, b) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Potassium chloride

**CAS RN:** 7747-40-7

**Molecular formula:** K-Cl

**Molecular weight:** 74.55

**Synonyms:** Potassium chloride

**SMILES:** [Cl-] [K+]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Potassium Chloride**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid; white crystals	2	ECHA
Melting Point	770°C	1	ECHA
Boiling Point	1,407°C	2	OECD, 2001a,b
Density	1.984 g/cm <sup>3</sup>	2	ECHA
Vapour Pressure	5.73 hPa @ 906°C	2	OECD, 2001a,b
Partition Coefficient (log Pow)	-	-	-
Water Solubility	255 g/L @ 25°C	2	Lide, 2009; ECHA

### III. ENVIRONMENTAL FATE PROPERTIES

Potassium chloride (KCl) dissociates completely in aqueous solutions to potassium (K<sup>+</sup>) and chloride (Cl<sup>-</sup>) ions. Potassium chloride and its dissociated ions are ubiquitous in the environment.

The transport and/or leaching of potassium (K<sup>+</sup>) and chloride (Cl<sup>-</sup>) ions is affected by clay minerals (type and content), pH, and organic matter. Potassium ions are less mobile and less prone to leaching than anions in soil, such as chloride and nitrate (NO<sub>3</sub><sup>-</sup>). Chloride binds only weakly to soil particles, and therefore follows water movement (OECD, 2001b).

Potassium (K<sup>+</sup>) and chloride (Cl<sup>-</sup>) ions are essential to all living organisms, and their intracellular and extracellular concentrations are actively regulated (OECD, 2001b; Ganong, 1995). Neither potassium chloride or its dissociated ions are expected to bioaccumulate.

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

Potassium chloride is not acutely toxic by the oral route. It is not a skin or eye irritant. Long-term studies in rat fed potassium chloride showed no toxicity or carcinogenic effects. Potassium chloride has shown some genotoxic effects *in vitro* assays; these occurred at high concentrations of potassium chloride and is thought to be due to a disruption of osmotic balance of the cells. No *in vivo* genotoxicity studies have been conducted on potassium chloride. There were no developmental effects in pregnant female rats and mice given potassium chloride in their feed.

### B. Toxicokinetics and Metabolism

Potassium chloride dissociates completely in aqueous solutions to potassium ( $K^+$ ) and chloride ( $Cl^-$ ) ions. Potassium is an essential nutrient: it has a number of critical roles, one of which is that it is the principal cation involved in maintaining the osmotic balance of bodily fluids (Ganong, 1995). Both potassium and chloride ions are involved in regulating the acid-base balance of the body (Ganong, 1995).

### C. Acute Toxicity

The oral  $LD_{50}$  in rats was reported to be 3,020 mg/kg (Boyd and Shanas, 1961). [Kl. score = 2]

No acute toxicity studies by the dermal or inhalation route were identified.

### D. Irritation

Potassium chloride did not produce an irritant response in an *in vitro* skin irritation (OECD TG 439) test (ECHA). [Kl. score = 1]

Potassium chloride did not produce an irritant response in an *in vitro* eye irritation test (ECHA). [Kl. score = 2]

### E. Sensitisation

No studies were identified

### F. Repeated Dose Toxicity

#### Oral

Male F344/Slc rats were given 0, 0.25, 1, 5, or 5% potassium chloride in their feed for two years. The mean daily intake was calculated to be 0, 110, 450, or 1,820 mg/kg-day, respectively. At the end of the study, survival rates were 48%, 64%, 58%, and 84% in the respective dose groups. Nephritis was predominant in all groups, including the controls. The only treatment-related effect was gastritis (inflammation of the stomach lining). The incidence of gastritis and ulcers were 6%, 18%, 18%, and 30% in the 0, 110, 450, and 1,820 mg/kg-day groups, respectively. The gastritis was thought to be indicative of a localised effect due to the irritating nature of the test material. The NOAEL for systemic effects is 1,820 mg/kg-day, the highest dose tested. (Imai et al., 1968; OECD 2001a,b). [Kl. score = 2]

Male and female Wistar rats were fed diets containing 0 or 3% potassium chloride over a total period of 30 months. Due to the reduction of feed intake the mean test substance intake and mean body weight decreased in time. The mean daily intake of potassium chloride was not calculated. There was hypertrophy of the zona glomerulosa in the adrenals (24/50 treated rats versus 4/50 in controls); and

cystitis in the urinary bladder (males: 3/59; females 3/50) and single epithelial hyperplasia of the bladder (males 3/50; females 2/50) (Lina and Kuijpers, 2004). [Kl. score = 2]

#### Inhalation

No studies were identified.

#### Dermal

No studies were identified.

### **G. Genotoxicity**

#### In vitro Studies

Potassium chloride was not mutagenic to *Salmonella typhimurium* strains TA100, TA 1535, TA 1537 and TA 98 strains in an in vitro bacterial mutation assay in the absence or presence of metabolic activation (Mortelmans et al., 1986).

Potassium chloride was weakly mutagenic in two separate L5178Y mouse lymphoma assays (Myhr and Caspary, 1988; Mitchell et al., 1988). It was mutagenic at 4,000 and 5,000 µg/ml in the presence of metabolic activation in one study, and mutagenic at 7,000 µg/ml in the absence of metabolic activation. The authors stated that these responses are due to high salt concentrations which affect the ionic balance and osmotic pressure of the medium, inducing mutations in cells surviving the treatment.

Potassium chloride induced a significant increase in chromosomal aberrations in Chinese Hamster lung fibroblasts (V79) cells only at the highest test dose (12,000 µg/ml) in the absence of a metabolic activation system. Measurements of the osmotic pressure of the medium showed a two-fold increase at this test compound concentration when compared to the normal medium (530 mOsmol/kg versus 253 mOsmol/kg) (OECD, 2001b).

There are two other reports on the effect of potassium chloride on the formation of chromosome aberrations in Chinese hamster ovary cells (CHO). In these studies potassium chloride concentrations of 75 and 80 mM (approximately 5,500 and 6,000 µg/ml) resulted in 19% and 28% aberrant cells, respectively. An increased number of chromosome aberrations was observed with potassium chloride concentrations that reduced cell survival 40% and more. The increases in mutagenicity and chromosome aberrations observed in these studies have been considered to be related to cytotoxicity resulting from the high potassium chloride concentrations used (Brusick, 1988).

The reported mutagenic effect of potassium chloride most probably results from a disruption of the osmotic balance of cells with a subsequent interference with chromosomal stability. This may result in the clastogenic effects (DNA breakage and chromosome structural instability) due to K<sup>+</sup> effects on sequestering of Mg<sup>++</sup> ions required for normal maintenance of chromatin integrity (OECD, 2001b).

#### In vivo Studies

No studies have been identified.

### **H. Carcinogenicity**

#### Oral

F344/Slc male rats were given 0, 110, 450 or 1,820 mg/kg-day potassium chloride in feed for two years. At the end of the study, survival rates were 48%, 64%, 58% and 84% in the 0, 110, 45 and 1,820

mg/kg/day groups. There was no increased incidence of tumours that were considered to be treatment-related (Imai et al., 1968). [K1. score = 2]

Male and female Wistar rats were fed diets containing 0 or 3% potassium chloride over a total period of 30 months. There were no treatment-related differences in tumour response among the groups (Lina and Kuijpers, 2004). [K1. score = 2]

### Inhalation

No studies were identified.

### Dermal

No studies were identified.

## **I. Reproductive Toxicity**

No studies were identified.

## **J. Developmental Toxicity**

Pregnant Wistar rats were given doses of 3.1 to 310 mg/kg potassium chloride by oral gavage during gestation days 5 through 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 310 mg/kg-day, the highest dose tested (FDRL 1975). [K1. score = 2]

Pregnant CD-1 mice were given doses of 2.35 to 235 mg/kg potassium chloride by oral gavage during gestation days 5 through 15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 235 mg/kg-day, the highest dose tested (FDRL 1975). [K1. score = 2]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for potassium chloride 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).

### **A. Non-Cancer**

#### Oral

Two chronic rat feeding studies have been conducted on potassium chloride: only the study by Imai et al. (1968) was conducted with multiple doses and provided mean daily intake values. In this study, the only treatment-related effects were associated with chronic irritation in the gastrointestinal tract (gastritis and ulcers), a localised effect due to the irritating properties of the test material. No systemic toxicity was observed at any of the doses tested. The NOAEL for systemic toxicity in this study is 1,820 mg/kg-day, the highest dose tested. The NOAEL of 1,820 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

*Oral Reference Dose (oral RfD)*

Oral RfD = NOAEL / (UF<sub>A</sub> x UF<sub>H</sub> x UF<sub>L</sub> x UF<sub>Sub</sub> x UF<sub>D</sub>)

Where:

$UF_A$  (interspecies variability) = 10

$UF_H$  (intraspecies variability) = 10

$UF_L$  (LOAEL to NOAEL) = 1

$UF_{Sub}$  (subacute to chronic) = 10

$UF_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 4(10 \times 10 \times 1 \times 10 \times 1) = 1,820/100 = \underline{18 \text{ mg/kg-day}}$$

*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 =  $(18 \times 70 \times 0.1)/2 = \underline{63 \text{ mg/L}}$

## **B. Cancer**

Potassium chloride was not carcinogenic to rats in two chronic feeding studies. Therefore, no cancer reference value was derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Potassium chloride does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Potassium chloride is of low toxicity concern to aquatic organisms.

### **B. Aquatic Toxicity**

#### Acute Studies

The results of the acute toxicity studies conducted on potassium chloride are presented in Table 2.

**Table 2: Acute Aquatic Toxicity Studies on Potassium Chloride**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	880	2	Mount et al., 1997; ECHA
<i>Daphnia magna</i>	48-hour EC <sub>50</sub>	660	2	Mount et al., 1997; ECHA
<i>Ceriodaphnia dubia</i>	48-hour EC <sub>50</sub>	630	2	Mount et al., 1997; ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub>	>100* (growth rate)	1	ECHA

\*NOEC = >100 mg/L

### Chronic Studies

In a fish early-life-stage test with the fathead minnow (*Pimephales promelas*), the 7-day NOEC was 500 mg/L (ECHA).

### **C. Terrestrial Toxicity**

No studies were identified.

### **D. Calculation of PNEC**

#### PNEC freshwater

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (720 mg/L), *Daphnia* (177 mg/L), and algae (>100 mg/L). Although a chronic study was conducted on fish that fulfils the requirements in the OECD TG 210, it is not considered adequate for deriving a PNEC because of the short duration of the test. On the basis of the short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 100 mg/L for algae. The PNEC<sub>water</sub> is 0.1 mg/L.

#### PNEC sediment

No reliable experimental toxicity data on sediment organisms are available. Potassium chloride dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as potassium chloride. Therefore, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of potassium chloride to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

#### PNEC soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of potassium chloride is dominated by its water solubility. Sorption of potassium chloride should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K<sub>oc</sub> and K<sub>ow</sub> parameters do not readily apply to inorganics, such as potassium chloride. Therefore, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, potassium chloride is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Potassium chloride is an inorganic salt that dissociates completely to potassium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and chloride 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.

Potassium and chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Therefore, potassium chloride is not expected to bioaccumulate.

No chronic toxicity data exist on potassium chloride; however, the acute E(L)C<sub>50</sub>s are >0.1 mg/L in fish, invertebrates and algae. Therefore, potassium chloride does not meet the screening criteria for toxicity.

The overall conclusion is that potassium chloride is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Not classified.

### B. Labelling

No signal word.

### C. Pictograms

None.

## X. SAFETY AND HANDLING

### A. First Aid

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) for KCL POTASSIUM CHLORIDE (revision date: 21-Sep-2015).

#### Eye Contact

In the case of contact or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS for KCL POTASSIUM CHLORIDE (revision date: 21-Sep-2015).

### Extinguishing Media

All standard firefighting media

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS for KCL POTASSIUM CHLORIDE (revision date: 21-Sep-2015).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS for KCL POTASSIUM CHLORIDE (revision date: 21-Sep-2015).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid breathing vapours.

### Storage

Store in a cool, dry location.



## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

Occupational exposure standards for potassium chloride have not been established.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS for KCL POTASSIUM CHLORIDE (revision date: 21-Sep-2015).

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

*Respiratory Protection:* Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Dustproof goggles.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

Potassium chloride is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Boyd, E.M., and Shanas, M.N. (1961). The acute oral toxicity of potassium chloride. Arch. Int. Pharmacodyn. Ther. 133: 275-283.

Brusick, D. (1988). Genotoxic effects in cultured mammalian cells produced by low pH treatment conditions and increased ion concentrations. Environ. Mutag. 8: 879-886.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>
- enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Ganong, W.F. (1995). Review of Medical Physiology, 17<sup>th</sup> Edition, Appleton & Lange, Norwalk, Connecticut, USA.
- Imai, S., Morimoto, J., Sekiya, N., Shima, M., Kiyozuka, Y., Nakamori, K., Tsubura, Y. (1986). Chronic toxicity test of KCl and NaCl in F344/Scl rats. J. Nara Med. Ass. 37:115-127 [in Japanese]; cited in OECD 2001a,b.
- 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.
- Lide, D.R. (2009). Physical Constants of Inorganic Compounds. CRC Handbook of Chemistry & Physics, 89<sup>th</sup> Edition, CRC Press.
- Lina, B.A.R., and Kuijpers, M.H.M. (2004). Toxicity and carcinogenicity of acidogenic or alkalogenic diets in rats; effects of feeding NH<sub>4</sub>Cl, KHCO<sub>3</sub> or KCl. Food Chem. Toxicol. 42: 135-153.
- Mitchell, A.D., Rudd, C.J., Caspary, W.J. (1988). Evaluation of the L5178Y mouse lymphoma cell mutagenesis assay: Intralaboratory results for sixty-three coded chemicals tested at SRI international. Env. Molecular Mutagenesis 12(13):37-101.
- Mortelmans, K., Haworth, S., Lawlor, T., Speck, W., Tainer, B., Zeiger, E. (1986). Salmonella mutagenicity tests: II. Results from the testing of 270 chemicals. Env. Mutagenesis 8(7):1-119.
- Mount, D.R., Gulley, D.D., Hockett, J.R., Garrison, T.D., and Evans, J.M. (1997). Statistical models to predict the toxicity of major ions to *Ceriodaphnia dubia*, *Daphnia magna* and *Pimephales promelas* (fathead minnows). Environ. Toxicol. Chem. 16: 2009-2019.
- Myhr, B.C., Caspary, W.J. (1988). Evaluation of the L5178Y mouse lymphoma cell mutagenesis assay: Intralaboratory results for sixty-three coded chemicals tested at Litton Bionetics, Inc. Env. Molecular Mutagenesis. 12(13):103-194.
- OECD. (2001a). IUCLID Data Set for Potassium chloride (CAS No. 7447-40-7), UNEP Publications. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=68BF142A-D550-432C-8C48-13883944BA1D](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=68BF142A-D550-432C-8C48-13883944BA1D).
- OECD. (2001b). Screening Information Assessment Report (SIAR) for Potassium chloride (CAS No. 7447-40-7), UNEP Publications. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=68BF142A-D550-432C-8C48-13883944BA1D](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=68BF142A-D550-432C-8C48-13883944BA1D).

#### **XIV. ACRONYMS AND GLOSSARY**

C	Centigrade
cm	centimetre
ECHA	European Chemicals Agency
EU	European Union
g	gram
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
hPa	hectopascal
hr	hour
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
kPa	kilopascal
L	litre
LOAEL	lowest observed adverse effect level
m	metre
mg/m <sup>3</sup>	milligrammes per cubic meter
mm	millimetre
µg	microgram
mg	milligram
mL	millilitre
mg/kg-day	milligrams per kilogram-day
SDS	Material Safety Data Sheet
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
KI	Klimisch scoring system
Koc	Soil Organic Carbon-Water Partitioning Coefficient
Pow	octanol/water partition coefficient
PNEC	Predicted No Effect Concentration
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	safety data sheet
SIAR	Screening Information Assessment Report
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

## SILICIC ACID, POTASSIUM SALT

This dossier on silicic acid, potassium salt (potassium silicate) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of potassium silicate in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained from the OECD-SIDS documents on Soluble Silicates which includes potassium silicate (OECD, 2004), and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Potassium hydroxyl(oxo)silanolate

**CAS RN:** 1312-76-1

**Molecular formula:**  $K_2O \cdot nO_2Si$

**Molecular weight:** 248.44 (tetrapotassium orthosilicate); soluble silicates are not generally stoichiometric chemical substances (with a specific chemical formula and molecular weight), but rather glasses or aqueous solutions of glasses.

**Molar ratio:** 0.5 for tetrapotassium orthosilicate. Commercial potassium silicates have molar ratios between 1.5 and 5.0.

**Synonyms:** Potassium silicate; potassium water glass; potassium polysilicate; silicic acid, potassium salt; soluble potash glass

**SMILES:** [O-][Si]([O-])([O-])[O-].[K+].[K+].[K+].[K+]

Potassium silicate is produced by fusing high purity quartz sand ( $SiO_2$ ) and potassium carbonate or potash ( $K_2CO_3$ ) at temperatures of 1,300 to 1,500°C. The product that is formed is an amorphous glass that can be dissolved in water to produce silicate solutions. Various products of potassium silicate are obtained by varying the mixing ratio of quartz and potash. Potassium silicates are Therefore characterised primarily by the  $SiO_2$  to  $K_2O$  ratio or molar ratio. (MR). Soluble silicates are not distinct stoichiometric chemical substances (with a specific chemical formula and molecular weight), but glasses or aqueous solutions of glasses (OECD, 2004).

Potassium silicate is an amorphous glass, and it is solidified as glass from the melt (solid or lump glasses). It is essentially anhydrous and differs from ordinary glasses in that it is soluble in water at elevated temperature and pressure leading to silicate solutions (liquid glasses). Both solid and liquid glasses are often referred to as water glass. Silicate solutions are defined by their density and viscosity, which together with the molar ratio defines a unique composition for the silicate solution. By evaporation of silicate solutions, fine powders or granules are obtained that have a residual water content of approximately 20%. Unlike ground lump glass, these materials dissolve readily in water to give silicate solutions (OECD, 2004).

Upon dissolution in water, potassium silicate forms potassium ions ( $K^+$ ) and molecular speciation of silicates. Depending on both pH and concentration the respective solutions contain varying proportions of monomeric tetrahydal ions, oligomeric linear or cyclic silicate ions (OECD, 2004).

## II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-Chemical Properties of Potassium Silicate**

Property	Value	Kl. score
Physical state	Amorphous glass melt; aqueous solution of spray-dried powder with ~20% residual water	OECD, 2004
Flow Point	905°C	OECD, 2004
Melting Point*	Slightly lower than water	OECD, 2004
Density	1.26 – 1.6 g/cm <sup>3</sup> (solution); 750 kg/m <sup>3</sup> spray-dried powder	OECD, 2004
Vapour Pressure	Negligible at ambient temperature	OECD, 2004
Partition Coefficient (log Pow)	Not relevant	OECD, 2004
Water Solubility	Solution: infinitely miscible; spray-dried solution: readily dissolvable	OECD, 2004

\*Aqueous solutions

## III. ENVIRONMENTAL FATE PROPERTIES

Potassium silicate readily dissolves in water to potassium ions (K<sup>+</sup>) and molecular speciation of silicates. Dissolved silica from commercial soluble silicates is indistinguishable from natural dissolved silica. Silica (SiO<sub>2</sub>) represents about 59% of the elemental composition of the earth's crust. Similar percentages are obtained for many sediments and soils (Jackson, 1964). Compounds of silicon and oxygen are ubiquitous in the environment; it is present in inorganic matter, like minerals and soils and in organic matter.

Silica is found in all natural waters, and the median values in the U.S. were reported to be 17 mg SiO<sub>2</sub>/L for ground waters and 14 mg SiO<sub>2</sub>/L for streams (Davis, 1964). The worldwide concentration in rivers is 13 mg SiO<sub>2</sub>/L (Edwards and Liss, 1973).

Potassium silicate is an inorganic substance and therefore not amenable to biodegradation. It is not expected to bioaccumulate.

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

Potassium silicates exhibit low acute toxicity by the oral and dermal routes. It can be irritating to corrosive to the skin of rabbits, depending on their molar ratio and concentration; it is not a dermal sensitizer. There is a low potential for toxicity from repeated oral exposures to potassium silicate. It is not genotoxic. Limited data indicate that potassium silicate does not pose a developmental hazard.

### B. Toxicokinetics and Metabolism

No toxicokinetic or metabolism studies are available for potassium silicate.

Rats were given a single oral dose of 40 or 1,000 mg/kg sodium silicate. Following oral dosing, excretion of silicon in the urine markedly increased and was most rapid during the first 24 hours post-dosing. At 40 and 1,000 mg/kg, 18.9% and 2.8%, respectively, of administered silicate was excreted in the urine. The urinary excretion half-life for ingested sodium silicate was calculated to be 24 hours. Although urinary excretion of silicon increased with dose level, the magnitude of this increase was

smaller than the increase in dose, suggesting either absorption or excretion or both of silicon becomes saturated (Benke and Osborn, 1979).

### C. Acute Toxicity

The acute oral LD<sub>50</sub> value of potassium silicate in rats is >5,000 mg/kg (ECHA). [Kl. score = 1]. In another study, the oral LD<sub>50</sub> value of potassium silicate in rats was reported to be >5,700 mg/kg (ECHA). [Kl. score = 2]

The 4-hour LC<sub>50</sub> value in rats is >2.06 mg/L. There were no deaths and animals gained weight over the 14-day observation period. During exposure, animals showed hunched posture and hypoactivity but recovered after the exposure period. No abnormalities were noted at gross necropsy (ECHA). [Kl. score = 1]

The acute dermal LD<sub>50</sub> value in rats was >5,000 mg/kg (ECHA). [Kl. score = 1]

### D. Irritation

Potassium silicates can be irritating to corrosive to the skin of rabbits, depending on their molar ratio and concentration (OECD, 2004). At a concentration of 35% and 29% (highest tested concentrations), potassium silicates with molar ratios of 3.4 and 3.9 were only slightly irritating, and not irritating to the eyes of rabbits, respectively.

### E. Sensitisation

Potassium silicate was not a dermal sensitizer in a guinea pig Beuhler test (ECHA). [Kl. score = 1]

### F. Repeated Dose Toxicity

#### Oral

No studies are available on potassium silicate.

Male and female Wistar rats were given in their drinking water 0, 200, 600 or 1,800 ppm polysodium silicate (Na<sub>2</sub>O.nSiO<sub>2</sub>) for 90 days. Polysodium silicate is assumed to be metasilicate. The mean daily intake was estimated to be (as sodium metasilicate): 26.4, 76.2, and 227.1 mg/kg-day for males; and 32.1, 97.6, and 237.2 mg/kg-day for females. There were no clear treatment-related effects. The NOAEL for this study is considered to be 227.1 and 237.2 mg/kg-day for males and females, respectively (OECD, 2004; ECHA). [Kl. score = 2]

Male and female mice were administered in their drinking water sodium metasilicate. The doses for males were 0, 300, 900, and 2,700 ppm which were estimated to be 0, 96-100, 264-280, and 776-832 mg/kg-day, respectively. The doses for females were 0, 333, 1,000 and 3,000 which were estimated to be 0, 88-104, 260-284, and 716-892 mg/kg-day, respectively. Parameters examined were body weight, urinalysis, clinical chemistry, haematology, organ weights, and histopathology. There were no deaths during the study. A significant decrease in pituitary gland weights was seen in the 3,000 ppm females. There were no other effects noted that were considered to be treatment-related. The NOAEL was considered to 260-284 mg/kg-day (OECD, 2004; ECHA). [Kl. score = 2]

Male and female SD rats were given sodium silicate in their drinking water for 180 days. The animals were administered 0, 600, or 1,600 mg SiO<sub>2</sub>/L, which were estimated to be 0, 79, or 159 mg/kg-day sodium silicate taking into account a diet containing 0.1 to 1.0% SiO<sub>2</sub> (based on dry weight). Body weight and mortality were the only parameters measured. There were statistical differences in body weight between treated and control groups; these differences were small (≤6%), and were no consistent

or dose-related. There were no deaths during the study. After 180 days of exposure, the male rats were used in a nitrogen and phosphorus retention study for a total of 17 days. Phosphorus retention was somewhat increased in the 159 mg/kg-day dose group (~12%), while the low-dose group showed no change. Nitrogen retention was 50% of controls in the lower dose group only. It is unclear whether the increased phosphorus retention in the high-dose animals represents an adverse effect or not. For the purposes of this dossier, the NOAEL for this study is 159 mg/kg-day as sodium silicate, the highest dose tested (Smith et al., 1973; OECD, 2004). [Kl. score = 2]

#### Inhalation

No inhalation studies on potassium silicate are available.

#### Dermal

No dermal studies on potassium silicate are available.

### **G. Genotoxicity**

#### In Vitro Studies

No in vitro guideline studies are available on potassium silicate.

Sodium silicate was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, or TA1537 or to *E. coli* VP2 in the absence or presence of metabolic activation (ECHA) [Kl. score = 1]. Sodium silicate was not mutagenic in Chinese hamster lung fibroblasts (V79) in the absence or presence of metabolic activation (ECHA) [Kl. score = 1]. Chromosomal aberrations were not increased in Chinese hamster lung fibroblasts (V79) when treated with sodium silicate with or without metabolic activation (ECHA) [Kl. score = 1].

#### In Vivo Studies

No in vivo genotoxicity studies are available on potassium silicate. Mice fed 740 to 1,340 mg/kg sodium metasilicate for 24 hours did not exhibit increased chromosomal aberrations in bone marrow cells (ECHA).

### **H. Carcinogenicity**

No studies are available.

### **I. Reproductive Toxicity**

No studies are available on potassium silicate. There is a four-generation reproductive toxicity study on sodium silicate (Smith et al., 1973), but this study is considered inadequate for hazard and risk assessments because of the severe methodology limitations of the study and the high mortality rates in the treated and control animals.

### **J. Developmental Toxicity**

No studies are available on potassium silicate.

Pregnant female mice were dosed by oral gavage 0, 12.5, 50, or 200 mg/kg sodium metasilicate in aqueous solution from GD 0 to 17 or 18. There were four deaths in the treated dams: two in the 50 mg/kg and two in the 200 mg/kg dose groups. Maternal body and organ weights were similar between treated and control dams. The number of pregnancies, living and dead fetuses, foetal body weights,

and malformations was similar across groups. A subgroup of pregnant dams was allowed to deliver their pups, and the neonates were observed for 30 days. Litter size, fertility index, pup body weight gain, organ weights, and behavioural development were unaffected by treatment. The NOAEL for developmental toxicity is 200 mg/kg-day, the highest dose tested (OECD, 2004; ECHA).

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for potassium silicate 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).

### A. Non-Cancer

#### Oral

The lowest NOAEL from three repeated dose toxicity studies conducted on sodium silicate or sodium metasilicate is 159 mg/kg-day from the 180-day drinking water study by Smith et al. (1973).

To convert the NOAEL of 159 mg/kg-day (as sodium silicate) to a NOAEL for potassium silicate, the following molecular weights were used:

From OECD (2004):

Sodium silicate (tetrasodium orthosilicate:  $\text{Na}_2\text{O} \cdot n\text{O}_2\text{Si}$ ,  $n = 4$ ) = 184.04

Potassium silicate (tetrapotassium orthosilicate:  $\text{K}_2\text{O} \cdot n\text{O}_2\text{Si}$ ,  $n = 4$ ) = 248.44

$\text{NOAEL} = 159 \text{ mg/kg-day} \times 248.44/184.04 = 215 \text{ mg/kg-day}$  (as potassium silicate)

The NOAEL of 215 mg/kg-day (as potassium silicate) will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

*Oral Reference Dose (oral RfD)*

$\text{Oral RfD} = \text{NOAEL} / (UF_A \times UF_H \times UF_L \times UF_{\text{Sub}} \times UF_D)$

Where:

$UF_A$  (interspecies variability) = 10

$UF_H$  (intraspecies variability) = 10

$UF_L$  (LOAEL to NOAEL) = 1

$UF_{\text{Sub}}$  (subchronic to chronic) = 10

$UF_D$  (database uncertainty) = 1

$\text{Oral RfD} = 215 / (10 \times 10 \times 1 \times 10 \times 1) = 215/1000 = \underline{0.2 \text{ mg/kg-day}}$

*Drinking water guidance value*

$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$



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 =  $(0.2 \times 70 \times 0.1) / 2 = 0.7 \text{ mg/L}$

An Australian drinking water guidance value of 80 ppm (aesthetics) for silica may also be applicable.

## B. Cancer

No studies are available. Therefore, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Potassium silicate does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Potassium silicate is of low toxicity concern to aquatic organisms. All of the available aquatic ecotoxicity tests with potassium silicate and with sodium silicate (used as read-across for algae) show toxicity at concentrations well above 100 mg/L.

### B. Aquatic Toxicity

#### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on potassium silicate.

**Table 2: Acute Aquatic Toxicity Studies on Potassium Silicate**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Leuciscus idus</i>	48-hr LC <sub>50</sub>	>146	2	OECD, 2004; ECHA
<i>Daphnia magna</i>	24-hr EC <sub>50</sub>	>146	2	OECD, 2004; ECHA
<i>Scenedesmus subspicatus</i>	72-hr EC <sub>50</sub>	207* (biomass)	2	OECD, 2004; ECHA

\*Test material was sodium silicate (CAS No. 1344-09-8).

#### Chronic Studies

No chronic studies are available.

## C. Terrestrial Toxicity

A honey bee acute contact toxicity study (USEPA OPPTS 850.3020) has been conducted on AgSil™ 25 potassium silicate solution (29.1% potassium silicate in water). The 48-hr LD<sub>0</sub> was 25 µg/animal, and the 48-hr LD<sub>50</sub> was 25 µg/animal (ECHA).

## D. Calculation of PNEC

### PNEC water

A PNEC<sub>water</sub> was not calculated. The primary hazard of commercial soluble silicates is their moderate-to-strong alkalinity, which can be harmful to aquatic life. However, most of the natural and artificial aquatic ecosystems are slightly acid, or alkaline and usually their pH values fall within the range of 6 to 9, and due to the high buffer capacity of these ecosystems, pH effects of released soluble silicates to aquatic organisms are very unlikely. Consequently, the PNEC derived from artificial laboratory test systems overestimate the effects of soluble silicates to aquatic organisms in ecosystems (OECD, 2004). Therefore, the PNEC value should be derived from the ubiquitous SiO<sub>2</sub> background concentration in the environment. The worldwide mean concentration in rivers is 13 mg SiO<sub>2</sub>/L (Edwards and Liss 1973).

### PNEC sediment

No experimental toxicity data on sediment organisms are available. Potassium silicate dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as potassium silicate. Therefore, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of potassium silicate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### PNEC soil

No experimental toxicity data on soil organisms are available. Potassium silicate dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as potassium silicate. Therefore, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, no adsorption of potassium silicate to the soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Potassium silicate is an inorganic compound that dissociates completely to potassium and silicate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and silicate 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 compound.

Potassium and silicate ions are essential to all living organisms and are ubiquitous in the environment. Therefore, potassium silicate is not expected to bioaccumulate.

No chronic toxicity data exist on potassium silicate; however, the acute E(L)C<sub>50</sub>s are >0.1 mg/L in fish, invertebrates and algae. Therefore, potassium silicate does not meet the screening criteria for toxicity.

The overall conclusion is that potassium silicate is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

The classification and labelling for potassium silicate depend on the molar ratio. Molar ratios define the ratio of  $\text{SiO}_2$  versus  $\text{K}_2\text{O}$  in the substance. The extent to which balancing potassium ions are present in a given silicate is defined by the molar ratio. The higher the molar ratio, the less potassium ions are present in the silica network and consequently the less potassium ions are present in the silica network and consequently the less alkaline the silicates are. From the molar ratio, the concentration of  $\text{SiO}_2$  and  $\text{K}_2\text{O}$  can be calculated. The concentration of  $\text{K}_2\text{O}$  can be taken as a measure of the skin and eye irritation potency. The EU defines the relationship between molar ratios, specific concentrations limits and GHS classifications for potassium silicate (see GHS classification for potassium silicate in the ECHA REACH database).

For the purposes of this dossier, the classification and labelling information for potassium silicate in the product BORE-HIB<sup>®</sup> was obtained from the Halliburton Safety Data Sheet (SDS) for BORE-HIB<sup>®</sup> (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%.

Skin Irritant Category 2  
Eye Damage Category 1

### B. Labelling

Danger

### C. Pictograms



## X. SAFETY AND HANDLING

### A. First Aid

First aid information was obtained from the Halliburton SDS for BORE-HIB<sup>®</sup> (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%.

#### Eye Contact

Immediately flush eyes with large amounts of water for at least 30 minutes. Seek prompt medical attention.

### Skin Contact

In the case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Do NOT induce vomiting. Give nothing by mouth. Obtain immediate medical attention.

### Notes to Physician

Treat symptomatically.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS for BORE-HIB® (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%

### Extinguishing Media

All standard firefighting media.

### Specific Exposure Hazards

Not applicable.

### Special Protective Equipment for Firefighters

Not applicable.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS for BORE-HIB® (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%.

### Personal Precautions

Spills of this product are very slippery. Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid breathing vapours. Ensure adequate ventilation. Evacuate all persons from the area.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Isolate spill and stop leak where safe. Contain spill with sand or other inert materials. Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS for BORE-HIB® (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%.

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid breathing mist. The material is slippery underfoot. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

### Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

### Storage

Store in a cool well-ventilated area. Keep container closed when not in use. Store at temperatures between 40 and 90 F (5 and 35 C). The product has a shelf life of 36 months.

## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for potassium silicate.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS for BORE-HIB® (revision date: 17-Sep-2015). The concentration of the potassium silicate in solution is 30 – 60%.

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Chemical-resistant protective gloves (EN 374) Suitable materials for longer, direct contact (recommended: protection index 6, corresponding to > 480-minute permeation time as per EN 374): Nitrile gloves. (>= 0.4 mm thickness). This information is based on literature references and on information provided by glove manufacturers or is derived by analogy with similar substances. Please note that in practice the working life of chemical-resistant protective gloves may be considerably shorter

than the permeation time determined in accordance with EN 374 as a result of the many influencing factors (e.g., temperature). If signs of wear and tear are noticed, then the gloves should be replaced. Manufacturer's directions for use should be observed because of the great diversity of types.

*Skin Protection:* Full protective chemical resistant clothing. Rubber apron.

*Eye Protection:* Chemical goggles; also wear a face shield if splashing hazard exists.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

The SDS for BORE-HIB® states that the product, which contains 30-60% potassium silicate, is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG. (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Benke, G. M., and Osborn, T. W. (1979). Urinary silicon excretion by rats following oral administration of silicon compounds. *Fd. Cosmet. Toxicol.* 17: 123-127.

Davis, S.N. (1964). Silica in streams and ground water. *Am. J. Sci.* 262: 870-891.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

Edwards, A.M.C., and Liss, P.S. (1973). Evidence of buffering of dissolved silicon in fresh waters. *Nature* 243: 341-342.

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

OECD. (2004). OECD SIDS Initial Assessment Report (SIAR) and IUCLID Data Set for Soluble Silicates, UNEP Publications. Available at: <http://www.inchem.org/documents/sids/sids/SolubleSilicates.pdf>

Smith, G.S., Neumann, A.L., Gledhill, V.H., and Arzola, C.A. (1973). Effects of soluble silica on growth, nutrient balance and reproductive performance of albino rats. J. Animal Sci. 36: 271-278.

#### **XIV. ACRONYMS AND GLOSSARY**

C	Centigrade
ECHA	European Chemicals Agency
EU	European Union
GD	gestational day
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
kPa	kilopascal
L	litre
LOAEL	lowest observed adverse effect level
m	metre
mg/m <sup>3</sup>	milligrammes per cubic meter
mm	millimetre
mg	milligram
mL	millilitre
mg/kg-day	milligrams per kilogram-day
SDS	Material Safety Data Sheet
NOAEL	no observed adverse effect level
OECD	Organisation for Economic Co-operation and Development
OPPTS	Office of Prevention, Pesticides and Toxic Substances
KI	Klimisch scoring system
Koc	Soil Organic Carbon-Water Partitioning Coefficient
Pow	octanol/water partition coefficient
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	safety data sheet

SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system
USEPA	United States Environmental Protection Agency



## SODIUM CARBONATE

This dossier on sodium carbonate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium carbonate in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on sodium carbonate (OECD, 2002a, b) and 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).

### I. SUBSTANCE IDENTIFICATION

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

**CAS RN:** 497-19-8

**Molecular formula:**  $\text{CH}_2\text{O}_3 \cdot 2\text{Na}$

**Molecular weight:** 106

**Synonyms:** sodium carbonate; disodium carbonate; carbonic acid, disodium salt; bisodium carbonate; soda ash, calcined soda

**SMILES:**  $\text{C(=O)}([\text{O-}][\text{O-}].[Na+].[Na+]$

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-Chemical Properties of Sodium Carbonate**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid; white powder	1	ECHA
Melting Point	851°C	2	ECHA
Boiling Point	No data	-	-
Density	>2.52 and <2.53 (20°C)	1	ECHA
Vapour Pressure	No data	-	-
Partition Coefficient (log Pow)	Not applicable	-	-
Water Solubility	404 g/L* [soluble]	2	ECHA
pH	ca 11.5**	2	ECHA
Flammability	No	1	ECHA

\*GLP-compliant study. The water solubility was overestimated, possibly due to the high temperature (during dissolution) or due to gel formation.

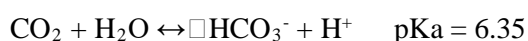
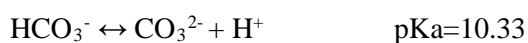
\*\*pH value from water solubility test.

Aqueous solutions are strongly alkaline. At 25°C, the pH of 1, 5 and 10 wt% sodium carbonate solutions are 11.37, 11.58, and 11.70, respectively (Eggeman, 2001).

### III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, sodium carbonate will be found predominantly in the aquatic environment where it dissociates completely to sodium ( $\text{Na}^+$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of sodium carbonate to an aquatic ecosystem will result in an increase in alkalinity and a tendency to increase the pH. The carbonate ions will react with water, forming bicarbonate ( $\text{HCO}_3^-$ ) and hydroxide ( $\text{OH}^-$ ) ions, until an equilibrium is reached. A re-equilibration takes place when carbonate ( $\text{CO}_3^{2-}$ ) is dissolved in water according to the following equations:



Only a small fraction of the dissolved  $\text{CO}_2$  is present as  $\text{H}_2\text{CO}_3$  (carbonic acid), the major part is present as  $\text{CO}_2$ . The amount of  $\text{CO}_2$  in water is in equilibrium with the partial pressure of  $\text{CO}_2$  in the atmosphere. The  $\text{CO}_2/\text{HCO}_3^-/\text{CO}_3^{2-}$  equilibria are the major buffer of the pH of freshwater.

Based on the above equations,  $\text{CO}_2$  is the predominant species at a pH smaller than 6.35, while  $\text{HCO}_3^-$  is the predominant species at a pH in the range of 6.35-10.33 and  $\text{CO}_3^{2-}$  is the predominant species at a pH higher than 10.33.

A release of sodium carbonate into the aquatic environment from the use of sodium carbonate could potentially increase the sodium concentration and the pH in the aquatic environment. Table 2 shows the concentration of sodium carbonate needed to increase the pH to values of 9.0, 10.0, and 11.0.

**Table 2: Sodium Carbonate Concentration (mg/L) Needed to Increase pH (DeGroot et al., 2002; taken from OECD, 2002b).**

Buffer capacity*	Final pH**		
	9.0	10.0	11.0
0 mg/L $\text{HCO}_3^-$ (distilled water)	11.1 (0.6)	16 (6.1)	603 (61)
20 mg/L $\text{HCO}_3^-$ (10 <sup>th</sup> percentile of 77 rivers)	2.7 (21)	32 (26)	766 (81)
106 mg/L $\text{HCO}_3^-$ (mean value of 77 rivers)	9.7 (107)	102 (112)	1467 (167)
195 mg/L $\text{HCO}_3^-$ (90 <sup>th</sup> percentile of 77 rivers)	17 (196)	175 (201)	2192 (256)

\*The initial pH of a bicarbonate solution with a concentration of 20-195 mg/L is 8.3 (calculated).

\*\*The final concentration of bicarbonate is given in parentheses.

$\text{Na}^+$  and  $\text{CO}_3^{2-}$  ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD 2002b).

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

There is limited toxicity data on sodium carbonate. It has a low order of acute toxicity by the oral, dermal, and inhalation routes. It is not a skin irritant, but it is an eye irritant. Sodium carbonate is not expected to be systemically available in the body from oral exposure due to its dissociation in bodily fluids and the neutralisation of the carbonate ion in the stomach. No developmental toxicity was seen in studies with rats, mice, or rabbits.

## B. Toxicokinetics and Metabolism

Sodium carbonate will dissociate in bodily fluids into sodium ( $\text{Na}^+$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions. The oral uptake of sodium carbonate would lead to neutralisation of carbonate in the stomach by the gastric acids which would lead to bicarbonate and/or carbon dioxide ( $\text{CO}_2$ ) formation. It is unlikely that an oral uptake of sodium carbonate would disrupt the acid-base balance of the body because  $\text{CO}_2$  formation in the stomach would alleviate the high amounts of carbonate that would be present in the stomach from an acute exposure. The equation that describes this reaction is:



## C. Acute Toxicity

An acute oral  $\text{LD}_{50}$  of sodium carbonate monohydrate in rats is 2,800 mg/kg, and the acute dermal  $\text{LD}_{50}$  in rabbits is >2,000 mg/kg (OECD, 2002a,b; ECHA). [Kl. scores = 1]

An acute inhalation toxicity study was conducted on an aerosol of sodium combustion products, which contain predominantly sodium carbonate. The 2-hour  $\text{LC}_{50}$  values for this aerosol to guinea pigs, mice and rats were 800, 1,200 and 2,300  $\text{mg}/\text{m}^3$ , respectively. The median aerodynamic diameter of the aerosol was  $0.77 \pm 2.1 \mu\text{m}$  (OECD, 2002a, b; ECHA). [Kl. score = 1]

## D. Irritation

As reviewed in OECD (2002a, b), skin irritation studies in laboratory animals and human volunteers with sodium carbonate either as a 50% solution or as a solid showed slight to no skin irritation.

Sodium carbonate is an eye irritant (OECD, 2002a, b; ECHA). A dose of 0.1 ml sodium carbonate monohydrate was irritating to the eyes of rabbits and, in another study, 0.1 ml of sodium carbonate (anhydrous) was highly irritating to rabbit eyes. However, 0.1 g sodium carbonate (anhydrous) was found not to be an eye irritant. [Kl scores of 1, 2, 1, respectively]

## E. Sensitisation

No studies were identified

## F. Repeated Dose Toxicity

No studies were identified by the oral, inhalation or dermal routes.

## G. Genotoxicity

### In Vitro Studies

Sodium carbonate did not induce primary DNA damage in an E. coli chromotest (Olivier and Marzin, 1987; OECD, 2002a, b). [Kl. score = 3]

### In Vivo Studies

No studies have been identified.

## H. Carcinogenicity

No studies were identified.

## **I. Reproductive Toxicity**

No studies were identified.

## **J. Developmental Toxicity**

Pregnant rats were dosed by oral gavage with 0, 2.45, 11.4, 52.9 or 245 mg/kg sodium carbonate on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 245 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

Pregnant mice were given doses of sodium carbonate (3.4 to 340 mg/kg) by oral gavage on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 340 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

Pregnant rabbits were dosed by oral gavage with 0, 1.79, 8.31, or 179 mg/kg sodium carbonate on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 179 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

There are no repeated dose toxicity studies conducted on sodium carbonate by any route of exposure. Developmental toxicity studies conducted by the oral route in three animal species showed no developmental effects at the highest doses tested. Sodium carbonate dissociates to sodium and carbonate ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms.

Sodium carbonate is used in many countries (e.g., U.S. and EU) as a food additive. It is regarded as a Generally Recognised as Safe (GRAS) substance in food with no limitation other than current good manufacturing practice (OECD, 2002a, b).

Therefore, a toxicological reference value was not derived from sodium carbonate. The Australian drinking water guideline values for sodium (180 ppm, aesthetic) and pH may be applicable (ADWG, 2011).

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Sodium carbonate does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Sodium carbonate is of low toxicity potential to aquatic and terrestrial organisms.

## B. Aquatic Toxicity

### Acute Studies

The results of the aquatic toxicity studies conducted on sodium carbonate are presented in Table 3.

**Table 3: Aquatic Toxicity Studies on Sodium Carbonate (OECD, 2002a,b)**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill sunfish	96-h LC <sub>50</sub>	300	2	OECD, 2002a, b
Mosquitofish	96-h LC <sub>50</sub>	740	2	OECD, 2002a, b
Bluefill sunfish	24-h LC <sub>50</sub>	385	4	OECD, 2002a, b
Molly	50-h LC <sub>50</sub>	297	4	OECD, 2002a, b
<i>Ceriodaphnia dubia</i>	48-h EC <sub>50</sub>	200 - 227	2	OECD, 2002a, b

There are other studies conducted invertebrates, but the results of these studies were not included in Table 3 because of the low reliability of the data (OECD, 2002a, b). No studies on algae were identified (OECD, 2002a, b).

## C. Terrestrial Toxicity

No studies were identified.

## D. Calculation of PNEC

The OECD-SIDS SIAR on sodium carbonate states the following regarding the aquatic toxicity studies on sodium carbonate (OECD, 2002b):

In general, the available toxicity studies with sodium carbonate were not conducted according to current standard guidelines. In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with sodium carbonate. In general, mortality of the test organisms was found at concentrations higher than 100 mg/l, but for *Amphipoda*, salmon and trout lethal effects were already observed at 67-80 mg/l although these studies had a low reliability. The main factor explaining the acute aquatic toxicity of sodium carbonate is most likely the increase of the pH.”

“Because the natural pH, bicarbonate and also the sodium concentration (and their fluctuations in time) varies significantly between aquatic ecosystems, it is not considered useful to derive a generic PNEC or PNEC<sub>added</sub>.

Based on the information above, PNEC values for freshwater, sediment, and soil were not derived from sodium carbonate.

## VIII. PBT ASSESSMENT

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).

Sodium carbonate is an organic salt that dissociates completely to sodium and carbonate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium 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.

Sodium and carbonate ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Therefore, sodium carbonate is not expected to bioaccumulate.

No chronic aquatic toxicity data exist on sodium carbonate; however, the acute EC(L)<sub>50</sub>s are >0.1 mg/L in fish, invertebrates and algae. Therefore, sodium carbonate does not meet the screening criteria for toxicity.

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

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Eye Irritant Category 2

### **B. Labelling**

Warning

### **C. Pictograms**



## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) for Soda Ash (revision date: 21-Jun-2016).

#### Eye Contact

In the case of contact or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Does not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS Soda Ash (revision date: 21-Jun-2016).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS Soda Ash (revision date: 21-Jun-2016).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS Soda Ash (revision date: 21-Jun-2016).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Avoid breathing vapours.

### Storage

Store away from acids. Store in a cool, dry location. The product has a shelf life of 36 months.

## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

Workplace Australia does not have an occupational exposure standard for sodium carbonate.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS on Soda Ash (revision date: 21-Jun-2016).

### Engineering Controls

Use in a well-ventilated area. Localised ventilation should be used to control dust levels.

### Personal Protection Equipment

*Respiratory Protection:* Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Dust proof goggles.

*Other Precautions:* Eyewash fountains and safety showers must be easily accessible.

## **F. Transport Information**

Sodium Carbonate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

De Groot *et al.* (2002). The addition of sodium carbonate to a solution with sodium bicarbonate to a fixed pH. Solvay Pharmaceuticals Int. Doc. No. 8320/48/01; cited in OECD, 2002a,b.

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: <http://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.
- Eggeman T. (2001). Sodium Carbonate. In: Kirk-Othmer Encyclopedia of Chemical Technology, John Wiley & Sons, New York, NY.
- 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.
- OECD (2002a). IUCLID Data Set for Sodium carbonate (CAS No. 497-19-8), UNEP Publications. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=7BCD380E-ADA2-4BAF-B2F7-DED360D32D7D](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=7BCD380E-ADA2-4BAF-B2F7-DED360D32D7D).
- OECD (2002b). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium carbonate (CAS No. 497-19-8), UNEP Publications. [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=7BCD380E-ADA2-4BAF-B2F7-DED360D32D7D](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=7BCD380E-ADA2-4BAF-B2F7-DED360D32D7D).
- Olivier, P.H., and Marzin, D. (1987). Study of the genotoxic potential of 48 inorganic derivatives with the SOS chromotest. Mutat. Res. 189: 263-269.
- UNEP. (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya; cited in OECD, 2002a, b.

#### **XIV. ACRONYMS AND GLOSSARY**

C	Centigrade
ECHA	European Chemicals Agency
EU	European Union
GD	gestational day
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GRAS	Generally Recognised as Safe
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
kPa	kilopascal
L	litre
LOAEL	lowest observed adverse effect level
m	metre
mg/m <sup>3</sup>	milligrammes per cubic meter
mm	millimetre
µg	microgram
mg	milligram
mL	millilitre
NOAEL	no observed adverse effect level

OECD	Organisation for Economic Co-operation and Development
KI	Klimisch scoring system
Pow	octanol/water partition coefficient
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

## SODIUM CARBOXYMETHYLCELLULOSE

This dossier on sodium carboxymethylcellulose does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium carboxymethylcellulose in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Sodium salt of a carboxymethyl ether of cellulose

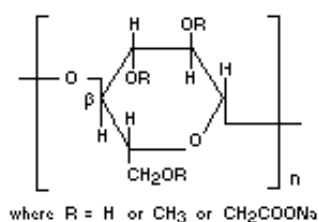
**CAS RN:** 9004-32-4

**Molecular formula:**  $K_2O \cdot nO_2Si$

**Synonyms:** Sodium carboxymethylcellulose, Carboxymethylcellulose, sodium; cellulose, carboxymethyl ether, sodium salt; sodium CMC; sodium cellulose glycolate; sodium CMC; Na CMC

**Chemical formula (WHO, 1967):**  $[C_6H_7O_2(OH)_x(OCH_2COONa)_y]_n$   
Where:  $x = 2.00$  to  $2.40$   
 $y = 1.00$  to  $0.60$   
 $x + y = 3.00$

**Structural formula (WHO, 1967):**



**Molecular weight (1967):** Unsubstituted structural unit: 162.14  
Monosubstituted structural unit: 242.16  
Macromolecules: from ~21,000 up to 500,000

Sodium carboxymethyl cellulose is the sodium salt of carboxymethylcellulose (CMC). CMC is a water-soluble semisynthetic polymer in which part of the hydroxyl groups of cellulose has been replaced at random by carboxymethyl groups. CMC is therefore composed of eight different glucose units, namely one unsubstituted, three monosubstituted, three di-substituted, and one tri-substituted. The average number of carboxymethyl groups per glucose unit is denoted by the degree of substitution (DS) (van Ginkel and Gayton, 1996).

### II. PHYSICO-CHEMICAL PROPERTIES

Sodium carboxymethylcellulose is a white or slightly yellowish, almost odourless and tasteless hygroscopic powder, consisting of very fine particles, fine granules, or fine fibres (WHO, 1967).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Sodium carboxymethylcellulose is biodegradable but is not considered to be readily biodegradable. It is not expected to bioaccumulate.

## **B. Biodegradation**

In an OECD 301A test, sodium carboxymethylcellulose (DS 0.7) showed 25% biodegradation after 28 days, followed by a much slower increase of the biodegradation percentage. At day 110, 58% of the theoretical oxygen demand (ThOD) was consumed, leading the investigators to conclude that there was a complete degradation of sodium carboxymethylcellulose (van Ginkel and Gayton, 1996). Therefore, sodium carboxymethylcellulose is degraded, but it is not readily biodegradable. [Kl. score = 1]

In an OECD 302A test, only 50% of the carbon from sodium carboxymethylcellulose (DS 0.7) was removed (van Ginkel and Gayton, 1996).

Other studies have also shown partial degradation of sodium carboxymethylcellulose in ready and inherent biodegradability tests (reviewed in van Ginkel and Gayton, 1996). [Kl. score = 4]

## **C. Bioaccumulation**

Sodium carboxymethylcellulose is a water-soluble semisynthetic polymer with a high molecular weight (~21,000 to 500,000). Due to its large molecular weight, it is not expected to bioaccumulate.

# **IV. HUMAN HEALTH HAZARD ASSESSMENT**

## **A. Summary**

Limited toxicity studies are available on sodium carboxymethylcellulose. Oral studies on sodium carboxymethylcellulose of up to 1% in the diet showed no toxicity or carcinogenic effects. It is not genotoxic, and no reproductive or developmental toxicity was observed in animal studies.

## **B. Acute Toxicity**

No studies were identified.

## **C. Irritation**

No studies were identified

## **D. Sensitisation**

No studies were identified

## **E. Repeated Dose Toxicity**

### Oral

Male and female rats were given in their diet 0, 0.1, or 1% sodium carboxymethylcellulose for two years. There were no differences between treated and controls in mortality and tumour incidence (WHO, 1966). [Kl. score = 4]

Male and female mice were given in their diet 0, 0.1, or 1% sodium carboxymethylcellulose for two years. There were no differences between treated and controls in mortality and tumour incidence (WHO, 1966). [Kl. score = 4]

### Inhalation

No studies were identified.

### Dermal

No studies were identified.

### Inhalation

No inhalation studies were identified.

### Dermal

No dermal studies were identified.

## **F. Genotoxicity**

No studies were identified.

## **G. Carcinogenicity**

### Oral

Male and female rats were given in their diet 0, 0.1, or 1% sodium carboxymethylcellulose for two years. There were no differences between treated and controls in mortality and tumour incidence (WHO, 1966). [Kl. score = 4]

Male and female mice were given in their diet 0, 0.1, or 1% sodium carboxymethylcellulose for two years. There were no differences between treated and controls in mortality and tumour incidence (WHO, 1966). [Kl. score = 4]

## **H. Reproductive/Developmental Toxicity**

No reproductive toxicity studies were identified. However, in a report of the Joint FAO/WHO Expert Committee on Food Additives (WHO, 1990), it states:

In reproduction and teratogenicity studies in mice, rats, and rabbits, the consumption of sodium carboxymethylcellulose did not interfere with the reproductive process, and no embryotoxic or developmental effects were observed. [Kl. score = 3]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

### **A. Non-Cancer**

#### Oral

Long-term studies have been conducted on sodium carboxymethylcellulose in rats and mice (WHO, 1966). These studies are considered inadequate for the purposes of deriving an oral Reference Dose due to the very limited information available on both the study design and the results.

NICNAS has assessed sodium carboxymethylcellulose in an IMAP Tier 1 assessment and considers it “a chemical identified as a low concern to human health by application of expert validated rules”<sup>1</sup>.

<sup>1</sup> [https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A\\_9004-32-4](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_9004-32-4)

It should also be noted that the Joint FAO/WHO Expert Committee on Food Additives has determined an Acceptable Daily Intake (ADI) for sodium carboxymethylcellulose of “Not Specified” (no upper limit) (JECFA, 1989).

## B. Cancer

Sodium carboxymethylcellulose was not carcinogenic to rats and mice in chronic feeding studies. Therefore, no cancer reference value was derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium carboxymethylcellulose does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Sodium carboxymethylcellulose is a low concern for toxicity to aquatic organisms.

### B. Aquatic Toxicity

#### Acute Studies

Table 1 lists the results of acute aquatic toxicity studies conducted on sodium carboxymethylcellulose.

**Table 1: Acute Aquatic Toxicity Studies on sodium carboxymethylcellulose or sodium carboxymethylcellulose**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Brachydanio rerio</i>	96-hr LC <sub>50</sub>	>2,500*	1	van Ginkel and Gayton (1996)
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>5,000*	1	van Ginkel and Gayton (1996)
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	87.26**	2	Warne and Schiffko (1999)
<i>Selenastrum capricornutum</i>	96-hr EC <sub>50</sub>	500*	1	van Ginkel and Gayton (1996)

\*sodium carboxymethylcellulose (0.7) was tested.

\*\* sodium carboxymethylcellulose was tested.

Additional aquatic toxicity studies on sodium carboxymethylcellulose by Schöberl *et al.* (1988) reported LC<sub>0</sub> values of >250 to 1,000 mg/L for fish and >1,000 mg/L for *Daphnia*.

Van Ginkel and Gayton (1996) also tested the degradation products of sodium carboxymethylcellulose from *Agrobacterium* CM-1 in acute toxicity studies. There was no toxicity to *Brachydanio rerio* (1,000 mg/L), *Daphnia magna* (1,000 mg/L), or *Selenastrum capricornutum* (500 mg/L).

It is unclear why there is a large difference in *Daphnia* EC<sub>50</sub> values between the studies of van Ginkel and Gayton (1996) and Warne and Schiffko. One possibility is that the two laboratories may have tested different sodium carboxymethylcellulose products. van Ginkel and Gayton (1996) tested sodium carboxymethylcellulose (0.7), whereas Warne and Schiffko (1999) tested sodium carboxymethylcellulose (with no further description) in their study. However, the studies by Schöberl *et al.* (1988) reported an acute toxicity for *Daphnia* that is similar to that reported by van Ginkel and Gayton (1996). As a water-soluble polymer, sodium carboxymethylcellulose or sodium

carboxymethylcellulose would be expected to exhibit low toxicity due to its large molecular weight and its inert characteristics. Based on the information provided, the EC<sub>50</sub> value from van Ginkel and Gayton (1996) will be used for the PNEC calculations.

#### Chronic Studies

No additional studies were identified. However, van Ginkel and Gayton (1996) reported that there was no toxicity to *Daphnia* in a 21-day reproduction test when tested using effluent from sodium carboxymethylcellulose treated with activated sludge in a CAS unit, *i.e.*, no toxicity due to partial degradation of sodium carboxymethylcellulose.

#### **C. Terrestrial Toxicity**

No studies were identified.

#### **D. Calculation of PNEC**

The PNEC calculations for sodium carboxymethylcellulose follow the methodology discussed in DEWHA (2009).

##### PNEC freshwater

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (>2,500 mg/L), *Daphnia* (>5,000 mg/L), and algae (>500 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 500 mg/L for algae. The PNEC<sub>water</sub> is 0.5 mg/L.

##### PNEC sediment

A PNEC<sub>sed</sub> was not calculated for sodium carboxymethylcellulose. There are no experimental toxicity data on sediment organisms, and a K<sub>oc</sub> value for sodium carboxymethylcellulose is unavailable for calculating the PNEC<sub>sed</sub> using the equilibrium partition method. A K<sub>oc</sub> value for sodium carboxymethylcellulose has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as sodium carboxymethylcellulose.

##### PNEC soil

A PNEC<sub>soil</sub> was not calculated for sodium carboxymethylcellulose. There are no experimental toxicity data on terrestrial organisms, and a K<sub>oc</sub> value for sodium carboxymethylcellulose is unavailable for calculating the PNEC<sub>sed</sub> using the equilibrium partition method. A K<sub>oc</sub> value for sodium carboxymethylcellulose has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as sodium carboxymethylcellulose.

### **VIII. PBT ASSESSMENT**

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).

sodium carboxymethylcellulose is a water-soluble semisynthetic polymer that is not readily biodegradable. Therefore, it meets the screening criteria for persistence.

sodium carboxymethylcellulose is a water-soluble semisynthetic polymer that has a high molecular weight (~21,000 to 500,000) which limits its bioavailability to aquatic organisms. Therefore, it is not expected to bioaccumulate.

The acute E(L)C<sub>50</sub> of sodium carboxymethylcellulose is >0.1 mg/L in fish, invertebrates and algae. Therefore, it does not meet the screening criteria for toxicity.

The overall conclusion is that sodium carboxymethylcellulose is not a PBT substance.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

Sodium carboxymethylcellulose is considered a non-hazardous material according to the criteria of NOHSC. Under the Australia GHS, no classification and labelling are necessary.

However, PAC<sup>™</sup>-L, the commercial product of sodium carboxymethylcellulose used in drilling muds, contains 0.1% glyoxal. The GHS classifications of glyoxal, which are provided in the dossier on glyoxal, includes skin sensitisation (category 1B). Because glyoxal is present in PAC<sup>™</sup>-L at 0.1%, the GHS skin sensitisation classification also is required for PAC<sup>™</sup>-L.

### **A. Classification**

Skin Sensitisation Category 1B

### **B. Labelling**

Warning

### **C. Pictograms**



## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) on PAC<sup>™</sup>-L (revision date: 20-Dec-2012) with additional GHS phrases for skin sensitisation classification.

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 25 minutes and get medical attention if irritation persists.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists. Wash contaminated clothing before reuse.



### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Under normal conditions, first aid procedures are not required.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS on PAC™-L (revision date: 20-Dec-2012).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS on PAC™-L (revision date: 20-Dec-2012).

### Personal Precautions

Avoid creating and breathing dust.

### Environmental Precautions

None known.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS on PAC™-L (revision date: 20-Dec-2012).

### General Handling

Avoid creating or inhaling dust. Avoid dust accumulations. Slippery when wet.

### Other Handling Precautions

#### Storage

Store away from oxidizers. Store in a dry location.

### **E. Exposure Controls/Personal Protection**

#### Occupational Exposure Standards

There are no workplace exposure standards for sodium carboxymethylcellulose.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS on PAC™-L (revision date: 20-Dec-2012) with additional GHS phrases for skin sensitisation classification.

#### Engineering Controls

A well-ventilated area to control dust levels. Local exhaust ventilation should be used in areas without good cross ventilation.

#### Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended. Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Wear protective gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* Contaminated work clothing should not be allowed out of the workplace.

### **F. Transport Information**

sodium carboxymethylcellulose is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

PAC™-L (containing 0.1% glyoxal) is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

### **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

### **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

### XIII. 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: <http://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.
- JECFA. (1989). <http://apps.who.int/ipsc/database/evaluations/chemical.aspx?chemID=3773>
- 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.
- Schöberl, P., Bock, K.J., and Huber, L. (1988). Ökologisch relevante Daten von nicht-tensidischen Inhaltstoffen in Wasch- und Reinigungsmitteln. Tenside Detergents 25: 99-107.
- Van Ginkel, C.G., and Gayton, S. (1996). The biodegradability and nontoxicity of carboxymethyl cellulose (DS 0.7) and intermediates. Environ. Toxicol. Chem. 15: 270-274.
- Warne, M. St. J, and Schiffko, A.D. (1999). Toxicity of laundry detergent components to a freshwater Cladoceran and their contribution to detergent toxicity. Ecotoxicol. Environ. Saf. 44: 196-206.
- WHO (1967). Toxicological evaluations of some antimicrobials, antioxidants, emulsifiers, stabilizers, flour-treatment agents, acids and bases: Cellulose, sodium carboxymethyl. FAO Nutrition Meetings Report Series No. 40A, B,C
- WHO/Food Add./67.29. Food and Agriculture Organization of the United Nations, World Health Organization. Available at: <http://www.inchem.org/documents/jecfa/jecmono/40abcj20.htm>
- WHO (1990). Evaluation of Certain Food Additives and Contaminants. Thirty-fifth Report of the Joint FAO/WHO Expert Committee on Food Additives. World Health Organization Technical Report Series 789, pp. 24-25, World Health Organization. Available at: [http://apps.who.int/iris/bitstream/10665/37651/1/WHO\\_TRS\\_789.pdf](http://apps.who.int/iris/bitstream/10665/37651/1/WHO_TRS_789.pdf)

### XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADI	Acceptable Daily Intake
ADWG	Australian Drinking Water Guidelines
CMC	carboxymethylcellulose
DEWHA	Department of the Environment, Water, Heritage and the Arts
DS	degree of substitution
ECHA	European Chemicals Agency
EU	European Union

GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GRAS	Generally Recognised as Safe
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
SDS	Material Safety Data Sheet
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system
ThOD	theoretical oxygen demand
WHO	World Health Organisation

## SODIUM HYDROXIDE

This dossier on sodium hydroxide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium hydroxide in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained from the OECD-SIDS documents on sodium hydroxide (OECD, 2002a, b) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Sodium hydroxide

**CAS RN:** 1310-73-2

**Molecular formula:** HNaO

**Molecular weight:** 40

**Synonyms:** Caustic soda, soda lye, NaOH

**SMILES:** O[Na]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Physico-Chemical Properties of Sodium Hydroxide**

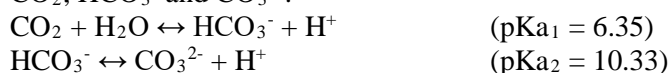
Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid	2	Lide, 2009; ECHA
Melting Point	318°C (solid, 100%); 52°C (60% solution)	2	ECHA
Boiling Point	1,388°C @ 101.325 kPa	2	Lide, 2009; ECHA
Density	2.13 g/cm <sup>3</sup> , 20°C (100%) 1.43 g/cm <sup>3</sup> , 20°C (40%)	2	Lide, 2009; ECHA
Vapour Pressure	1 Pa @ 513°C	2	Lide, 2009; ECHA
Partition Coefficient (log Pow)	Not applicable	-	-
Water Solubility	Very soluble	2	Lide, 2009; ECHA
Dissociation Constant (pKa)	14.8 @ 25°C	2	Lide, 2009; ECHA
pH of 5% NaOH solution	14	2	O'Neil, 2006

Sodium hydroxide (NaOH) is a strong alkaline substance that dissociates completely in water to sodium (Na<sup>+</sup>) and hydroxyl (OH<sup>-</sup>) ions.

### III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, sodium hydroxide will be found predominantly in the aquatic environment where it dissociates completely to sodium (Na<sup>+</sup>) and hydroxyl (OH<sup>-</sup>) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of sodium hydroxide to an aquatic ecosystem may increase the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between  $\text{CO}_2$ ,  $\text{HCO}_3^-$  and  $\text{CO}_3^{2-}$ :



A release of sodium hydroxide into the aquatic environment from the use of NaOH could potentially increase the sodium concentration and the pH in the aquatic environment. Table 2 shows the concentration of sodium hydroxide needed to increase the pH to values of 9.0, 10.0, 11.0, and 12.0.

**Table 2: Sodium Hydroxide Concentration (mg/L) Needed to Increase pH**  
(DeGroot et al., 2002; taken from OECD, 2002b).

Buffer capacity*	Final pH			
	9.0	10.0	11.0	12.0
0 mg/L $\text{HCO}_3^-$ (distilled water)	0.4	4.0	40	400
20 mg/L $\text{HCO}_3^-$ (10 <sup>th</sup> percentile of 77 rivers)	1.0	8.2	51	413
106 mg/L $\text{HCO}_3^-$ (mean value of 77 rivers)	3.5	26	97	468
195 mg/L $\text{HCO}_3^-$ (90 <sup>th</sup> percentile of 77 rivers)	6.1	45	145	525

\*The initial pH of a bicarbonate solution with a concentration of 20-195 mg/L was 8.25 to 8.35.

$\text{Na}^+$  and  $\text{OH}^-$  ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002b).

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

Limited toxicity data exist for sodium hydroxide (NaOH). Depending on the concentration, solutions of NaOH are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. NaOH is not a skin sensitiser.

##### B. Toxicokinetics/Metabolism

Sodium hydroxide dissociates completely in aqueous solutions to sodium ( $\text{Na}^+$ ) and hydroxyl ( $\text{OH}^-$ ) ions. Sodium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function (Ganong, 1995). Sodium is the major extracellular cation in the body; the total body content is tightly regulated (Ganong, 1995).

##### C. Acute Toxicity

There are no oral toxicity guideline studies on sodium hydroxide. An oral  $\text{LD}_{50}$  of a 1 to 10% solution of NaOH in rabbits was reported to be 325 mg/kg (expressed as 100% NaOH) (OECD, 2002a,b). Mortality was also observed when a 1% NaOH solution was dosed, but in this case, the applied volume was relatively high (24 mL per kg body weight) (OECD, 2002a,b).

Acute toxicity studies were not identified for the inhalation and dermal route.

##### D. Irritation

Animal studies have shown that an 8% NaOH solution is corrosive to the skin. In human, 0.5 to 4% NaOH concentrations produced skin irritation; and, based on the results of two different human patch

tests, a NaOH solution that is slightly less than 0.5% would be non-irritating to human skin (OECD, 2002a,b).

Results from animal eye irritation studies indicate that a 0.2-1.0% NaOH solution would be non-irritating, while 1.2 or >2% NaOH solutions would be corrosive (OECD, 2002a, b).

## **E. Sensitisation**

Male volunteers were exposed on the skin of their back to 0.063 to 1.0% NaOH solutions in the induction phase of human patch test. After 7 days the volunteers were challenged to a concentration of 0.125% NaOH. The irritant response correlated well with the concentration of NaOH, but an increased response was not observed when the previously patch tested sites were re-challenged. Based on this study, sodium hydroxide is not a skin sensitizer (OECD, 2002a, b; ECHA). [Kl. score = 2]

## **F. Repeated Dose Toxicity**

No studies were identified for the oral and dermal route. An inhalation study was conducted in rats exposed to aerosols of NaOH solutions ranging from 5% to 40%. Exposures were twice weekly (hours/day and total exposure days unspecified). All animals in the 40% solution group died within a month mostly from bronchopneumonia. At the lower concentrations, respiratory tract lesions were observed; an NOAEL was not identified (NIOSH, 1975).

## **G. Genotoxicity**

### In Vitro Studies

Several in vitro studies have been conducted on NaOH (OECD, 2002a, b; ECHA). Although these studies reported negative results, they are considered unreliable (Kl. score = 3) due to methodological or reporting deficiencies.

### In Vivo Studies

Several in vivo studies have been conducted on NaOH (OECD, 2002a,b; ECHA). Although these studies reported negative results, they are considered unreliable (Kl. score = 3) due to methodological or reporting deficiencies.

## **H. Carcinogenicity**

No studies were identified.

## **I. Reproductive Toxicity**

No valid studies were identified regarding toxicity to reproduction in animals after oral, dermal or inhalation exposure to NaOH.

## **J. Developmental Toxicity**

No valid studies were identified regarding developmental toxicity in animals after oral, dermal or inhalation exposure to NaOH (OECD, 2002a, b; ECHA).

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Oral and dermal repeated dose, reproductive, and developmental toxicity studies have not been conducted on NaOH. A repeated dose toxicity study was conducted by the inhalation route, but the methodology and documentation preclude its use for deriving a toxicological reference value. These toxicity studies would have questionable usefulness because of the corrosive/irritating nature of NaOH, which would limit the amount absorbed. NaOH dissociates to sodium and hydroxyl ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, a toxicological reference value was not derived for NaOH.

The Australian drinking water guideline values for sodium (180 ppm, aesthetic) and pH may be applicable (ADWG, 2011).

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium hydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Aquatic Toxicity

The OECD-SIDS SIAR on NaOH states the following regarding the aquatic toxicity studies on NaOH (OECD, 2002b):

At concentrations reported in publications and study reports, the toxicity has been assumed to be due to hydroxide only, because at these effect concentrations the concentration of sodium is too low to explain the effects. However, it should be realised that the results of toxicity tests with NaOH depend on the buffer capacity of the test medium. In a highly buffered test medium, the hydroxyl ion will be neutralised, and the observed toxicity will be low, while in a poorly buffered test medium the pH will increase rapidly and therefore the observed toxicity will be relatively high. Besides the direct effects (pH change) NaOH could also have indirect effects. The pH change could influence the speciation of other chemicals and therefore increase and/or decrease the toxicity, e.g.;  $\text{NH}_3$  is more toxic than  $\text{NH}_4^+$ .

There are no guideline studies on NaOH; the studies summarised below have Klimisch scores of 3 or 4.

#### Acute Fish

The 24-hour  $\text{LC}_{50}$  to *Carassius auratus* (goldfish) is 160 mg/L. At 100 mg/L, which was equivalent to a pH of 9.8, no mortality was observed. The 48-hour  $\text{LC}_{50}$  to *Leuciscus idus melanotus*, is 189 mg/L. The 96-hour  $\text{LC}_{50}$  of *Gambusia affinis* (mosquitofish) is 125 mg/L. At 84 mg/L, no effects on the fish were observed. The pH was 9 at 100 mg/L.

#### Acute Invertebrate

The 48-hour  $\text{LC}_{50}$  is 40 mg/L for *Ceriodaphnia cf. dubia*. The toxicity threshold concentration of NaOH for *Daphnia magna* was reported to range from 40 to 240 mg/L.



### Acute Algae

No studies were identified.

### **B. Terrestrial Toxicity**

No studies were identified.

### **C. Calculation of PNEC**

The OECD-SIDS SIAR on NaOH states the following regarding the aquatic toxicity studies on NaOH (OECD, 2002b):

In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with NaOH. This is the most important reason why most of the studies, mentioned above were considered invalid. Although valid acute ecotoxicity tests and chronic ecotoxicity tests with NaOH are not available, there is no need for additional testing with NaOH. A significant number of acute toxicity tests are available, and the results of the tests are more or less consistent. Altogether they give a sufficient indication of acute toxicity levels of sodium hydroxide.”

Furthermore, acute toxicity data cannot be used to derive a PNEC or a PNEC added for sodium hydroxide. Aquatic ecosystems are characterised by an alkalinity/pH, and the organisms of the ecosystem are adapted to these specific natural conditions. Based on the natural alkalinity of waters, organisms will have different optimum pH conditions, ranging from poorly buffered waters with a pH of 6 or less to very hard waters with pH values up to 9. A lot of information is available about the relationship between pH and ecosystem structure and also natural variations in pH of aquatic ecosystems have been quantified and reported extensively in ecological publications and handbooks.

Normally a PNEC or a PNEC added has to be derived from the available ecotoxicity data. A PNEC added is a PNEC which is based on added concentrations of a chemical (added risk approach). Based on the available data it is not considered useful to derive a PNEC or a PNEC added for NaOH because:

- The natural pH of aquatic ecosystems can vary significantly between aquatic ecosystems,
- Also, the sensitivity of the aquatic ecosystems to a change of the pH can vary significantly between aquatic ecosystems and
- The change in pH due to an anthropogenic NaOH addition is influenced significantly by the buffer capacity of the receiving water.

Although a PNEC or a PNEC added was not calculated for NaOH, there is a need to assess the environmental effect of a NaOH (alkaline) discharge. Based on the pH and buffer capacity of effluent and receiving water and the dilution factor of the effluent, the pH of the receiving water after the discharge can be calculated. Of course, the pH change can also be measured very easily via a laboratory experiment or by conducting field measurements. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison it should be assessed if the pH change is acceptable.

Based on the information above, PNEC values for freshwater, sediment, and soil were not derived for sodium hydroxide.

## VIII. PBT ASSESSMENT

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).

Sodium hydroxide is an inorganic salt that dissociates completely to sodium and hydroxide ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and hydroxide 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.

Sodium and hydroxide ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, sodium hydroxide is not expected to bioaccumulate.

No chronic toxicity data exist on sodium hydroxide; however, the acute E(L)C<sub>50</sub> values are >0.1 mg/L in fish, invertebrates and algae. Thus, sodium hydroxide does not meet the screening criteria for toxicity.

The overall conclusion is that sodium hydroxide is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

For sodium hydroxide solutions of >5%:

### A. Classification

Skin corrosion, Category 1A  
Eye damage, Category 1

In addition to the hazard statements corresponding the GHS classifications, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

### B. Labelling

Danger

### C. Pictograms



## X. SAFETY AND HANDLING

### A. First Aid

#### Eye Contact

Flush with plenty of fresh water for 15 minutes holding eyelids open, lifting eyelids occasionally to ensure complete removal of the product. DO NOT allow rubbing of eyes or keeping eyes closed. Remove contact lenses. Seek medical advice.

### Skin Contact

Rinse with soap and plenty of water for several minutes. Remove contaminated clothing. Seek medical attention immediately.

### Inhalation

Remove person to fresh air. Apply artificial respiration if not breathing. Seek medical attention.

### Ingestion

Rinse mouth with water (only if the person is conscious). Do NOT induce vomiting. Seek medical advice immediately.

## **B. Fire Fighting Information**

### Extinguishing Media

Suitable Extinguishing Media: carbon dioxide, water spray, foam, dry chemical.

### Specific Exposure Hazards

Containers may explode when heated. May form explosive mixtures with strong acids. Hazardous combustion products may include the following materials: halogenated compounds, metal oxides/oxides, sodium monoxide.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

### Personal Precautions

Use appropriate protective equipment and avoid direct contact. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Ventilate the area before entry.

### Environmental Precautions

Prevent spills from entering storm drains or sewers and contact with soil.

### Steps to be Taken if Material is Released or Spilt

Use an absorbent material to recover as much product as possible, then, rinse the affected area with water to dilute the residue. Disposal of leftover product and used containers should be carried out in accordance with all local, state and federal regulations.

## **D. Storage and Handling**

### General Handling

Wear appropriate personal protective equipment. Avoid contact with eyes, skin or clothing. Avoid breathing mist, vapours or spray. Use only with adequate ventilation. Wash hands after use. Launder contaminated clothing.

### Storage

Store away from acids. Keep container closed when not in use. Store in a cool well-ventilated area.

## **E. Exposure Controls / Personal Protection**

### Occupational Exposure Standards

The workplace exposure standard for sodium hydroxide in Australia is 2 mg/m<sup>3</sup> as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

### Engineering Controls

Good general ventilation should be used. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

### Personal Protection Equipment

*Respiratory Protection:* Use a mask or approved air-purifying respirator with appropriate cartridge or canister in spray applications or in confined spaces.

*Hand Protection:* Wear impervious gloves to prevent skin contact and absorption of this material. Rubber or Neoprene gloves may afford adequate skin protection.

*Skin Protection:* Wear appropriate clothes (i.e., coveralls). Use non-slip footwear.

*Eye protection:* Wear eye protection in situations where splash or thick mists are possible.

*Other Precautions:* Avoid contact with skin, eyes and clothing. When using, do not eat or drink. Wash hands thoroughly with soap and water before eating or drinking. Remove contaminated clothing and laundry before reuse.

## **F. Transport Information**

For sodium hydroxide solutions of >5%:  
Australian Dangerous Goods  
UN1824, Corrosive liquid, (Sodium hydroxide solution)  
Class 8  
Packing Group: II

Lower concentrations of sodium hydroxide may require a different packing group or may not require any hazard code if the concentration of NaOH is low enough not to be considered a corrosive material.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

De Groot et al. (2002). The addition of sodium hydroxide to a solution with sodium bicarbonate to a fixed pH. Solvay Pharmaceuticals Int. Doc. No. 8320/47/01; cited in OECD, 2002a,b.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

Ganong, W.F. (1995). Review of Medical Physiology, 17th Edition, Appleton & Lange, Norwalk, Connecticut, USA.

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

Lide, D.R. (2009). Physical Constants of Inorganic Compounds. CRC Handbook of Chemistry & Physics, 89th Edition, CRC Press.

NIOSH (1975). National Institute of Occupational Safety and Health: Criteria Document: Sodium Hydroxide p.46 (1975) DHEW Pub. NIOSH 76-105; cited in NICNAS IMAP assessment report for sodium hydroxide, [https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessment-details?assessment\\_id=1406#cas-A\\_1310-73-2](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessment-details?assessment_id=1406#cas-A_1310-73-2).

O'Neil, M.J. [Ed.] (2006). The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. P. 1485, Whitehouse Station, NJ: Merck and Co., Inc.

OECD (2002a). IUCLID Data Set for Sodium hydroxide (CAS No. 1310-73-2), UNEP Publications. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=DC48343F-5AEA-4850-9A17-0A89331E4320](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=DC48343F-5AEA-4850-9A17-0A89331E4320)

OECD (2002b). Screening Information Dataset (SIDS) Initial Assessment Report for Sodium hydroxide (CAS No. 1310-73-2), UNEP Publications. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=DC48343F-5AEA-4850-9A17-0A89331E4320](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=DC48343F-5AEA-4850-9A17-0A89331E4320)

UNEP. (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya; cited in OECD, 2002a,b.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
BMD	benchmark dose
CERHR	Centre for Evaluation of Risks to Human Reproduction
CNS	central nervous system
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
FOB	functional observation battery
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IRIS	Integrated Risk Information System
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

## SODIUM POLYACRYLATE

This dossier on sodium polyacrylate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium polyacrylate in its use in drilling muds and hydraulic fracturing fluids. The majority of information presented in this dossier was obtained from the HERA document on polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7) (HERA, 2014). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** 1-Propenoic acid, homopolymer, sodium salt

**CAS RN:** 9003-04-7

**Molecular formula:**  $(C_3H_4O_2)_x \cdot x \cdot Na$

**Molecular Weight:** Variable

**Synonyms:** 2-Propenoic acid, homopolymer, sodium salt; polyacrylic acid, sodium salt, sodium polyacrylate; acrylic acid, polymers, sodium salt; poly(acrylic acid), sodium salt; polyacrylate sodium salt

### II. PHYSICO-CHEMICAL PROPERTIES

Sodium polyacrylates are polymers that range in molecular weight (MW) from 1,000 to 78,000 (HERA, 2014). The sodium polyacrylates mostly used in detergents have a typical molecular weight of approximately 4,500 (HERA, 2014). For sodium polyacrylate (MW 4,500), the melting point is  $>150^\circ\text{C}$ , where it decomposes; and the water solubility is  $>400\text{ g/L}$  (HERA, 2014).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Abiotic Degradation

Abiotic degradation mechanisms like photolytic and hydrolytic processes do not significantly influence the environmental fate of sodium polyacrylates (HERA, 2014).

#### B. Biodegradation

Sodium polyacrylates are not readily biodegradable but are partly accessible to ultimate biodegradation particularly under long incubation conditions. Sodium polyacrylates with MW of  $<2,000$  are partly biodegradable under the conditions of soil and sediment inoculation. Test results with activated sludge inoculum indicate different elimination degrees, apparently due to adsorption and precipitation processes. The removal degrees of different sodium polyacrylates show no clear relationship between elimination extent and molecular weight (HERA, 2014).

#### C. Bioaccumulation

No experimental studies are available on sodium polyacrylates. Estimated bioconcentration factors based on octanol-water coefficients are not appropriate since the molecular weights of these polymers are higher than the molecular weight range of the QSAR models. Due to their high molecular weights, sodium polyacrylates are not expected to bioaccumulate. Also, these water-soluble polymers can form insoluble calcium salts in natural waters, suggesting that bioaccumulation is unlikely.

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

Sodium polyacrylates have low acute toxicity by the oral and dermal routes. These polymers are not irritating to the skin and eyes; nor are they skin sensitizers. No systemic toxicity was observed in rats given high oral doses of a sodium polyacrylate for four weeks; pulmonary irritation was seen in rats that inhaled an aerosol or dust of a sodium polyacrylate for 13 weeks, but no systemic toxicity. No developmental toxicity was seen in rats when given high oral doses of sodium polyacrylates. Sodium polyacrylates are not genotoxic.

##### B. Acute Toxicity

Acute oral toxicity studies have been conducted in rats on the sodium polyacrylate with MW of 1,000 to 78,000. The oral LD50 values are >5,000 or >10,000 mg/kg (the highest doses tested), with the exception of one study on a 3,500 MW sodium polyacrylate, which was reported to be >1,000 mg/kg (the attainable limit dose of a 10% aqueous solution) (HERA, 2014). [Kl. scores = 2]

The dermal LD50 values in rabbits for sodium polyacrylates with MW of 1,000 or 4,500 are >5,000 mg/kg (HERA, 2014). [Kl. scores = 2]

No acute inhalation studies are available.

##### C. Irritation

The sodium polyacrylates with MW of 1,000 to 78,000 are not irritating to the skin or eyes (HERA, 2014). [Kl. scores = 2]

##### D. Sensitisation

Sodium polyacrylates with MW of 4,500 or 78,000 were not dermal sensitizers in the guinea pig maximisation test (HERA, 2014). [Kl. scores = 2 and 4, respectively]

##### E. Repeated Dose Toxicity

###### Oral

Male rats were given in their feed 0 or 2.5% sodium polyacrylate (MW 2,500) for four weeks. Body weight, body weight gain and appearance of the animals were similar between treated and controls. In the fourth week of the study, a small, but significant, decrease in total weight of bone minerals was detected and confirmed by radiographic and histological examination. There was a significant reduction in the concentration of magnesium in the bones and plasma of the treated animals. Calcium loss was slight and not statistically significant. Urinary excretion of sodium and phosphorus was markedly increased; calcium only slightly increased. The authors of the study interpreted the finding as a metabolic imbalance rather than systemic toxicity. Sodium excretion could have been increased by the high intake of the sodium-neutralized test substance. The NOAEL for the study was considered to be 2.5% sodium polyacrylate in the diet, which was estimated to be 1,136 mg/kg-day (HERA, 2014). [Kl. score = 2]

###### Inhalation

Male and female rats were exposed by inhalation to 0, 0.2, 1.0, or 5.0 mg/m<sup>3</sup> sodium polyacrylate (MW 4,500) as an aerosol for 6 hours/day, 5 days/week for 13 weeks. Additional groups of animals were exposed for 13 weeks followed by a 91-day recovery period. There were no treatment-related effects



on body weights, organ weights, feed and water consumption, clinical observations, and blood chemistry. In the histopathologic examination, the lungs of the mid- and high-dose animals showed signs of mild pulmonary irritation: increased in polymorphonuclear granulocytes or alveolar macrophages, pneumocyte hyperplasia, alveolar wall thickening and focal alveolitis. The lung effects were reversible and were not seen in the recovery group animals, with an NOEC for systemic effects in this study was considered to be 5 mg/m<sup>3</sup>, and the NOEC for localised irritation being 0.2 mg/m<sup>3</sup> (HERA, 2014). [Kl. score = 2]

#### Dermal

No studies were identified.

### **F. Genotoxicity**

#### In Vitro Studies

The *in vitro* studies conducted on sodium polyacrylates are presented below in Table 1. All of the studies show that sodium polyacrylates are not mutagenic or genotoxic.

**Table 1: In Vitro Genotoxicity Studies on Sodium Polyacrylates (HERA, 2014)**

Mean MW	Test System	Results*	Klimisch Score	Reference
2,000	Bacterial reverse mutation	-	2	HERA (2014)
2,000	Mouse lymphoma	-	2	HERA (2014)
2,000	Unscheduled DNA synthesis	-	2	HERA (2014)
4,500	Bacterial reverse mutation	-	2	HERA (2014)
4,500	Mouse lymphoma	-	2	HERA (2014)
4,500	Unscheduled DNA synthesis	-	2	HERA (2014)
4,500	Cytogenetic (CHO cells)	-	2	HERA (2014)
4,500	Bacterial reverse mutation	-	2	HERA (2014)
4,500	Mammalian cell gene mutation	-	2	HERA (2014)
4,500	Unscheduled DNA synthesis	-	2	HERA (2014)

\*+, positive; -, negative

#### In Vivo Studies

There was no increase in micronuclei in polychromatic erythrocytes from the bone marrow of mice given a single oral gavage dose of 13,850 mg/kg sodium polyacrylate with an MW of 2,000 (HERA, 2014).

### **G. Carcinogenicity**

No studies are available.

### **H. Reproductive Toxicity**

No studies are available

## I. Developmental Toxicity

Pregnant female rats were dosed by oral gavage with 0, 500, 1,000, or 3,000 mg/kg sodium polyacrylate (MW 4,500) on GD 6 to 15. At 3,000 mg/kg, the dams had soft or liquid stools during the treatment period. There was no maternal or developmental toxicity observed in this study. The NOAEL for maternal and developmental toxicity is 3,000 mg/kg-day (HERA, 2014). [Kl. score = 2]

Pregnant female rats were dosed by oral gavage with 0, 125, 375, or 1,125 mg/kg sodium polyacrylate (MW 90,000 as a 77.5% aq. solution) during GD 6 to 13. Some of the dams were sacrificed on GD 13 and the remaining on GD 19. One mid-dose dam and 6 high-dose dams died during the study; of these, three of the high-dose deaths were treatment-related, and the remaining were considered the result of gavage errors. There was a transient decrease in feed consumption in the high-dose dams during GD 7-9, but not other indications of maternal toxicity. There was no developmental toxicity. The NOAELs for maternal and developmental toxicity are 375 and 1,125 mg/kg-day (HERA, 2014). [Kl. score = 2]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

NICNAS has assessed sodium polyacrylates in an IMAP Tier 1 assessment and considers it “a chemical identified as a low concern to human health by application of expert validated rules”.<sup>1</sup>

The toxicological reference values developed for sodium polyacrylates 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).

### A. Non-Cancer

#### Oral

A 4-week dietary study showed no systemic toxicity in rats given 2.5% sodium polyacrylate (MW 2,500) in their feed. The estimated dose is 1,136 mg/kg-day. Two prenatal developmental toxicity studies showed no effects at the highest dose tested: 3,000 and 1,125 mg/kg-day for sodium polyacrylates with MW of 4,500 and 90,000, respectively. The NOAEL of 1,136 mg/kg-day from the 4-week dietary study will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subacute to chronic) = 10

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 1,136 / (10 \times 10 \times 1 \times 10 \times 1) = 1,136 / 1,000 = \underline{1.0 \text{ mg/kg-day}}$$

<sup>1</sup>[https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A\\_9003-04-7](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_9003-04-7)

### 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 =  $(1 \times 70 \times 0.1)/2 = 4 \text{ mg/L}$

## B. Cancer

No carcinogenicity studies have been conducted on sodium polyacrylates. Thus, a cancer reference value was not derived.

## VI. Human Health Hazard Assessment of Physico-Chemical Properties

Sodium polyacrylates do not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Sodium polyacrylates exhibit a low toxicity concern for aquatic organisms, terrestrial invertebrates, and plants.

### B. Aquatic Toxicity

#### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on sodium polyacrylates.

**Table 2: Acute Aquatic Toxicity Studies on Sodium Polyacrylates**

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
1,000	<i>Brachydanio rerio</i>	96-hr LC <sub>50</sub>	>200	1	HERA, 2014
1,000	<i>Salmo gairdneri</i>	96-hr LC <sub>50</sub>	>1,000	1	HERA, 2014
1,200	<i>Leuciscus idus</i>	96-hr LC <sub>50</sub>	>500	1	HERA, 2014
2,000	<i>Brachydanio rerio</i>	96-hr LC <sub>50</sub>	>200	1	HERA, 2014
2,500	<i>Leuciscus idus</i>	96-hr LC <sub>50</sub>	>500	1	HERA, 2014
4,500	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	>1,000	1	HERA, 2014
4,500	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	>1,000	1	HERA, 2014

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
8,000	<i>Leuciscus idus</i>	96-hr LC <sub>50</sub>	>500	1	HERA, 2014
10,000	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	>1,000	1	HERA, 2014
15,000	<i>Leuciscus idus</i>	96-hr LC <sub>50</sub>	>10,000	1	HERA, 2014
78,000	<i>Brachydanio rerio</i>	96-hr LC <sub>50</sub>	>400	2	HERA, 2014
1,000	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>200	1	HERA, 2014
1,000	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>1,000	1	HERA, 2014
2,000	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>200	1	HERA, 2014
4,500	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>200	1	HERA, 2014
4,500	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>1,000	1	HERA, 2014
78,000	<i>Daphnia magna</i>	24-hr EC <sub>50</sub>	276	2	HERA, 2014
8,000	<i>Selenastrum capricornutum</i>	72-hr EC <sub>50</sub>	40	1	HERA, 2014
78,000	<i>Scenedesmus subspicatus</i>	96-hr EC <sub>50</sub>	44	2	HERA, 2014

### Chronic Studies

Table 3 lists the results of chronic aquatic toxicity studies conducted on sodium polyacrylates.

**Table 3: Chronic Aquatic Toxicity Studies on Sodium Polyacrylates (HERA, 2014)**

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
4,500	<i>Pimephales promelas</i>	32-d NOEC	56	2	HERA, 2014
4,500	<i>Brachydanio rerio</i>	28-d NOEC	>450	1	HERA, 2014
78,000	<i>Brachydanio rerio</i>	14-d NOEC	>400	2	HERA, 2014
4,500	<i>Daphnia magna</i>	21-d NOEC	450	1	HERA, 2014
4,500	<i>Daphnia magna</i>	21-d NOEC	58	1	HERA, 2014
4,500	<i>Daphnia magna</i>	21-d NOEC	12	2	HERA, 2014
78,000	<i>Daphnia magna</i>	21-d NOEC	100	2	HERA, 2014
4,500	<i>Scenedesmus subspicatus</i>	96-hr NOEC	180	2	HERA, 2014
78,000	<i>Scenedesmus subspicatus</i>	96-hr NOEC	32.8	2	HERA, 2014

There is considerable variability in the chronic aquatic toxicity results for *Daphnia magna* for sodium polyacrylates with the same molecular weight of 4,500. This was discussed in HERA (2014) and was explained by the solubility of sodium polyacrylates in water. In distilled water, the solubility of sodium polyacrylates with the molecular weight of 4,500 is >400 mg/L; however, under test conditions, water solubility will decrease due to the presence of Ca<sup>++</sup> and Mg<sup>++</sup> (as measured by water hardness). In a study by BASF (reviewed in HERA, 2014), the water solubility of sodium polyacrylate (MW 4,500) was determined with radiolabelled compounds in a test system with a calcium concentration of 70 mg/L, which corresponds to the mean water hardness to the media used in an OECD TG 202 test. Under these

conditions, the water solubility of sodium polyacrylate was 1.3 mg/L after 24 hours. So, one explanation for the variability of the chronic *Daphnia* studies may be due to differences in water hardness.

### C. Toxicity to Sediment Organisms

The 96-hr EC<sub>0</sub> to *Chironomus riparius* (larvae) is >4,500 mg/kg sediment dry weight (HERA, 2014).

### D. Terrestrial Toxicity

The results of terrestrial toxicity studies conducted on sodium polyacrylate polymers are listed below.

**Table 3: Terrestrial Toxicity Studies on Sodium Polyacrylates (HERA, 2014)**

Mean MW	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
4,500	<i>Eisenia foetida foetida</i>	14-d EC <sub>0</sub>	1,000	1	HERA, 2014
78,000	<i>Eisenia foetida andrei</i>	14-d EC <sub>0</sub>	1,000	2	HERA, 2014
78,000	<i>Brassica rapa</i>	21-d NOEC	1,000	2	HERA, 2014
4,500	Nitrogen transformation*	28-d EC <sub>10</sub>	>2,500	1	HERA, 2014
4,500	Carbon transformation*	28-d EC <sub>10</sub>	>2,500	1	HERA, 2014

\*Soil organisms

### E. Calculation of PNEC

The PNEC calculations for sodium polyacrylates follow the methodology discussed in DEWHA (2009).

#### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (>200 mg/L), invertebrates (>200 mg/L), and plants (40 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 12 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 12 mg/L for invertebrates. The PNEC<sub>water</sub> is 1.2 mg/L.

#### PNEC sediment

Experimental results are available for one trophic level. There were no visual signs of toxicity to *Chironomus riparius* (larvae) at the highest concentration tested (>4,500 mg/kg sediment dry weight) (HERA) 2014). The EC<sub>0</sub> is considered to be above 4,500 mg/kg, and an assessment factor cannot apply. Thus, the equilibrium partitioning method will be used to determine the PNEC<sub>sed</sub>. The HERA (2014) risk assessment is calculated a PNEC<sub>sed</sub> of 130 mg/kg sediment wet weight using the default of 0.05 as the weight fraction of organic carbon in sediment according to the EU Technical Guidance Document (TGD) (EU 2003).

#### PNEC soil

Experimental results are available for three trophic levels. An acute LC<sub>50</sub> value is available for earthworms (1,000 mg/kg soil dry weight). A 21-day NOEC for *Brassica rapa* was reported to be 1,000 mg/kg soil dry weight. Results from two long-term studies are available for soil microorganisms, with the NOECs for nitrogen and carbon transformation being >2,500 mg/kg soil dry weight. On the basis that the data consists of short-term tests, as well as one long-term test from one trophic level, an

assessment factor of 100 has been applied to the lowest reported long-term NOEC of >2,500 mg/kg soil dry weight. The PNEC<sub>soil</sub> is 25 mg/kg soil dry weight.

## **VIII. PBT ASSESSMENT**

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).

The sodium polyacrylates are not readily biodegradable; thus, they meet the screening criteria for persistence.

The sodium polyacrylates are expected to have high molecular weights and are not expected to be bioavailable. Thus, these polymers do not meet the criteria for bioaccumulation.

Chronic NOECs for fish, daphnia and algae are available for sodium polyacrylates, and the NOEC values are >0.1 mg/L. Thus, sodium polyacrylates do not meet the screening criteria for toxic.

The overall conclusion is that sodium polyacrylates are not PBT substances.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Not classified.

### **B. Labelling**

No signal word.

### **C. Pictograms**

None.

## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) on THERMA-THIN® (revision date: 29 January 2013).

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Do not induce vomiting. Slowly dilute with 1-2 glasses of water or milk and seek medical attention. Never give anything by mouth to an unconscious person.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS on THERMA-THIN® (revision date: 29 January 2013).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS on THERMA-THIN® (revision date: 29 January 2013).

### Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS on THERMA-THIN® (revision date: 29 January 2013).

### General Handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Slippery when wet.

## Storage

Store away from oxidizers. Store in a cool, dry location. The product has a shelf life of 36 months.

## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

There are no occupational exposure standards for sodium polyacrylates.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS on THERMA-THIN® (revision date: 29 January 2013).

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None known.

## **F. Transport Information**

Sodium polyacrylates are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.



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.

enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

HERA (2014). Human & Environmental Risk Assessment (HERA) on ingredients of European household cleaning products. Polycarboxylates used in detergents (Part I): Polyacrylic acid homopolymers and their sodium salts (CAS 9003-04-7). ([http://www.heraproject.com/files/HERA\\_P-AA\\_final\\_v3\\_23012014.pdf](http://www.heraproject.com/files/HERA_P-AA_final_v3_23012014.pdf))

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.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
QSAR	quantitative structure–activity relationship
RfD	oral Reference Dose

SDS	Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document

## STARCH

This dossier on starch does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of starch in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Starch

**CAS RN:** 9005-25-8

**Molecular formula:**  $(C_6H_{10}O_5)_n$

**Molecular Weight:** Not available

**Synonyms:** Corn starch, rice starch, sorghum gum, starch gum, tapioca starch

Starch is a polysaccharide comprising glucose monomers joined in  $\alpha 1,4$  linkages. The simplest form of starch is the linear polymer amylose; amylopectin is the branched form. Starch is manufactured in the green leaves of plants from excess glucose produced during photosynthesis and serves the plant as a reserve food supply. When required, starch is broken down, in the presence of certain enzymes and water, into its constituent monomer glucose units, which diffuse from the cell to nourish the plant tissues. In humans and other animals, starch is broken down into its constituent sugar molecules, which then supply energy to the tissues<sup>1</sup>.

### II. PHYSICO-CHEMICAL PROPERTIES

Starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol or other solvents<sup>2</sup>

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Starch is a polysaccharide comprising glucose monomers joined in  $\alpha 1,4$  linkages. The simplest form of starch is the linear polymer amylose; amylopectin is the branched form. Starch is manufactured in the green leaves of plants from excess glucose produced during photosynthesis and serves the plant as a reserve food supply. Starch is expected to be biodegradable and not bioaccumulative.

#### B. Biodegradation

When required, starch is broken down, in the presence of certain enzymes and water, into its constituent monomer glucose units, which diffuse from the cell to nourish the plant tissues. In humans and other animals, starch is broken down into its constituent sugar molecules, which then supply energy to the tissues<sup>3</sup>.

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<sup>1</sup> <https://www.britannica.com/science/starch>

<sup>2</sup> <https://www.britannica.com/science/starch>

<sup>3</sup> <https://www.britannica.com/science/starch>

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

No toxicity studies are available on starch. It is the most common carbohydrate in human diets and is contained in large amounts in staple foods such as potatoes, wheat, maize (corn), rice, and cassava.<sup>4</sup>

NICNAS has assessed starch in an IMAP Tier 1 assessment and considers it “a chemical identified as a low concern to human health by application of expert validated rules”.<sup>5</sup>

#### V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

No toxicological reference or drinking water guidance values were derived from starch.

#### VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Starch does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

#### VII. ENVIRONMENTAL HAZARD ASSESSMENT

##### A. Summary

Starch is not toxic to aquatic organisms.

##### B. Aquatic Toxicity

###### Acute Studies

Table 1 lists the results of acute aquatic toxicity studies conducted on starch

**Table 1: Acute Aquatic Toxicity studies on Starch**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Orthopristis chrysoptera</i> (pinfish)	96-hr LC <sub>50</sub>	>5,000 (no mortality)	4	USEPA
<i>Bairdiella chrysoura</i> (silver perch)	96-hr LC <sub>50</sub>	>5,000 (no mortality)	4	USEPA
<i>Lagodon rhomboids</i> (pinfish)	96-hr LC <sub>50</sub>	>5,000 (no mortality)	4	USEPA

###### Chronic Studies

No chronic studies are available.

<sup>4</sup> <https://en.wikipedia.org/wiki/Starch>

<sup>5</sup> [https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A\\_9005-25-8](https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessments/tier-i-human-health-assessments#cas-A_9005-25-8)

### C. Terrestrial Toxicity

No studies were identified.

### D. Calculation of PNEC

The PNEC calculations for starch follow the methodology discussed in DEWHA (2009).

#### PNEC freshwater

Experimental results are available for only one trophic level. The acute  $LC_{50}$  values for three different species of freshwater fish is  $>5,000$  mg/L. On the basis that the data consists of short-term results from one trophic level, an assessment factor of 1,000 has been applied to the reported value of 5,000 mg/L. The  $PNEC_{water}$  is 5 mg/L.

#### PNEC sediment

A  $PNEC_{sed}$  was not calculated for starch. There are no experimental toxicity data on sediment organisms, and a  $K_{oc}$  value for starch is unavailable for calculating the  $PNEC_{sed}$  using the equilibrium partition method. A  $K_{oc}$  value for starch has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as starch.

#### PNEC soil

A  $PNEC_{soil}$  was not calculated for starch. There are no experimental toxicity data on terrestrial organisms, and a  $K_{oc}$  value for starch is unavailable for calculating the  $PNEC_{sed}$  using the equilibrium partition method. A  $K_{oc}$  value for starch has not been determined experimentally, and QSAR models are invalid for high molecular weight polymers, such as starch.

## VIII. PBT ASSESSMENT

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).

Starch is expected to be readily biodegradable. Therefore, it does not meet the screening criteria for persistence.

Starch is a polysaccharide with a high molecular weight (~21,000 to 500,000) which limits its bioavailability to aquatic organisms. Therefore, it is not expected to bioaccumulate.

There are no chronic toxicity studies on starch. The acute  $E(L)C_{50}$  values for starch are  $>0.1$  mg/L. Therefore, starch does not meet the screening criteria for toxicity.

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

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

Starch is considered a non-hazardous material according to the criteria of NOHSC. Under the Australia GHS, no classification and labelling are necessary.

However, DEXTRID® LTE, the commercial product of starch used in drilling muds, contains 0.1 to 1% tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet). Dazomet is a hazardous material

according to the criteria of NOHSC. Because dazomet is present in DEXTRID® LTE at concentrations up to 1%, the following GHS classification and labelling is required for DEXTRID® LTE:

#### A. Classification

Acute Toxicity Category 4 [oral]

Eye Irritant Category 2

STOT RE Category 2 [liver]

Note: Aquatic toxicity classification is not required for Australia GHS.

#### B. Labelling

Warning

#### C. Pictograms



### X. SAFETY AND HANDLING

#### A. First Aid

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) for DEXTRID® LTE (revision 24-Nov-2015). Bold text is additional information that is required under GHS from the presence of up to 1% Dazomet in the product.

##### Eye Contact

**IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.**

##### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

##### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

##### Ingestion

**IF SWALLOWED: Call a POISON CENTER or physician if you feel unwell. Rinse mouth.**

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS for DEXTRID® LTE (revision 24-Nov-2015).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential. Decomposition in fire may produce toxic gases.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained from the Halliburton SDS for DEXTRID® LTE (revision 24-Nov-2015). Bold text is additional information that is required under GHS from the presence of up to 1% Dazomet in the product.

### Personal Precautions

Use Appropriate protective equipment. **Do not breath dust.**

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS for DEXTRID® LTE (revision 24-Nov-2015). Underlined text is additional information that is required under GHS from the presence of up to 1% Dazomet in the product.

### General Handling

Avoid creating or inhaling dust. Avoid dust accumulations. Wash hands after use. **Do not breathe dust. Get medical attention if you feel unwell.**

### Storage

Store away from oxidizers. Store in a cool, dry location. The product has a shelf life of 12 months.

## E. Exposure Controls/Personal Protection

### Occupational Exposure Standards

The workplace exposure standard for starch in Australia is 10 mg/m<sup>3</sup> as an inhalable dust.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS for DEXTRID® LTE (revision 24-Nov-2015). Bold text is additional information that is required under GHS from the presence of up to 1% Dazomet in the product.

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

*Respiratory Protection:* Not normally needed; however, if significant exposure is possible then the following respirator is recommended. Dust/mist/respirator. (N95, P2/P3)

*Hand Protection:* Impervious rubber gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* **Wear protective gloves/protective clothing/eye protection/face protection.**

## F. Transport Information

Starch and DEXTRID® LTE are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

## XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

## XIII. 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.

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.



USEPA. ECOTOX Database. Available at: <http://cfpub.epa.gov/ecotox/>

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system
USEPA	United States Environmental Protection Agency

## XANTHAN GUM

This dossier on xanthan gum does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of xanthan gum in its use in drilling muds and hydraulic fracturing fluids. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

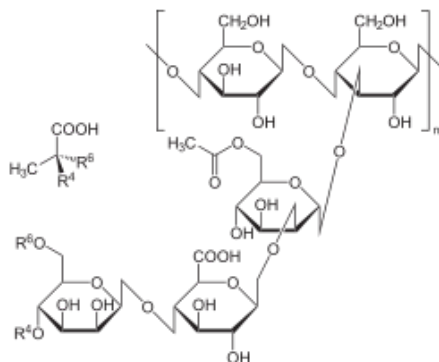
**Chemical Name:** Xanthan Gum

**CAS RN:** 11138-66-2

**Molecular Weight:**  $2 \times 10^6$  (Dintzis et al., 1970)

**Synonyms:** Xanthan gum, gum xanthan, corn sugar gum

Xanthan gum is a high molecular weight polysaccharide gum produced by the bacterium *Xanthomonas campestris*. The chemical structure has been described by García-Ochoa, et al. (2000): the primary structure consists of repeating pentasaccharide units formed by two glucose units, two mannose units, and one glucuronic acid unit, in the molar ratio 2.8:2.0:2.0 (see figure 1). Its main chain consists of  $\beta$ -D-glucose units linked at the 1 and 4 positions. The chemical structure of the main chain is identical to that of cellulose. Trisaccharide side chains contain a D-glucuronic acid unit between two D-mannose units linked at the O-3 position of every other glucose residue in the main chain. Approximately one-half of the terminal D-mannose contains a pyruvic acid residue linked via keto group to the 4 and 6 positions, with an unknown distribution. D-Mannose unit linked to the main chain contains an acetyl group at position O-6. The presence of acetic and pyruvic acids produces an anionic polysaccharide type.



### II. PHYSICO-CHEMICAL PROPERTIES

No specific data were located. Xanthan gum has unique physical properties that have resulted in applications in the food, cosmetic, pharmaceutical, and oil and gas industry. Xanthan gum shows pseudoplasticity of the solution, minimal change of viscosity over a wide range of temperatures, solubility and stability in both acid and alkaline solutions, viscosity stability over a wide pH range, and suspending properties for hard-to-suspend solids (Rocks, 1971).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Xanthan gum is a high molecular weight polysaccharide gum produced by the bacterium *Xanthomonas campestris*. Studies have shown that xanthan gum may be degraded by some micro-organisms, but it is not readily biodegradable. It is not expected to bioaccumulate due to its large molecular weight.

#### B. Biodegradation

No studies were identified. Xanthan gum is a highly stable polysaccharide that is not easily degraded by most micro-organisms (Cadmus et al., 1982). The stability of xanthan gum may be affected when soil organisms at high concentrations are in contact with it for one month (Cadmus et al., 1982). These investigators were also able to isolate certain strains of bacteria isolated from sewage sludge and soil that released enzymes that could degrade xanthan gum (Cadmus et al., 1982). These findings suggest that xanthan gum may be degradable, but not readily biodegradable.

#### C. Bioaccumulation

Xanthan gum is a high molecular weight polysaccharide ( $2 \times 10^6$ ). Due to its large molecular weight, it is not expected to be bioavailable. This is confirmed in rat studies (see section IV.A.). Therefore, xanthan gum is not expected to bioaccumulate.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Xanthan is not acutely toxic. It is neither irritating or sensitising to the skin. No toxicity or carcinogenicity was seen in rats given xanthan gum up to 1,000 mg/kg-day in their diet for two years. No reproductive or developmental toxicity was seen in rats given high doses of xanthan gum in the feed.

#### B. Toxicokinetics and Metabolism

Xanthan gum is practically not absorbed from the gastrointestinal tract.

In caloric availability and digestibility studies in which rats were fed a diet supplemented with xanthan gum for seven days, none of the xanthan gum was digestible and could be accounted for in the feces. (Booth *et al.* 1963). [Kl. score = 4]

[ $^{14}\text{C}$ ]-labelled xanthan gum, prepared by the fermentation of uniformly labelled glucose with *Xanthomonas campestris*, was fed to rats at a level of 2% (50 mg. total) in the diet. A maximum of 15% of the [ $^{14}\text{C}$ ] label was metabolised to  $\text{CO}_2$  in 100 hours. It was found from *in vitro* tests that acetate content of the xanthan gum test sample was labile at gastric pH, which would account for some of the  $^{14}\text{CO}_2$ . That fact that 15% of the [ $^{14}\text{C}$ ] label was metabolised to  $\text{CO}_2$  suggests that there was limited metabolism of the hexoses. No accumulation in the tissues was found, and the observed metabolism of labelled material and distribution of  $^{14}\text{C}$  in tissues was that expected from feeding a simple  $^{14}\text{C}$ -labelled molecule such as acetate or hexose. Analysis of fecal material showed no accumulation of the five polysaccharide constituents, except acetate. Some 98% of the radioactivity in the feces could be attributed to the unchanged or only slightly modified polysaccharide. *In vitro* studies indicated that non-enzymatic hydrolysis and the action of fecal microorganisms are responsible for the initial breakdown of polysaccharide *in vivo* (WHO, 1987). [Kl. score = 4]

### C. Acute Toxicity

The oral LD<sub>50</sub> values have been reported to be >45,000 mg/kg in rats (WHO, 1987); >1,000 mg/kg in mice (Booth et al. 1963), and >20,000 mg/kg in dogs (WHO, 1987). No mortality or signs of toxicity were observed when rats were exposed by inhalation to 21 mg/L of xanthan gum for one hour (WHO, 1987). [Kl. scores = 4]

### D. Irritation

Daily application of a 1% solution for 15 days to the skin of rats produced no signs of irritation (WHO, 1987). Daily application of a 1% solution for five days to the eyes of rabbits produced no signs of irritation (WHO, 1987). [Kl. score = 4]

### E. Sensitisation

Xanthan gum is not a skin sensitiser to guinea pigs (WHO, 1987). [Kl. score = 4]

### F. Repeated Dose Toxicity

#### Oral

Rats were fed 0, 3, 6, 7.5 or 15% xanthan gum for 91 days. Weight gain was reduced in the  $\geq 7.5\%$  dose groups. No significant alterations in haemoglobin, red or white cell counts, or organ weights were observed at any dose level. No adverse treatment-related effects were noted in the histopathological examination at the 15% dose level. However, the animals in the 15% dose level produced abnormally large faecal pellets, but diarrhoea did not occur. A paired-feeding test was used to compare the growth of rats ingesting a diet containing 7.5% xanthan gum and comparable rats restricted to the same intake of control diet. No differences in weight gain were found at the end of 18 days, indicating a lack of systemic toxicity from xanthan gum exposure (Booth et al. 1963). [Kl. score = 4]

Male and female CD rats were fed in their diets 0, 250, 500 or 1,000 mg/kg-day xanthan gum for 104 weeks. There were no treatment-related effects on survival, body weight gain, food consumption, behaviour, or appearance. Ophthalmic and hematologic examination, analysis of blood for glucose, SGOT, and prothrombin time showed no differences between treated and controls animals. Organ weights were within normal limits, and no lesions attributable to xanthan gum were found on gross and histopathological examination. The NOAEL for this study is 1,000 mg/kg-day (Woodard et al., 1973). [Kl. score = 2]

Male and female beagle dogs (three/group) were given in their diet 0, 250, or 500 mg/kg-day xanthan gum for 12 weeks. In the 500 mg/kg-day group, the animals had softer stools than normal, but no diarrhoea. There was slightly reduced growth in the 500 mg/kg-day males, and the serum cholesterol level was lowered in both sexes of the 500 mg/kg-day group. No other adverse effects were seen. The NOAEL for this study was considered to be 250 mg/kg-day (WHO, 1987). [Kl. score = 2]

Male and female beagle dogs (four/group) were given in their diet 0, 250, 370, or 1,000 mg/kg-day for 107 weeks. There were no treatment-related effects on survival, food intake, body weight gain, electrocardiograms, blood pressure, heart rate, body temperature, or ophthalmic and neurological examinations. Haematological and clinical chemistry parameters were comparable between treated and control animals. There were no treatment-related effects in the urinalysis except for a dose-related increase in urine specific gravity and a more frequent appearance of urinary albumin in the high-dose group compared to the other groups. Stool consistency was normal in the 370 mg/kg dose level but was loose in the 1,000 mg/kg group. The weight of the faeces showed a dose-related increase, as would be expected from feeding a non-absorbed hydrophilic gum at high-dose levels. The increased urinary specific gravity is consistent with physiological adjustment for the extra water excreted in the faeces.

Examination of the appearance and weights of organs and histopathological examinations showed no adverse treatment-related effects. The NOAEL for this study is 1,000 mg/kg-day (Woodward et al., 1973). [Kl. score = 2]

#### Inhalation

No studies were identified.

#### Dermal

No studies were identified.

### **G. Genotoxicity**

No studies were identified.

### **H. Carcinogenicity**

#### Oral

Male and female CD rats were fed in their diets 0, 250, 500 or 1,000 mg/kg-day xanthan gum for 104 weeks. There were no treatment-related effects on survival. Tumour incidences were similar between treated and control rats (Woodard et al., 1973). [Kl. score = 2]

### **I. Reproductive Toxicity**

A three-generation reproduction study was conducted in rats given 0, 250 or 500 mg/kg-day xanthan gum in the diet. There were no treatment-related reproductive effects (Woodard et al. 1973). [Kl. score = 2]

### **J. Developmental Toxicity**

A three-generation reproduction study was conducted in rats given 0, 250 or 500 mg/kg-day xanthan gum in the diet. There were no treatment-related developmental effects (Woodard et al., 1973). [Kl. score = 2]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for xanthan gum 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).

### **A. Non-Cancer**

#### Oral

A two-year rat feeding study has been conducted on xanthan gum (Woodward et al., 1973). There were no adverse effects seen at doses up to 1,000 mg/kg-day, the highest dose tested. The NOAEL of 1,000 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

### *Oral Reference Dose (oral RfD)*

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subacute to chronic) = 10

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 1,000 / (10 \times 10 \times 1 \times 10 \times 1) = 1,000/100 = \underline{10 \text{ mg/kg-day}}$$

### *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 = 2 L (ADWG, 2011)

Drinking water guidance value =  $(10 \times 70 \times 0.1)/2 = 35 \text{ mg/L}$

## **B. Cancer**

Xanthan gum was not carcinogenic to rats in a chronic feeding study. Therefore, no cancer reference value was derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Xanthan gum does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Aquatic Toxicity**

No studies are available on xanthan gum. Xanthan gum is a high molecular weight polysaccharide ( $2 \times 10^6$ ), which due to its size, is not expected to be bioavailable. Hence, xanthan gum is expected to be non-toxic to aquatic organisms.

### **B. Terrestrial Toxicity**

No studies were identified.

### **C. Calculation of PNEC**

PNEC values were not calculated for xanthan gum. Xanthan gum is a high molecular weight polysaccharide ( $2 \times 10^6$ ), which due to its size, is not expected to be bioavailable.

## **VIII. PBT ASSESSMENT**

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).

No biodegradation studies have been conducted on xanthan gum. Xanthan gum is a highly stable polysaccharide that is not easily degraded by most micro-organisms, although there are some bacterial strains that can degrade this polysaccharide. Xanthan gum is expected to be degradable but is unlikely to be readily biodegradable. Therefore, it is expected to meet the screening criteria for persistence.

Xanthan gum is a high molecular weight polysaccharide ( $2 \times 10^6$ ), which due to its size, is not expected to be bioavailable. Therefore, xanthan gum is not expected to meet the criteria for bioaccumulation.

No aquatic toxicity studies are available on xanthan gum. Xanthan gum is expected to be non-toxic to aquatic organisms because of its lack of bioavailability due to its high molecular weight.

The overall conclusion is that xanthan gum is not a PBT substance.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Not classified.

### **B. Labelling**

No signal word.

### **C. Pictograms**

None

## **X. SAFETY AND HANDLING**

### **A. First Aid**

First aid information was obtained from the Halliburton Safety Data Sheet (SDS) (revision date: 20-Dec-2012).

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

#### Skin Contact

Wash with soap and water. Get medical attention if irritation persists.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Under normal conditions, first aid procedures are not required.

## **B. Firefighting Information**

Firefighting information was obtained from the Halliburton SDS (revision date: 20-Dec-2012).

### Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Decomposition in fire may produce toxic gases. Organic dust in the presence of an ignition source can be explosive in high concentrations. Good housekeeping practices are required to minimise this potential.

### Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

## **C. Accidental Release Measures**

Information on accidental release measures was obtained the Halliburton SDS (revision date: 20-Dec-2012).

### Personal Precautions

Use Appropriate protective equipment. Avoid creating and breathing dust.

### Environmental Precautions

None known

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. Storage and Handling**

Information on storage and handling was obtained from the Halliburton SDS (revision date: 20-Dec-2012).

### General Handling

Slippery when wet. Avoid creating or inhaling dust.



### Storage

Store away from oxidizers. Store in a cool, dry location. Product has a shelf life of 24 months

## **E. Exposure Controls/Personal Protection**

### Occupational Exposure Standards

Occupational exposure standards for xanthan gum have not been established.

The information below on exposure controls and personal protection was obtained from the Halliburton SDS (revision date: 20-Dec-2012).

### Engineering Controls

Use in a well-ventilated area.

### Personal Protection Equipment

*Respiratory Protection:* Not normally needed. However, if significant exposures are possible then the following respirator is recommended. Dust/mist respirator. (N95, P2/P3)

*Hand Protection:* Normal work gloves.

*Skin Protection:* Normal work coveralls.

*Eye protection:* Wear safety glasses or goggles to protect against exposure.

*Other Precautions:* None known.

## **F. Transport Information**

Xanthan gum is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Biesinger, K.E. et al. (1976). Comparative toxicity of polyelectrolytes to selected aquatic animals. J. Water Pollut. Control Fed. 48: 183-187; cited in NZ HSNO CCID.

- Booth, A.N., Hendrickson, A.P., and De Eds, F. (1963). Physiologic effects of three microbial polysaccharides on rats. *Toxicol. Appl. Pharmacol.*, 5: 478-484.
- 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.
- Dintzis, F.R., Babcock, G.E., and Tobin, R. (1970). Studies on dilute solutions and dispersions of the polysaccharide from *Xanthomonas campestris* NRRL B-1459. *Carbohydrate Res.* 13: 257-267.
- enHealth Human Risk Assessment (HHRA). (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency (ECHA). (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- García-Ochao, F., Santos, V.E., Casas, J.A., and Gómez, E. (2000). Xanthan gum: production, recovery, and properties. *Biotechnol. Adv.* 18: 549-579.
- 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.
- Rocks (1971). Xanthan Gum. *Food Technol.* 25: 22-31.
- WHO (1987) Xanthan Gum, WHO Food Additive Series, 21. Available at: <http://www.inchem.org/documents/jecfa/jecmono/v21je01.htm>
- Woodard, G., Woodard, M.W., McNeely, W.H., Kovacs, P., and Cronin, M.T.I. (1973). Xanthan gum: safety evaluation by two-year feeding studies in rats and dogs and a three-generation reproduction study in rats. *Toxicol. Appl. Pharmacol.* 24: 30-36.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight

NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
WHO	World Health Organisation

**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Aluminium chlorohydrate	1327-41-9	Aluminium chlorohydrate is very soluble in water and will dissociate to form Aluminium hydroxide species and chloride ions. Biodegradation is not applicable to Aluminium chlorohydrate. The Aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Aluminium chlorohydrate is not expected to bioaccumulate in aquatic organisms. Aluminium chlorohydrate has low acute toxicity by the oral and dermal routes. It is non-irritating to the skin and slightly irritating to the eyes. It is not a skin sensitiser. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day Aluminium chlorohydrate in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Aluminium chlorohydrate is not genotoxic. The Australian drinking water guideline values for aluminium (acid-soluble) is 0.2 mg/L based on aesthetics. ADWG has concluded that there is insufficient data to set a guidance value based on health considerations. The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of trigger values for Aluminium, which are 55 µg/L at pH >6.5 and 0.8 µg/L at pH of <6.5.
Calcium chloride	10043-52-4	Calcium chloride dissociates completely in aqueous solutions to calcium (Ca <sup>2+</sup> ) and chloride (Cl <sup>-</sup> ) ions. Calcium chloride and its dissociated ions are ubiquitous in the environment. Because of its dissociation properties and high water solubility, calcium chloride is not expected to be adsorbed to soil. Calcium (Ca <sup>2+</sup> ) and chloride (Cl <sup>-</sup> ) ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Neither calcium chloride or its dissociated ions are expected to bioaccumulate. Calcium chloride exhibits low acute toxicity by the oral and dermal routes. It is irritating to the eyes, but not to the skin. There was no toxicity or carcinogenic effects in rats given calcium chloride in the diet for 12 months. Calcium chloride is not genotoxic. No developmental toxicity was reported in pregnant female rats, mice, or rabbits given oral doses of calcium chloride. Calcium chloride is of low toxicity concern to aquatic organisms.
Citric acid	77-92-9	Citric acid is readily biodegradable and is not expected to bioaccumulate. Citric acid has very low acute toxicity by the oral and dermal routes. It is an eye irritant, but slightly to non-irritating to the skin. No adequate studies were found to evaluate the sensitisation potential of citric acid. Minimal toxicity and no carcinogenic effects was observed in rats given oral doses of citric acid for up to two years. Citric acid was not mutagenic to bacteria, but in vitro studies using human lymphocytes showed genotoxic effects. In vivo genotoxicity studies were negative. There were no reproductive or developmental effects in rats given oral doses of citric acid. Citric acid is a low toxicity concern to aquatic organisms.
Mixture of 5-chloro-2-methyl-4-isothiazolin-3-one (CMI) and isothiazolin-3-one (MI)	26172-55-4/2682-20-4	CMI is susceptible to hydrolysis at alkaline pH (half-life = 22 days), but stable at acidic and neutral pHs. MI is not susceptible to hydrolysis at any pHs. Both CMI and MI are very volatile. MI is not susceptible to hydrolysis at any pHs. Both CMI and MI are expected to be rapidly biodegraded in the environment. The calculated half-lives of CMI and MI in a river sediment-water system were 17.3 and 9.1 hours, respectively. CMI and MI have a high potential for mobility in soil and a low bioconcentration potential. The CMI/MI [3:1] mixture is moderately to highly toxic by oral, dermal, and inhalation routes. CMI/MI [3:1] is corrosive to the skin and eyes. It is a skin sensitiser. Repeated exposures to rats by the oral, dermal, or inhalation routes have shown no systemic toxicity; however, evidence of localised irritation (site-of-contact) was observed by all routes of exposure. A lifetime drinking water study in rats showed no evidence of carcinogenicity. CMI/MI [3:1] showed evidence of genotoxicity when evaluated in in vitro tests, however, in vivo studies were negative. The limited information on the reproductive and developmental toxicity studies of CMI/MI [3:1] mixture indicates a low potential. CMI/MI is highly toxic to aquatic organisms. It is moderately toxic to birds on an acute basis; and moderately toxic to practically non-toxic on a subacute dietary basis.

**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Proprietary Mixture D1	MixtureD1-CASRn	<p>The dominant degradation pathway under use conditions of Proprietary Mixture D1 involves reaction with nucleophilic substances or organic material that is found in water. Other degradation pathways include pH-dependent hydrolysis, reaction with soil, and breakdown via exposure to ultraviolet radiation. Proprietary Mixture D1 is not readily biodegradable, but in an aerobic metabolism study, the half-life was &lt;4 hours. If released to water, Proprietary Mixture D1 is not expected to adsorb to suspended solids and sediments. If released to soil, Proprietary Mixture D1 is expected to have high mobility. The estimated Henry's Law constant indicates that volatilisation from moist soil surfaces or water is not expected to be an important environmental fate pathway. Soil degradation half-lives in seven different soils (pH 4.8 – 7.5) ranged from 4 to 25 hours. Proprietary Mixture D1 has a low potential for bioaccumulation. Proprietary Mixture D1 is acutely toxic by the oral and inhalation routes, but not by the dermal route. It is corrosive to the skin and eyes. Proprietary Mixture D1 is a skin sensitiser. Inhalation exposure of an aerosol or mist can cause respiratory irritation. Repeated oral exposures in rats showed some evidence of kidney toxicity. There was no evidence of systemic toxicity following repeated dermal exposures. It is not genotoxic. In a rabbit study, possible delayed development (retarded skeletal ossification) was seen in the fetuses at a lower oral dose than those that caused maternal toxicity. Proprietary Mixture D1 is very toxic to aquatic organisms. Proprietary Mixture D1 is also acutely toxic to birds.</p>
Proprietary Ester A	EsterA-CASRn	<p>Proprietary Ester A has the consistency of a syrup at room temperature. Proprietary Ester A is a strong complexing agent, and is highly hydrophilic. Proprietary Ester A has low to moderate acute toxicity by the oral and dermal routes. Proprietary Ester A is a severely irritating to the eyes. It is not a skin sensitiser. Repeated exposure of Proprietary Ester A in rats by the oral route showed effects primarily related to its ability to chelate metal ions and affect calcium and iron homeostasis. Lifetime studies in rats showed no carcinogenic effects when Proprietary Ester A was given in the diet. In a rat study, high oral doses of Proprietary Ester A was toxic to the developing fetus at levels that did not cause maternal toxicity; no teratogenic effects were noted. No developmental effects were seen in a rabbit study. Proprietary Ester A are of low acute toxicity to fish and invertebrates; it does exhibit moderate toxicity concern to algae, which may be due to the complexation of Proprietary Ester A with essential trace metals.</p>
Homopolymer of Maleic acid	26009-09-2	<p>The homopolymer of maleic acid has a molecular weight ranging from 400 to 800. It is expected to be acidic in solution. No information is available on its environmental fate properties, mammalian or aquatic toxicity. HPMA is not readily biodegradable. There is evidence for partial degradation over short time periods, and with evidence of mineralization, particularly in light, over long periods. It strongly absorbs to inorganic surfaces, sediment and soils. HPMA has a low potential for bioaccumulation.</p>

**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Hydrochloric acid	7647-01-0	Hydrochloric acid (HCl) can exist in a gaseous phase at room temperature and pressure. Due to its high water solubility and low vapour pressure, hydrochloric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H <sup>+</sup> ) and chloride (Cl <sup>-</sup> ) ions. Both ions are ubiquitous in the environment. H <sup>+</sup> and Cl <sup>-</sup> ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Hydrochloric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of hydrochloric acid (HCl) are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of HCl can cause respiratory irritation. HCl is not a skin sensitiser. Subchronic inhalation studies show localised irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some in vitro genotoxicity studies, which are considered to be the result of the pH change in the test system. A lifetime inhalation study showed no carcinogenic effects in rats exposed to HCl. No adequate reproductive or developmental studies have been conducted on HCl. The hazard of hydrochloric acid for aquatic organisms is caused by the hydrogen ion (H <sup>+</sup> ). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.
Magnesium nitrate	10377-60-3	Mg(NO <sub>3</sub> ) <sub>2</sub> is an inorganic compound that dissociates completely in aqueous solutions to magnesium (Mg <sup>++</sup> ) and nitrate (NO <sub>3</sub> <sup>-</sup> ) ions. Biodegradation is not applicable to magnesium nitrate. Magnesium nitrate and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment or to bioaccumulate. Magnesium nitrate exhibits a low order of toxicity by the oral and dermal route. It is not a skin or eye irritant; nor is it a skin sensitiser. Magnesium nitrate is not mutagenic. The Australian drinking water guideline value for nitrate (as nitrate) is 50 mg/L. The guideline will protect bottle-fed infants under 3 months from methemoglobinemia. Adults and children over 3 months can safely drink water with up to 100 mg/L nitrate. No aquatic toxicity studies were located on magnesium nitrate. The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of "trigger values" for nitrate, which is 700 µg/L as NO <sub>3</sub> (nitrate).
Ethylene diaminetetraacetic acid tetrasodium salt	13235-36-4	Ethylene diaminetetraacetic acid tetrasodium salt (Na <sub>4</sub> EDTA) is not readily biodegradable, but it can under certain conditions (i.e., alkaline pH) be degraded. It is not expected to adsorb to soil or sediment. EDTA has a low potential for bioaccumulation. Na <sub>4</sub> EDTA exhibits low acute toxicity by the oral route. It is irritating to the eyes. Data on other sodium salts of EDTA show that these substances are not skin sensitisers. Exposures of sodium EDTA salts to rats in their diet for up to two years showed no systemic or carcinogenic effects. No systemic effects were seen in rats exposed by inhalation to a sodium EDTA salt for 13 weeks, although there were some localised (site-of-contact) effects seen in the respiratory tract. Sodium EDTA salts are not considered to be genotoxic. No reproductive toxicity was seen in a multi-generation rat study with a sodium EDTA salt. There was no developmental toxicity when Na <sub>4</sub> EDTA, as well as other sodium EDTA salts, were given by oral gavage to pregnant female rats. However, other studies have shown specific fetotoxic and teratogenic effects when high doses of sodium EDTA salts were given to pregnant females; these effects appear to be caused by zinc deficiency. The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism. In general, complexed and non-complexed EDTA has a low toxicity concern for fish and invertebrates. EDTA is highly toxic to algae in tests using standard media; the effect is probably caused by nutritional deficiency. If nutrient metal concentrations are increased, then EDTA has a low toxicity concern for algae; this is more likely scenario in the environment.

**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Proprietary Polymer A	PolymerA-CASRn	Proprietary Polymer A is not readily biodegradable. As a polymer, it is not expected to bioaccumulate, because its molecular weight will limit its bioavailability. It is acutely non-toxic by the oral route. Repeated dose toxicity studies have been conducted in rats, but the limited information available is insufficient to evaluate this studies. Proprietary Polymer A exhibits low toxicity concern to aquatic organisms.
Polyacrylamide	9003-05-8	Polyacrylamide is the homopolymer from the polymerisation of acrylamide monomers. No studies on the environmental fate of polyacrylamide were located. As a high-molecular weight polymer, it is not expected to biodegrade or bioaccumulate. Polyacrylamide is not bioavailable when ingested. It is essentially non-toxic by the oral route, and it is not irritating to the skin or eyes. Lifetime dietary studies in rats showed no toxicity or carcinogenic effects. There were no indications of reproductive or developmental toxicity in rats given polyacrylamide in their feed over several generations. No aquatic or terrestrial toxicity studies were located. Polyacrylamide is expected to non-toxic to aquatic and terrestrial organisms due to its large molecular size; it is not expected to be bioavailable.
Polydiallyldimethylammonium chloride	26062-79-3	Polydiallyldimethylammonium chloride (polyDADMAC) is a highly charged cationic homopolymer with high molecular weights; those used in water treatment may have molecular weights less than 500,000. PolyDADMAC is a highly charged cationic polymer with high molecular weights. It is expected to be poorly biodegraded, and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility. As a cationic polymer, polyDADMAC will rapidly react with many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays. Due to its physical properties (i.e., molecular size), polyDADMAC is not expected to bioaccumulate. PolyDADMAC is not acute toxic by the oral route; nor does it exhibit any systemic toxicity from repeated exposures through ingestion. PolyDADMAC exhibits a moderate toxicity concern to aquatic organisms.
Proprietary Mixture D2	MixtureD2-CASRn	Proprietary Mixture D2 are water-soluble linear polymers formed by the addition reaction of ethylene oxide to an ethylene glycol equivalent. All of the lower molecular weight Proprietary Mixture D2 are liquid at room temperature; Proprietary Mixture D2 with higher molecular weights exist as solids at room temperature. No data are available on the low molecular weight Proprietary Mixture D2. Data on some of the major constituents indicate that the low molecular weight Proprietary Mixture D2 are inherently biodegradable, have a low potential for bioaccumulation, and have a high mobility in soil. The low molecular weight Proprietary Mixture D2 are partially absorbed from the small intestine; can undergo metabolism in the body; and both Proprietary Mixture D2 and its metabolites are excreted mainly in the urine. These polymeric compounds are non-toxic by the oral, dermal, and inhalation routes. Proprietary Mixture D2 are minimally irritating to the skin and eyes, and are not skin sensitisers. Repeated exposures to very high oral doses of Proprietary Mixture D2 400 produced slight kidney toxicity in rats. The overall evidence is that the low molecular weight Proprietary Mixture D2 polymers are not genotoxic. No developmental toxicity was observed in the animal studies. The low molecular weight Proprietary Mixture D2 polymers are not toxic to aquatic organisms.

**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Sodium dodecyl sulfate	151-21-3	Sodium dodecyl sulfate is a white, granular or powdered solid. The powdered form is highly flammable. Sodium dodecyl sulfate is readily biodegradable. It exhibits moderate sorption to sediments and has a low potential for bioaccumulation. Sodium dodecyl sulfate exhibits moderate acute toxicity by the oral and dermal routes. It is irritating to the skin and severely irritating to the eyes. Sodium dodecyl sulfate is not a skin sensitiser. Repeated dose toxicity studies have shown liver effects in rats given sodium dodecyl sulfate (or similar compounds) in the diet; these effects have been considered to be adaptive changes (i.e., metabolism) and not toxicity. Sodium dodecyl sulfate is not genotoxic, and similar compounds to sodium dodecyl sulfate were not carcinogenic to rats when tested in lifetime dietary studies. There is no indication that sodium dodecyl sulfate is a reproductive toxicant. Developmental toxicity was seen at high doses that cause maternal toxicity; however, there were no malformations. Sodium dodecyl sulfate is of moderate concern for toxicity to aquatic organisms.
Sodium hypochlorite	7681-52-9	Sodium hypochlorite is a yellow, limpid liquid with a chlorinated odor. In water, sodium hypochlorite (NaOCl) dissociates into the sodium (Na <sup>+</sup> ) ion and the hypochlorite (ClO <sup>-</sup> ) ion. The hypochlorite ion (ClO <sup>-</sup> ) is in equilibrium with hydrochlorous acid (HOCl) in water and chlorine gas (Cl <sub>2</sub> ), with the relative amounts determined by pH, temperature and ionic strength of the water. Between pH 2 and 7, hydrochlorous acid (HOCl) is the dominant form; at pH 7.4 and 20°C, there is equimolar contribution of HOCl and ClO <sup>-</sup> . Sodium hypochlorite (NaOCl) dissociates into the sodium (Na <sup>+</sup> ) ion and the hypochlorite (ClO <sup>-</sup> ) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride. Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative. Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes, and gastrointestinal tract, depending on the concentration. Inhalation of vapors for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitiser. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some in vitro genotoxicity studies, the in vivo studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant. Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.
Sodium metabisulfite	7681-57-4	Sodium metabisulfite is an inorganic compound that dissociates in water to form sodium (Na <sup>+</sup> ) ions, disulfite (S <sub>2</sub> O <sub>5</sub> <sup>2-</sup> ) ions, and sulfur dioxide (SO <sub>2</sub> ). The disulfite ions can form bisulfite (HSO <sub>3</sub> <sup>-</sup> ) and sulfite ions (SO <sub>3</sub> <sup>2-</sup> ) in varying proportions dependent on the pH of the solution (OECD, 2001). Sodium metabisulfite is commonly used for removal of free chlorine in water. Biodegradation is not applicable to sodium metabisulfite. As an inorganic compound that dissociates in aqueous solutions, sodium metabisulfite is not expected to bioaccumulate. Sodium metabisulfite exhibits low-to-moderate acute toxicity by the oral route. It is not irritating to the skin, but severely irritating to the eyes. Sodium metabisulfite is not a skin sensitiser. No systemic toxicity was seen in rats when given sodium metabisulfite in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localised irritation from the ingestion of sodium metabisulfite. Genetic toxicity studies were equivocal in vitro, but were negative in vivo. Lifetime oral feeding studies in rats and mice showed no evidence of carcinogenicity. No reproductive or developmental toxicity was observed in animal studies. Aquatic toxicity studies have not been conducted on sodium metabisulfite; however, other inorganic sulfite compounds show low to moderate toxicity concern to aquatic organisms.



**Table D-2**  
**Summary of Risk Dossiers for Water Treatment Facility Chemicals**

Chemical name	CAS Number	Summary
Proprietary Mixture A2	MixtureA2-CASRn	Proprietary Mixture A2 is an inorganic compound that will dissociate completely in water. Biodegradation is not applicable to Proprietary Mixture A2. As an inorganic salt, Proprietary Mixture A2 is not expected to bioaccumulate. The Koc of Proprietary Mixture A2 was experimentally determined to be <17.8 (log Koc is <1.25). Proprietary Mixture A2 exhibits low acute toxicity by the oral and dermal route. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Proprietary Mixture A2 was inactive when evaluated in in vitro genotoxicity tests. Proprietary Mixture A2 exhibits low acute toxicity to fish and invertebrates, but moderate toxicity concern to aquatic plants.

## ALUMINIUM CHLOROHYDRATE

This dossier on aluminium chlorohydrate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of aluminium chlorohydrate in water treatment. The majority of information presented in this dossier was obtained 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Dialuminium chloride pentahydroxide

**CAS RN:** 12042-91-0

**Molecular formula:**  $\text{Al}_2\text{ClH}_5\text{O}_5$ ; general formula  $\text{Al}(\text{OH})_x(\text{Cl})_{(3-x)}$  with x between 2.3 and 2.6

**Molecular weight:** 174.45

**Synonyms:** Aluminium chlorohydrate; dialuminium chloride pentahydroxide; aluminium chlorohydroxide; aluminium hydroxychloride dehydrate; aluminium chloride hydroxide, dihydrate

### II. PHYSICO-CHEMICAL PROPERTIES

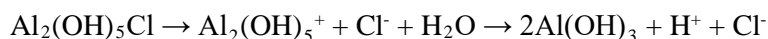
**Table 1: Overview of the Physico-chemical Properties of Aluminium Chlorohydrate**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid; fine flakes	1	ECHA
Melting Point	No melting point below 400°C could be determined.	1	ECHA
Boiling Point	No boiling point below 400°C could be determined.	1	ECHA
Density	1.95 g/cm <sup>3</sup> @ 20°C	1	ECHA
Vapor Pressure	-	-	-
Partition Coefficient (log P <sub>ow</sub> )	-	-	-
Water Solubility	Very soluble	1	ECHA
Auto flammability	Not auto flammable.	1	ECHA

Polyaluminium coagulants, which have been developed for water treatment applications, have the general formula  $(\text{Al}_n(\text{OH})_m\text{Cl}_{(3n-m)})_x$ . The length of the polymerised chain, molecular weight, and the number of ionic charges is determined by the degree of polymerization. The polyaluminium coagulants include polyaluminium chloride (n=2; m=3), aluminium chlorohydrate (n=2; n=5), and polyaluminium chlorohydrate (similar to aluminium chlorohydrate) (Gebbie, 2001).

On hydrolysis, various mono- and polymeric species are formed, with an important cation being  $\text{Al}_{13}\text{O}_4(\text{OH})_{24}^{7+}$ . A less predominant species is  $\text{Al}_8(\text{OH})_{20}^{4+}$ .

Depending on the pH, the following reaction takes place (Gebbie, 2006):



This reaction will typically take place at a water pH of 5.8 to 7.5. Within this pH, colour and the colloidal matter are removed by adsorption onto/within the metal hydroxide hydrolysis products that are formed (Gebbie, 2006).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Aluminium chlorohydrate is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to aluminium chlorohydrate. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Aluminium chlorohydrate is not expected to bioaccumulate in aquatic organisms.

#### B. Bioaccumulation

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions (Spry and Wiener, 1991). The initial uptake of aluminium by fish occurs mainly on the gill mucous layer (Wilkinson and Campbell, 1993); both mucus and bound aluminium may be rapidly eliminated following exposure. Roy (1999) calculated the BCFs in fish to range from 400 to 1,365.

The BCF for *Daphnia magna* varied from 10,000 at pH 6.5 to 0 at pH 4.5, based on the results of Havas (1985). Most of the metal appears to be adsorbed to external surfaces and is not internalised (Havas, 1985; Frick and Hermann, 1990).

The accumulation of aluminium by the algae *Chlorella pyrenoidosa* increased with the concentration of inorganic monomeric aluminium (Parent and Campbell, 1994). A comparison of assays performed at different pH values but the same concentration of aluminium showed suppression of that aluminium accumulation at low pH.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Aluminium chlorohydrate has low acute toxicity by the oral and dermal routes. It is non-irritating to the skin and slightly irritating to the eyes. It is not a skin sensitizer. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day aluminium chlorohydrate in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Aluminium chlorohydrate is not genotoxic.

#### B. Acute Toxicity

The oral LD<sub>50</sub> in rats is 9,187 mg/kg (ECHA) [Kl. score = 2]. Another study showed no deaths in rats at the limit dose of 2,000 mg/kg (ECHA) [Kl. score = 2].

The dermal LD<sub>50</sub> in rats is >2,000 mg/kg (ECHA) [Kl. score = 2].

#### C. Irritation

Aluminium chlorohydrate was non-irritating to the skin of rabbits following a 4-hour exposure under semi-occlusive conditions (ECHA). [Kl. score = 2].

Aluminium chlorohydrate was slightly irritating to the eyes of rabbits. The mean of the 24, 48, and 72-hour conjunctival redness scores was 1.00; all other parameters were zero (ECHA). [Kl. score = 1]

#### **D. Sensitization**

Aluminium chlorohydrate was not a skin sensitizer in a guinea pig maximisation test (ECHA) [Kl. score = 1].

#### **E. Repeated Dose Toxicity**

##### Oral

Aluminium chlorohydrate was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg chlorohydrate; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There were no effects in the females at any dose level. In males, there were effects indicative of stomach irritation at the high-dose; no other effects were noted. The NOAEL for systemic effects in this study is 1,000 mg/kg-day, the highest dose tested. The NOAEL for localized effects (site-of-contact) is 200 mg/kg-day (ECHA). [Kl. score = 2]

##### Inhalation

No adequate studies were located.

##### Dermal

No studies were located.

#### **F. Genotoxicity**

##### In Vitro Studies

Aluminium chlorohydrate was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537 and *E. coli* strain WP2uvrA in the absence or presence of metabolic activation (ECHA). [Kl. score = 1]

##### In Vivo Studies

Aluminium chlorohydrate was inactive in a mouse bone marrow micronucleus assay (ECHA). [Kl. score = 1]

#### **G. Carcinogenicity**

No studies were located.

#### **H. Reproductive/Developmental Toxicity**

Aluminium chlorohydrate was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg chlorohydrate; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There was no reproductive or developmental toxicity at any dose level. The NOAELs for reproductive and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

### Oral

Toxicological reference values were not derived for aluminium chlorohydrate.

The Australian drinking water guideline values for aluminium (acid-soluble) is 0.2 mg/L based on aesthetics. ADWG has concluded that there is insufficient data to set a guidance value based on health considerations (ADWG, 2011).

The Australian drinking water guidance value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Aluminium chlorohydrate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Aquatic Toxicity

#### Acute Studies on Aluminium Polychlorohydrate

The 96-hr LC<sub>50</sub> for aluminium polychlorohydrate in *Danio rerio* was determined to be 142 mg/L nominal. For dissolved aluminium, the 96-hr LC<sub>50</sub> was 0.58 mg/L. A very steep concentration-effect relationship was observed for the test substance; this was due to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance (ECHA). [Kl. score = 2]

The 96-hr LC<sub>50</sub> for aluminium polychlorohydrate in *Danio rerio* was determined to be 186 mg/L nominal. For dissolved aluminium, the 96-hr LC<sub>50</sub> was 1.39 mg/L, corresponding to 16.9 mg/L Total Al (measured values). A very steep concentration-effect relationship was observed for the test substance; this was due to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance. Theoretically, 186 mg/L of aluminium polychlorohydrate reduced the pH of reconstituted water to a level which enabled 1.4 mg Al/L to be dissolved. (ECHA). [Kl. score = 2]

The 96-hr EC<sub>50</sub> and NOEC for aluminium polychlorohydrate in *Danio rerio* were determined to be >0.357 mg/L measured as dissolved Al (equivalent to 91.5 Total Al). The NOEC was >1,000 mg/L nominal, which is equivalent to 91.5 mL Total Al. In this study, the pH of the test media was maintained at 7.5 (ECHA). [Kl. score = 1]

The 48-hr EC<sub>50</sub> for aluminium chlorohydrate in *Daphnia magna* is 98 mg/L nominal and 7.8 mg/L measured (ECHA) [Kl. score = 2]. Another study reported 48-hr EC<sub>50</sub> values for aluminium chlorohydrate of 38 mg/L nominal and 3.45 mg/L measured (ECHA) [Kl. score = 2].

The 72-hr EC<sub>50</sub> for growth rate in *Pseudokirchneriella subcapitata* was 14 mg/L nominal, which was equivalent to 0.644 mg/L as Total Al. The average measured concentrations of dissolved Al was 0.24 mg/L at a pH between 7.1 and 8.4. The EC<sub>10</sub> for growth rate was 0.14 mg/L as Total Al and

0.051 mg/L based on measured Al. The NOEC for growth inhibition was nominally 1.0 mg/L (0.046 mg/L based on Total Al and <0.02 mg/L when based on measured Al (ECHA). [Kl. score = 1]

#### Data used by ANZECC for Aluminium water quality guideline

In developing a water quality guideline for aluminium (ANZECC 2000), ANZECC separated the screened freshwater toxicity data into those conducted at pH >6.5 and those at pH <6.5. These data are summarised below (it should be noted that only the acute toxicity data was used to derive a water quality guideline):

Freshwater pH >6.5

#### Fish

The 48-96 hour LC<sub>50</sub> values for 5 species were 600 to 106,000 µg/L (the lowest value was for *Salmo salar*). The chronic 8- to 28-day NOEC equivalents<sup>1</sup> from seven species were 34-7,100 µg/L. The lowest measured chronic value was an 8-day LC<sub>50</sub> for *Micropterus* species of 170 µg/L.

#### Amphibian

The 96-hour LC<sub>50</sub> values for *Bufo americanus* were 860-1,660 µg/L. The chronic 8-day LC<sub>50</sub> for *Bufo americanus* was 2,280 µg/L.

#### Crustacean

The 48-hour LC<sub>50</sub> values for one species were 2,300-36,900 µg/L. The chronic 7- to 28-day NOECs were 136-1,720 µg/L.

#### Algae

The 96-hour EC<sub>50</sub> values were 460-570 µg/L based on population growth. The NOECs for two species were 800-2,000 µg/L.

Freshwater pH <6.5 (all between pH 4.5 and 6.0)

#### Fish

The 24-96-hour LC<sub>50</sub> values for two species were 15-4,200 µg/L (the lowest value was for *Salmo trutta*). The 21- to 42-day LC<sub>50</sub> values were 15-105 µg/L,

#### Amphibian

The 96- to 120-day LC<sub>50</sub> values were 540-2,670 µg/L; the absolute range was 400-5,200 µg/L.

#### Algae

The NOEC from one species was 2,000 µg/L based on growth.

<sup>1</sup>Chronic toxicity values were a mixture of LC/EC<sub>50</sub> LOEC, MATC, and NOEC values; where stated, these were converted to NOEC equivalents.

## **B. Terrestrial Toxicity**

The 14-day LC<sub>50</sub> to earthworm *Eisenia andrei* is 316 mg/kg soil dry weight (ECHA). [Kl. score = 2]

## C. Calculation of PNEC

### PNEC water

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of trigger values for aluminium. The guideline for freshwater is: “A *freshwater moderate reliability trigger value of 55 µg/L for aluminium at pH >6.5 using the statistical distribution method (Burr distribution as modified by SCIRO, Section 8.3.3.3) with 95% protection and an ACR of 8.2.*

“A freshwater low-reliability trigger value of 0.8 µg/L was derived for aluminium at pH of <6.5 using an AF of 20 (essential element) on the low pH trout figure.”

“The low-reliability figures should only be used as indicative interim working levels.”

### PNEC sediment

No experimental toxicity data on sediment organisms are available.  $K_{ow}$  and  $K_{oc}$  parameters do not readily apply to inorganics, such as aluminium chlorohydrate. Thus, the equilibrium partitioning method cannot be used to calculate the  $PNEC_{sed}$ . Based on its properties, no adsorption of aluminium chlorohydrate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of aluminium chlorohydrate is dominated by its water solubility. Sorption of aluminium chlorohydrate should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound.  $K_{oc}$  and  $K_{ow}$  parameters do not readily apply to inorganics, such as aluminium chlorohydrate. Thus, the equilibrium partitioning methods cannot be used to calculate the  $PNEC_{soil}$ . Based on its properties, aluminium chlorohydrate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Aluminium chlorohydrate is an inorganic compound that dissociates in water to form chloride ions and various species of aluminium hydroxide hydrolysis. Biodegradation is not applicable to aluminium chlorohydrate. Both chloride ions and aluminium hydroxide ionic species can be found naturally in the environment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic compound.

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions. Chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, aluminium chlorohydrate and its dissociated ions are not expected to meet the criteria for bioaccumulation.

The lowest chronic NOEC value in fish for aluminium is <0.1 mg/L; thus, the dissolved aluminium from aluminium chlorohydrate meets the screening criteria for toxicity.

The overall conclusion is that aluminium chlorohydrate is not a PBT substance.

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

### **A. Classification**

No classification.

### **B. Labelling**

No signal word.

### **C. Pictogram**

None

## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

### **B. FIRE FIGHTING INFORMATION**

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on the conditions, decomposition products may include the following: hydrogen chloride.

#### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.



## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidising agents.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has established an occupational exposure standard of 2 mg/m<sup>3</sup> as an 8-hour TWA for aluminium, soluble salts (as Al).

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## F. TRANSPORT INFORMATION

Aluminium chlorohydrate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

## XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

## XIII. REFERENCES

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated February 2016.

ANZECC & ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

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: <http://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.

Frick, K.G., and Herrmann J. (1990). Aluminium accumulation in a lotic mayfly at low pH — a laboratory study. *Ecotoxicol. Environ. Safety* 19: 81–88.

Gebbie, P. (2001). Using Polyaluminium coagulants in water treatment, 64<sup>th</sup> Annual Water Industry Engineers and Operator's Conference. Available at: [http://wioa.org.au/conference\\_papers/2001/pdf/paper6.pdf](http://wioa.org.au/conference_papers/2001/pdf/paper6.pdf)

Gebbie, P. (2005). A Dummy's Guide to Coagulants. 68<sup>th</sup> Annual Water Industry Engineers and Operator's Conference. Available at: [http://www.wioa.org.au/conference\\_papers/2005/pdf/10wioa2005.pdf](http://www.wioa.org.au/conference_papers/2005/pdf/10wioa2005.pdf)

Havas, M. (1985). Aluminium bioaccumulation and toxicity to *Daphnia magna* in soft water at low pH. *Can. J. Fish. Aquat. Sci.* 42: 1741–1748.

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.

- Parent, L., and Campbell, P.G.C. (1994). Aluminium bioavailability to the green alga *Chlorella pyrenoidosa* in acidified synthetic soft water. *Environ. Toxicol. Chem.* 13: 587–598.
- Roy R. (1999). The chemistry, bioaccumulation and toxicity of aluminium in the aquatic environment for the PSL2 assessment of aluminium salts. Report prepared by Fisheries and Oceans Canada for Environment Canada. Montreal (QC): Environment Canada. 110 pp. Unpublished report.
- Spry, D.J., and Wiener, J.G. (1991). Metal bioavailability and toxicity to fish in low-alkalinity lakes — a critical review. *Environ. Pollut.* 71: 243–304.
- Wilkinson, K.J., and Campbell, P.G.C. (1993). Aluminium bioconcentration at the gill surface of juvenile Atlantic salmon in acidic media. *Environ. Toxicol. Chem.* 12: 2083–2095.

#### XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals

RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## CALCIUM CHLORIDE

This dossier on calcium chloride does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of calcium chloride in its use in water treatment. The information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA) and the OECD-SIDS documents on calcium chloride (OECD, 2002). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Calcium dichloride

**CAS RN:** 10043-52-4

**Molecular formula:**  $\text{CaCl}_2$

**Molecular weight:** 110.98

**Synonyms:** Calcium chloride; calcium dichloride; calcium chloride anhydrous

**SMILES:** [Cl-].[Cl-].[Ca+2]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Calcium Chloride**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White odourless solid; crystals; powder; or granules	2	ECHA
Melting Point	782°C	2	ECHA
Boiling Point	>1,600°C	2	ECHA
Density	2.15 @ 25°C	2	ECHA
Vapor Pressure	-	-	-
Partition Coefficient (log Pow)	Not applicable	-	-
Water Solubility	Very soluble	2	ECHA

### III. ENVIRONMENTAL FATE PROPERTIES

Calcium chloride dissociates completely in aqueous solutions to calcium ( $\text{Ca}^{2+}$ ) and chloride ( $\text{Cl}^-$ ) ions. Calcium chloride and its dissociated ions are ubiquitous in the environment.

Because of its dissociation properties and high water solubility, calcium chloride is not expected to be adsorbed to soil. The calcium ion may bind to soil particulate or may form stable inorganic salts with sulfate and carbonate ions. The chloride ion is mobile in soil and eventually drains into the surface water because it is readily dissolved in water (OECD, 2002).

Calcium ( $\text{Ca}^{2+}$ ) and chloride ( $\text{Cl}^-$ ) ions are essential to all living organisms, and their intracellular and extracellular concentrations are actively regulated (Ganong, 1995). Neither calcium chloride or its dissociated ions are expected to bioaccumulate.

## **IV. HUMAN HEALTH HAZARD ASSESSMENT**

### **A. Summary**

Calcium chloride exhibits low acute toxicity by the oral and dermal routes. It is irritating to the eyes, but not to the skin. There was no toxicity or carcinogenic effects in rats given calcium chloride in the diet for 12 months. Calcium chloride is not genotoxic. No developmental toxicity was reported in pregnant female rats, mice, or rabbits given oral doses of calcium chloride.

### **B. Acute Toxicity**

The oral LD<sub>50</sub> values in rats are 2,301, 4,179, and 3,798 mg/kg (ECHA) [Kl. score = 2]. The dermal LD<sub>50</sub> in rabbits is >5,000 mg/kg (ECHA). [Kl. score = 1]

### **C. Irritation**

Application of 0.5 ml to the skin of rabbits for 4 hours under occlusive conditions was non-irritating. Erythema and edema scores at all time points were zero (ECHA) [Kl. score = 1]

Instillation of 100 mg of calcium chloride into the eyes of rabbits was moderately irritating. The mean of the 24, 48, and 72 hours scores were: 0.67 for conjunctival redness; 0.78 for chemosis; 1.0 for corneal opacity; and 0.0 for iridial lesions. There were no signs of irritation by day 21 (ECHA). [Kl. score = 1]

Instillation of 100 mg of calcium chloride into the eyes of rabbits was highly irritating. The mean of the 24, 48, and 72 hours scores were: 1.9 for conjunctival redness; 2.2 for chemosis; 2.0 for corneal opacity; and 1.0 for iridial lesions. The effects were not fully reversible by day 21 (ECHA). [Kl. score = 1]

Instillation of 100 mg of calcium chloride into the eyes of rabbits was irritating. The mean of the 24, 48, and 72 hours scores were: 1.54 for conjunctival redness; 1.65 for chemosis; 1.0 for corneal opacity; and 0.33 for iridial lesions. The effects were not fully reversible by day 21 (ECHA). [Kl. score = 2]

### **D. Sensitization**

No reliable studies are available.

### **E. Repeated Dose Toxicity**

#### Oral

Rats were fed 20 mg calcium chloride/g diet for 12 months. There were no differences in mortality, weight gain, or feed consumption between treated and control groups. No neoplastic lesions were observed in the gastrointestinal tract, urinary tract, liver, heart, brain, or spleen. The estimated daily intake of calcium chloride is 1,000 to 2,000 mg/kg-day (OECD, 2002). [Kl. score = 3]

#### Inhalation

No studies are available.

#### Dermal

No studies are available.

## F. Genotoxicity

### In Vitro Studies

**Table 2: In Vitro Genotoxicity Studies on Calcium Chloride**

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> )	-	-	2	ECHA
Bacterial reverse mutation ( <i>S. typhimurium</i> )	-	-	2	ECHA
Chromosomal aberration (Chinese hamster lung cells)	-	NC	2	ECHA

\*+, positive; -, negative; NC, not conducted.

### In Vivo Studies

No studies are available.

## G. Carcinogenicity

Rats were fed 20 mg calcium chloride per gramme diet for 12 months. There were no differences in mortality, weight gain, or feed consumption between treated and control groups. No neoplastic lesions were observed in the gastrointestinal tract, urinary tract, liver, heart, brain, or spleen. The estimated daily intake of calcium chloride is 1,000 to 2,000 mg/kg-day (OECD, 2002). [Kl. score = 3]

## H. Reproductive Toxicity

No studies are available.

## I. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage with 0, 1.76, 8.18, 38, or 176 mg/kg calcium chloride on GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 176 mg/kg-day (ECHA). [Kl. score = 1]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 1.89, 8.78, 40.8, or 189 mg/kg calcium chloride on GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 189 mg/kg-day (ECHA). [Kl. score = 1]

Pregnant female Dutch rabbits were dosed by oral gavage with 0, 1.69, 7.85, 35.6, or 169 mg/kg calcium chloride on GD 6-18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 169 mg/kg-day (ECHA). [Kl. score = 1]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

### A. Non-Cancer

#### Oral

Toxicological reference values were not derived from calcium chloride.

Calcium chloride dissociates in water to calcium and chloride ion. An Australian drinking water guidance value is not available for calcium (ADWG, 2011). The Australian drinking water guidance value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Calcium chloride does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Calcium chloride is of low toxicity concern to aquatic organisms.

### B. Aquatic Toxicity

#### Acute Studies

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

**Table 3: Acute Aquatic Toxicity Studies on Calcium Chloride**

Test Species	End point	Results (mg/L)	Klimisch score	Reference
<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	4,630	2	OECD, 2002; ECHA
<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	9,500-11,300	2	OECD, 2002; ECHA



Test Species	End point	Results (mg/L)	Klimisch score	Reference
<i>Gambusia affinis</i>	96-hr LC50	13,400	2	OECD, 2002; ECHA
<i>Lepomis macrochirus</i>	96-hr LC50	10,650	2	OECD 2002; ECHA
<i>Daphnia magna</i>	48-hr EC50	2,400	1	OECD, 2002; ECHA
<i>Daphnia magna</i>	48-hr EC50	2,770	2	OECD, 2002; ECHA

Test Species	E n d p o i n t	Results (mg/L)	Klimisch score	Reference
<i>Ceriodaphnia dubia</i>	4 8 - h r  E C 5 0	1,830	2	OECD, 2002; ECHA
<i>Daphnia magna</i>	4 8 - h r  E C 5 0	1,062	2	OECD, 2002; ECHA
<i>Pseudokirchneriella subcapitata</i>	7 2 - h r  E C 5 0	2,900 (biomass)	1	OECD, 2002; ECHA

### Chronic Studies

The 21-day EC<sub>50</sub> and EC<sub>16</sub> values for calcium chloride in a chronic *Daphnia* reproduction study were 610 and 320 mg/L, respectively (OECD, 2002).

### **C. Terrestrial Toxicity**

No studies are available.

### **D. Calculation of PNEC**

The PNEC calculations for calcium chloride follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (4,630 mg/L), *Daphnia* (1,062 mg/L), and algae (2,900 mg/L). Although a chronic *Daphnia* study is

available, an NOEC or EC<sub>10</sub> was not determined. On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 100 has been applied to the lowest reported acute E(L)C<sub>50</sub> value of 1,062 mg/L from invertebrates. The PNEC<sub>water</sub> is 11 mg/L.

#### PNEC sediment

No experimental toxicity data on sediment organisms are available. Calcium chloride dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as calcium chloride. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of calcium chloride to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

#### PNEC soil

No experimental toxicity data on soil organisms are available. Calcium chloride dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as calcium chloride. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, no adsorption of calcium chloride to the soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### **VIII. PBT ASSESSMENT**

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 chloride is an inorganic salt that dissociates completely to calcium and chloride ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both calcium and chloride 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 chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, calcium chloride is not expected to bioaccumulate.

A chronic toxicity has been conducted on calcium chloride, but an NOEC of EC<sub>10</sub> was not determined. The acute E(L)C<sub>50</sub>s values for calcium chloride are >0.1 mg/L in fish, invertebrates and algae. Thus, calcium chloride does not meet the screening criteria for toxicity.

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

### **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

#### **A. Classification**

Eye Irritant Category 2

[Note: anhydrous calcium chloride requires the GHS classification Eye Irritant Category 1]

#### **B. Labelling**

Warning

## C. Pictogram



## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

## B. FIRE FIGHTING INFORMATION

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on the conditions, decomposition products may include the following: hydrogen chloride gas, calcium oxide.

#### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## C. ACCIDENTAL RELEASE MEASURES

#### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for calcium chloride.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Calcium chloride is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://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.

Ganong, W.F. (1995). Review of Medical Physiology, 17<sup>th</sup> Edition, Appleton & Lange, Norwalk, Connecticut, USA.

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.

OECD (2002). OECD-SIDS: Calcium chloride (CAS No. 10043-52-4), UNEP Publications. Available at: <http://www.inchem.org/documents/sids/sids/10043524.pdf>

## **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre

mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## CITRIC ACID

This dossier on citric acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of citric acid in its use in drilling muds and water treatment. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on citric acid (OECD 200,1a,b) and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** 2-Hydroxy-1,2,3-propanetricarboxylic acid

**CAS RN:** 77-92-9

**Molecular formula:** C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>

**Molecular weight:** 192.122

**Synonyms:** citric acid; 1,2,3-propanetricarboxylic acid, 2-hydroxy-; 2-hydroxy-1,2,3-propanetricarboxylic acid

**SMILES:** C(C(=O)O)C(CC(=O)O)(C(=O)O)O

Citric acid is an ubiquitous natural substance that appears as an intermediate in the basic physiological tricarboxylic acid (TCA) cycle in every eukaryote cell.

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Citric Acid**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White crystalline solid; odourless.	2	ECHA
Melting Point	153°C	2	ECHA
Boiling Point	Not available; decomposition	-	ECHA
Density	1.67 @ 20°C	2	ECHA
Vapor Pressure	2.21 x 10 <sup>-6</sup> Pa @ 25°C	2	ECHA
Partition Coefficient (log Pow)	-1.61 to -1.80	2	ECHA
Water Solubility	Very soluble	4	ECHA
Flash Point	345°C	4	ECHA
Auto flammability	1010°C	4	ECHA

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Citric acid is readily biodegradable and is not expected to bioaccumulate.



## B. Biodegradation

Citric acid can be considered readily biodegradable based on the results of the ready and inherent aerobic biodegradation studies listed in Table 2.

**Table 2: Biodegradation Studies on Citric Acid (OECD 2001a,b)**

Test System	Results*	Notes	Klimisch Score
Modified Sturm	97% (CO <sub>2</sub> evolution); 100% (DOC removal)	Readily biodegradable; exposure period not stated	2
Closed Bottle Test	BOD <sub>30</sub> /COD Ratio = 90%	Readily biodegradable	2
BOD <sub>5</sub> /COD Ratio	BOD <sub>5</sub> = 526 mg; COD = 728 mg; BOD <sub>5</sub> /COD Ratio = 0.72	Readily biodegradable; concentration of test substance and activated sludge not stated	2
BOD <sub>1</sub> /ThOD Ratio	BOD <sub>1</sub> /ThOD Ratio = 13%		2
BOD <sub>20</sub> /ThOD Ratio	BOD <sub>20</sub> /COD Ratio = 98%	Readily biodegradable; initial test substance concentration 720 mg/L	2
Zahn-Wallen Test	85%, 1 day (DOC removal)	Inherently biodegradable	2
Zahn-Wallen Test	98%, 7 days (DOC removal)	Inherently biodegradable	
Coupled Units Test	93% (COD removal)	Ultimately biodegradable; exposure period not stated.	2

## C. Environmental Distribution

Absorption/desorption

No experimental values were found. Using KOCWIN program in EPISuite™, the estimated K<sub>oc</sub> from a K<sub>ow</sub> value of -1.08 is 0.3617 L/kg (EPA, 2016).

## D. Bioaccumulation

The octanol-water partition coefficient (log P<sub>ow</sub>) for citric acid is -1.61 to -1.80. Thus, citric acid is not expected to bioaccumulate.

# IV. HUMAN HEALTH HAZARD ASSESSMENT

## A. Summary

Citric acid is essentially non-toxic by the oral and dermal routes. It is an eye irritant, but slightly to non-irritating to the skin. No adequate studies were found to evaluate the sensitization potential of citric acid. Minimal toxicity and no carcinogenic effects were observed in rats given oral doses of citric acid for up to two years. Citric acid was not mutagenic to bacteria, but *in vitro* studies using human lymphocytes showed genotoxic effects. *In vivo* genotoxicity studies were negative. There were no reproductive or developmental effects in rats given oral doses of citric acid.

## B. Acute Toxicity

The acute oral LD<sub>50</sub> in male rats was reported to be 11,700 mg/kg (ECHA) [Kl. score = 2]. The acute oral LD<sub>50</sub> values in mice are 5,400 and 5,790 mg/kg (ECHA) [Kl. score = 2]. The acute dermal LD<sub>50</sub> value in rats is >2,000 mg/kg (ECHA) [Kl. score = 1].

## **C. Irritation**

Application of 0.5 g powder to the skin of rabbits for 4 hours under semi-occlusive conditions resulted in mild irritation. The mean of the 24, 48, and 72-hour erythema scores were 0.3. The mean of the 24, 48, and 72-hour edema scores were 0 (ECHA) [Kl. score = 1]. Application of a 50% aqueous solution of citric acid to the skin of rabbits for 4 hours under occlusive conditions was non-irritating (ECHA) [Kl. score = 2].

Instillation of a 30% aqueous solution of citric acid into the eyes of rabbits produced well defined to moderate conjunctival irritation that did not fully resolve after the 14-day observation period. A 10% solution was associated with weak to moderate conjunctival effects, which resolved after 7 days (ECHA) [Kl. score = 2].

## **D. Sensitization**

No adequate studies were found to evaluate the sensitization potential of citric acid.

## **E. Repeated Dose Toxicity**

### Oral

Male rats were given 0, 1.2, 2.4, or 4.8% citric acid in their feed for 6 weeks. The daily intakes were reported to be 1,150, 2,260, or 4,670 mg/kg-day. The high-dose animals had mild blood and urine parameter changes and slight degeneration of the thymus gland and spleen. The NOAEL is 2.4% in the diet or 2,260 mg/kg-day (OECD, 2001a,b). [Kl. score = 4]

Rats were given 3% or 5% citric acid in their diet for two years. The estimated daily intakes were 1,200 and 2,000 mg/kg/day, respectively. A slight decrease in growth was reported in the 2% group, but no tissue abnormalities in the major organs. The NOAEL is 1,200 mg/kg-day (OECD, 2001a,b). [Kl. score = 4]

### Inhalation

No studies are available.

### Dermal

No studies are available.

## **F. Genotoxicity**

### In Vitro Studies

Citric acid was not mutagenic in bacterial reverse mutation assays with strains of *S. typhimurium* or *E. coli* with and without metabolic activation (OECD, 2001a,b; ECHA). [Kl. score = 2]

Peripheral human lymphocytes were treated with 50 to 3,000 µg/ml citric acid. A statistically significant dose-dependent increase in the micronuclei was observed. In another set of studies by the same laboratory, there was a statistically significant and dose-related increase in the number of cells with aberrations, including sister chromatid unions. The study authors reported that the pH of the medium was unchanged (ECHA). [Kl. score = 2]

## In Vivo Studies

Citric acid was not mutagenic in a dominant lethal assay when male rats were given either a single oral dose of citric acid (1.2 to 120 mg/kg) or a single oral dose on five consecutive days (300 to 3,500 mg/kg) (OECD 2001a,b) [Kl. score = 2]. There were no increases in chromosomal aberrations in the bone marrow of rats given either a single oral dose of citric acid (1.2 to 120 mg/kg) or a single oral dose on five consecutive days (300 to 3,500 mg/kg) (ECHA) [Kl. score = 2].

### **G. Carcinogenicity**

#### Oral

There was no evidence of carcinogenicity in rats given 3% or 5% citric acid in feed (1,200 or 2,000 mg/kg/day, respectively) for two years (OECD, 2001a,b). [Kl. score = 4]

### **H. Reproductive Toxicity**

In a non-standard repeat dose dietary study (duration and frequency not specified), 5% citric acid in feed did not affect either the number of young born to mice or rats or their subsequent survival up to the point of weaning (ECHA). [Kl. score = 4]

### **I. Developmental Toxicity**

Pregnant female rats were dosed by oral gavage with 0, 2.95, 13.7, 63.6, or 295 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 295 mg/kg-day (OECD, 2001a,b; ECHA). [Kl. score = 2]

Pregnant female rats were dosed by oral gavage with 0, 2.41, 11.2, 52, or 241 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 241 mg/kg-day (OECD, 2001a,b; ECHA). [Kl. score = 2]

Pregnant female rabbits were dosed by oral gavage with 0, 4.25, 19.75, 91.70, or 425 mg/kg citric acid on GD 6-18. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 425 mg/kg-day (OECD, 2001a,b; ECHA). [Kl. score = 2]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for citric acid 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).

### **A. Non-Cancer**

#### Oral

In a two-year dietary study, the only effect was seen in rats fed either 3 or 5% citric acid in the feed (approx. 1,200 or 2,000 mg/kg-day) was a slight decrease in growth in the 5% dose group. In the absence of statistical analysis of the body weight gain data, a conservative approach was taken, and the 5% dose group was considered an LOAEL. The NOAEL of 3% citric acid in the diet (1,200 mg/kg-day) will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 1,200 / (10 \times 10 \times 1 \times 1 \times 1) = 1,200 / 100 = \underline{12 \text{ mg/kg-day}}$$

### Drinking water guidance value

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

Using the oral RfD,

$$\text{Drinking water guidance value} = (\text{oral RfD}) \times (\text{human weight}) \times (\text{proportion of water consumed}) / (\text{volume of water consumed})$$

Where:

Human weight = 70 kg (ADWG, 2011)

Proportion of water consumed = 10% (ADWG, 2011)

Volume of water consumed = 2L (ADWG, 2011)

$$\text{Drinking water guidance value} = (12 \times 70 \times 0.1) / 2 = \underline{42 \text{ mg/L}}$$

## **B. Cancer**

Citric acid was not carcinogenic to rats in a chronic dietary study. Thus, no cancer reference value was derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Citric acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Citric acid is a low toxicity concern to aquatic organisms.

## B. Aquatic Toxicity

### Acute Studies

The 48-hour LC<sub>50</sub> values in *Leuciscus idus melanotus* (golden orfe) from two separate laboratories were 440 mg/L and 760 mg/L (ECHA) [Kl. score = 2]. The 96-hour LC<sub>50</sub> in *Lepomis macrochirus* (fathead minnow) is >100 mg/L (ECHA) [Kl. score = 2].

The 24-hour EC<sub>50</sub> in *Daphnia* is 85 mg/L in un-neutralized test solution and 1,535 mg/L in a neutralized solution (OECD, 2001a,b; ECHA). [Kl. score = 2]

The 8-day toxicity threshold value (EC<sub>0</sub>) in *Scenedesmus quadricauda* is 640 mg/L (ECHA; OECD, 2001a,b). [Kl. score = 2]

### Chronic Studies

No studies are available.

## C. Terrestrial Toxicity

No studies are available.

## D. Calculation of PNEC

The PNEC calculations for citric acid follow the methodology discussed in DEWHA (2009).

### PNEC water

PNEC<sub>aquatic</sub>: Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for only fish (440 mg/L) and *Daphnia* (1,535 mg/L, neutralized). On the basis that the data consist of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 440 mg/L for *Daphnia*. The PNEC<sub>quatic</sub> is 0.44 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 0.277 mg/kg wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (\text{K}_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (0.807/1280) \times 1000 \times 0.44 \\ &= 0.277 \end{aligned}$$

Where:

$\text{K}_{\text{sed-water}}$  = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)  
 $\text{BD}_{\text{sed}}$  = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned} \text{K}_{\text{sed-water}} &= 0.8 + [(0.2 \times \text{KP}_{\text{sed}})/1000 \times \text{BD}_{\text{soild}}] \\ &= 0.8 + [(0.2 \times 0.014)/1000 \times 2400] \\ &= 0.807 \end{aligned}$$

Where:

Kp = solid-water partition coefficient (L/kg).

$BD_{\text{solid}}$  = bulk density of the solid phase ( $\text{kg/m}^3$ ) = 2,400 [default]

$$\begin{aligned} K_p &= K_{oc} \times f_{oc} \\ &= 0.3617 \times 0.04 \\ &= 0.014 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The estimated  $K_{oc}$  for citric acid is 0.3617 L/kg.

$f_{oc}$  = fraction of organic carbon suspended sediment = 0.04 [default].

#### PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the  $PNEC_{\text{soil}}$  was calculated using the equilibrium partitioning method. The  $PNEC_{\text{soil}}$  is 0.05 mg/kg soil dry weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{\text{soil}} &= (K_{p\text{soil}}/BD_{\text{soil}}) \times 1000 \times PNEC_{\text{water}} \\ &= (0.007/1500) \times 1000 \times 0.44 \\ &= 0.002 \end{aligned}$$

Where:

$K_{p\text{soil}}$  = soil-water partition coefficient ( $\text{m}^3/\text{m}^3$ )  
 $BD_{\text{soil}}$  = bulk density of soil ( $\text{kg/m}^3$ ) = 1,500 [default]

$$\begin{aligned} K_{p\text{soil}} &= K_{oc} \times f_{oc} \\ &= 0.3617 \times 0.02 \\ &= 0.007 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The estimated  $K_{oc}$  for citric acid is 0.3617 L/kg.

$f_{oc}$  = fraction of organic carbon in soil = 0.02 [default].

### **VIII. PBT ASSESSMENT**

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).

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

The octanol-water partition coefficient ( $P_{ow}$ ) values for citric acid are -1.61 to -1.80. Thus, citric acid does not meet the screening criteria for bioaccumulation.

There are no adequate chronic toxicity studies on citric acid. The acute  $E(L)C_{50}$  values of citric acid are  $>0.1$  mg/L in fish and invertebrates. Thus, it does not meet the screening criteria for toxicity.

The overall conclusion is that citric acid is not a PBT substance.

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

The information in this section is for a citric acid solution.

### **A. Classification**

Eye Irritant Category 2

### **B. Labelling**

Warning

### **C. Pictogram**



## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

### **B. FIRE FIGHTING INFORMATION**

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

No data are available.

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Pick up with absorbent material. Dispose of contaminated material as prescribed.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for citric acid.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.



*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Citric acid is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

OECD (2001a). IUCLID Data Set for Citric acid (CAS No. 77-92-9), UNEP Publications.

OECD (2001b). Screening Information Dataset (SIDS) Initial Assessment Report for Citric acid (CAS No. 77-92-9), UNEP Publications).

U.S. Environmental Protection Agency [EPA] (2016). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: <https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface>.

## **XIV. ACRONYMS AND GLOSSARY**

°C                      degrees Celsius

ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## **MIXTURE OF 5-CHLORO-2-METHYL-4-ISOTHIAZOLIN-3-ONE AND 2-METHYL-4-ISOTHIAZOLIN-3-ONE [3:1]**

This dossier on the mixture of 5-chloro-2-methyl-4-isothiazolin-3-one (CMI) and 2-methyl-4-isothiazolin-3-one (MI) and the individual constituents do not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of the CMI/MI mixture in its use in drilling muds and water treatment. The information presented in this dossier was obtained primarily from an opinion document from the EU Scientific Committee on Consumer Safety (EFSA, 2009). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### **I. SUBSTANCE IDENTIFICATION**

#### **A. Mixture of 5-chloro-2-methyl-4-isothiazolin-3-one (CMI) and 2-methyl-4-isothiazolin-3-one (MI) [3:1]**

**CAS RN:** 55965-84-9

**Synonyms:** Kathon™ CG, Kathon 886, Kathon WT, Kathon 886, Acticide LG, Acticide 14 L, Acticide 14P, Microcare IT, Microcare ITL, CMI, MI

#### **B. 5-Chloro-2-methyl-4-isothiazolin-3-one (CMI)**

**Chemical Name (IUPAC):** 5-Chloro-2-methyl-1,2-thiazol-3(2H)-one

**CAS RN:** 26172-55-4

**Molecular formula:** C<sub>4</sub>H<sub>4</sub>ClNOS

**Molecular weight:** 149.45

**Synonyms:** 5-Chloro-2-methyl-4-isothiazolin-3-one; CMIT; methylchloroisothiazolinone; 5-chloro-2-methyl-3(2H)-isothiazolone; 5-Chloro-2-methyl-1,2-thiazol-3(2H)-one; 5-chloro-2-methyl-2H-isothiazol-3-one

**SMILES:** CN1C(=O)C=C(S1)Cl

#### **C. 2-Methyl-4-isothiazolin-3-one (MI)**

**Chemical Name (IUPAC):** 2-Methyl-1,2-thiazol-3-one

**CAS RN:** 2682-20-4

**Molecular formula:** C<sub>4</sub>H<sub>5</sub>NOS

**Molecular weight:** 115.16

**Synonyms:** 2-Methyl-4-isothiazolin-3-one; MI; methyl-isothiazolinone; methylisothiazolinone; 2-methyl-3(2H)-isothiazolone; 3(2H)-isothiazolone, 2-methyl-,

**SMILES:** CN1C(=O)C=CS1

Combined formulations of CMI and MI are marketed under several trade names, such as Kathon CG, Kathon 886, Kathon 886 WT, Kathon™ 886, Acticide LG, Acticide 14 L, Acticide 14P, Microcare IT, Microcare ITL, etc. (EFSA, 2009). Initially, all formulations were prepared as a mixture of two individual active ingredients CMI and MI and salts. However, Kathon™ 886 biocide is now defined as a combination of the two active ingredients produced by an integrated production process, resulting in an approximate total of 14% active ingredients, 16% magnesium nitrate, 10% magnesium chloride and 62% water. There is no indication as to when this change was made in the manufacturing process (EFSA, 2009).

Magnesium nitrate and magnesium chloride are present in the commercial CMI/MI mixture as an inert ingredient and impurity, respectively. The amount of these two salts vary depending on the source (EFSA, 2009).

## II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of CMI/MI [3:1]**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear, light amber liquid	-	EFSA, 2009
Melting Point	22.3-35.1°C 46.2-50.3°C	-	EFSA, 2009
Boiling Point	100°C 106.5°C	-	EFSA, 2009
Density	1.296 g/ml @ 20°C 1.256 g/ml @ 20°C	-	EFSA, 2009
Partition Coefficient (log P <sub>ow</sub> )	0.67-0.7 @ 20°C	-	EFSA, 2009
Water Solubility	367 g/L @ 20°C	-	EFSA, 2009
Flash Point	Not applicable	-	
Viscosity	11.4 Cp at 25.7°C 8.4 Cp at 44.6°C	-	EFSA, 2009
pH	1.90 @ 23.8°C	-	EPA, 1998

**Table 2: Overview of the Physico-chemical Properties of CMI**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa			
Melting Point	54-55°C	-	HSDB
Boiling Point			
Density		-	HSDB
Vapour Pressure	0.018 mm Hg	-	EPA, 1998
Partition Coefficient (log P <sub>ow</sub> )	0.401 @ 24°C	-	EFSA, 2009
Water Solubility	706-751 g/L @ 20°C		EFSA, 2009

**Table 3: Overview of the Physico-chemical Properties of MI**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colourless prisms	-	HSDB
Melting Point	50-51°C	-	HSDB
Boiling Point	93°C	-	HSDB
Density	1.35 g/mL		
Vapour Pressure	0.062 mmHg	-	HSDB
Partition Coefficient (log $P_{ow}$ )	-0.486 (MI) @ 24°C;	-	
Water Solubility	Readily miscible	-	HSDB

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

CMI is susceptible to hydrolysis at alkaline pH (half-life = 22 days) but stable at acidic and neutral pHs. MI is not susceptible to hydrolysis at any pHs. Both CMI and MI are very volatile. MI is not susceptible to hydrolysis at any pHs. Both CMI and MI are expected to be rapidly biodegraded in the environment. The calculated half-lives of CMI and MI in a river sediment-water system were 17.3 and 9.1 hours, respectively. CMI and MI have a high potential for mobility in soil and a low bioconcentration potential.

#### B. Abiotic Degradation

##### Hydrolysis

CMI is susceptible to hydrolysis at alkaline pH ( $t_{1/2}$  = 22 days) but stable at neutral and acidic pHs. MI is not susceptible to hydrolysis at alkaline, neutral, or acidic pHs (EPA, 1998).

#### C. Biodegradation

##### CMI

CMI was tested in an OECD 301B test that was modified for low concentrations of  $^{14}\text{C}$ -labelled compounds. The accumulated  $^{14}\text{CO}_2$  reached 38.8%, 55.3%, and 62% in the respective concentrations (0.3, 0.1, and 0.03 mg/L) after 29 days. During the 10-day window, 25%, 40%, and 48%, respectively, of the initial CMI was mineralized to  $^{14}\text{CO}_2$ . The ultimate biodegradability of CMI exceeded the 60%-pass level for ready biodegradability at the lowest test concentration of 0.03 mg/L, but the pass level was not reached within the 10-day window (Bashir, 1998a).

The primary biodegradability of CMI was investigated in a river sediment-water system. During the 7-day experiment, [ $^{14}\text{C}$ ]-CMI was rapidly metabolised: only 30% of the initial CMI remained after 24 hours of incubation at 25°C. The calculated half-life for the intact CMI was 17.3 hours (Reynolds, 1994a).

##### MI

MI was tested in an OECD 301B test that was modified for low concentrations of  $^{14}\text{C}$ -labelled compounds. The accumulated  $^{14}\text{CO}_2$  reached 54.1%, 55.8%, and 47.6% in the respective concentrations (0.1, 0.03 and 0.01 mg/L) after 29 days. During the 10-day window, 37%, 30% and

30%, respectively, of the initial MI was mineralized to  $^{14}\text{CO}_2$ . MI is biodegradable, but not readily biodegradable (Bashir, 1998b).

The primary aerobic biodegradability of MI was investigated in a river sediment-water system. During the 7-day experiment, [ $^{14}\text{C}$ ]-MI was rapidly metabolised: only 12.6% of the initial MI was present after 24 hours of incubation at 25°C. The calculated half-life for the parent compound was 9.1 hours (Reynolds, 1994b).

## D. Environmental Distribution

### Adsorption/desorption

[4,5- $^{14}\text{C}$ ]-CMI was found to be very mobile in sandy, loam, silt loam, clay loam, and sand soils in an aerobic soil metabolism study, with Freundlich  $K_{\text{ads}}$  values of 0.1 to 1.5. The Freundlich  $K_{\text{ads}}$  value in sandy loam sediment was 4.9. the  $K_{\text{oc}}$  values were 30 – 144 for the soils and 310 for sediment (EPA, 1998).

## E. Bioaccumulation

### CMI

The BCF values of CMI in bluegill sunfish (*Lepomis macrochirus*) were determined to be 102, 114, and 67 at nominal concentrations of 0.02, 0.12, and 0.8 mg/L (Erikson et al., 1995). These BCF values are based on total accumulated  $^{14}\text{C}$  and include both the parent compound and metabolites.

### MI

The BCF for MI was 2.3 at a nominal concentration of 0.12 mg/L (Erikson et al., 1995).

## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

The CMI/MI [3:1] mixture is moderate to highly toxic by oral, dermal, and inhalation routes. CMI/MI [3:1] is corrosive to the skin and eyes. It is a skin sensitizer. Repeated exposures to rats by the oral, dermal, or inhalation routes have shown no systemic toxicity; however, evidence of localised irritation (site-of-contact) was observed by all routes of exposure. A lifetime drinking water study in rats showed no evidence of carcinogenicity. CMI/MI [3:1] showed evidence of genotoxicity when evaluated in *in vitro* tests, however, *in vivo* studies were negative. The limited information on the reproductive and developmental toxicity studies of CMI/MI [3:1] mixture indicates a low potential.

### B. Acute Toxicity

The oral  $\text{LD}_{50}$  of Kathon WT (1.5% a.i.) is >5,000 mg/kg (>75 mg a.i./kg) in male rats and >3,310 mg/kg (~49.6 mg a.i./kg) in female rats (EFSA, 2009). The oral  $\text{LD}_{50}$  of Acticide 14 (14% a.i.) is 472-490 mg/kg (~66 to 69 mg a.i./kg) in rats (combined sexes); and 465 mg/kg (69 mg a.i./kg) in male rats and 393 mg/kg (59 mg a.i./kg) in female rats (EFSA, 2009).

The dermal  $\text{LD}_{50}$  of Kathon CG is >5,000 mg/kg (>75 mg a.i./kg) in female rabbits (EFSA, 2009). The dermal  $\text{LD}_{50}$  of Acticide 14 (14% a.i.) is 1,008 mg/kg (141 mg a.i./kg) in rats (combined sexes) (EFSA, 2009).

The inhalation  $\text{LC}_{50}$  of Kathon 886F (13.9% a.i.) in male and female rats is 2.36 mg/L (0.33 mg a.i./L) (EFSA, 2009).

## C. Irritation

### CMI/MI [3:1]

Undiluted Kathon MW (1.5% a.i.) and Acticide 14 (14% a.i.) were corrosive to rabbit skin (EFSA, 2009). Undiluted Kathon CG was severely irritating to the eyes of rabbits (EFSA, 2009). Kathon RH 886T at 100 ppm (0.01% a.i.) was non-irritating to the eyes of rabbits (EFSA, 2009).

## D. Sensitisation

The CMI/MI mixture has been tested in the guinea pig Buehler and Magnusson-Kligman tests and has been shown to be a strong skin sensitizer. It is also a strong contact allergen in humans (EFSA, 2009).

## E. Repeated Dose Toxicity

### Oral

Rats were exposed to a CMI/MI mixture (75.3% a.i.) in a powdered commercial diet. The CMI/MI concentrations were increased over the 13-week period (initial concentration up to week 2, intermediate concentration week 3-4, final concentration week 5 to 13). Concentrations in the control and CMI/MI groups were: 0/0/0, 40/57/80, 132/187/260, 400/570/800 ppm. There were no mortalities and no effects on body weight or food consumption. In each group, some animals showed slight alopecia or reddened raw or scabbed areas on the skin. There were no other differences in general behaviour or appearance. There were no treatment-related changes in haematological, biochemical, urinary parameters nor any pathology. No systemic toxicity was observed up to and including the highest dose of either CMI/MI (800 ppm, equivalent 29.1 mg a.i./kg-day). The NOAEL in this study is 800 ppm (29.1 mg a.i. /kg-day) (EFSA, 2009).

Male and female COBS CD(SD)BR rats were given in their drinking water Kathon 886 NAR (CMI/MI, 15.1% a.i.) at concentrations of 25, 75 or 225 ppm a.i. for three months (equivalent to an average intake of 2.38, 6.28 and 16.3 mg/kg/day in males and 4.06, 10.8, and 24.7 mg/kg-day in females). There were two additional groups of rats that were given tap water or tap water containing the inorganic ions present in the CMI/MI solution, at a concentration equal to that in the high-dose group (225 ppm). This solution is referred to as the ion control solution. There were no deaths during the study. Body weights were significantly decreased in the high-dose males during the first two weeks of the study. Food consumption was significantly decreased in males ( $\geq 25$  ppm a.i.) and in females ( $\geq 75$  ppm a.i.) during the first few weeks of dosing. Water consumption was significantly decreased in all dosed groups. There were no clinical signs of toxicity or ophthalmic effects. Haematology parameters were similar across all groups. There was a significant decrease in globulin and an increase in the albumin/globulin (A/G) ratio in males in both the high-dose and in the ion control groups, at study termination. A significant decrease in total protein was also seen in the high-dose group but was not seen in the ion control group. Females in the high-dose group showed a modest (40%) increase in SGOT (AST, aspartate aminotransferase) levels at the end of the exposure period. No changes were observed at any dose in mixed-function oxidase activities of the liver. In the high-dose groups, relative liver (males) and kidney (females) weights were significantly increased but there were no correlative changes in organ pathology. Histopathological examination showed a local irritation of the glandular mucosa of the stomach in 7 of 15 males and 5 of 15 females at 225 ppm a.i. These subtle low-level changes did not occur at the lower doses or where they present in either control group. No other compound-related changes were seen. The NOAEL for systemic toxicity is 225 ppm a.i. (equivalent to 16.3 and 24.7 mg/kg-day in males and females, respectively), the highest dose tested. The NOAEL for localised irritation (site-of-contact effects) is 75 ppm a.i. (equivalent to 6.28 and 10.8 mg/kg-day in males and females, respectively) (EFSA, 2009).



Male and female CRL: CDBR rats were given in their drinking water Kathon 886 (14.2% a.i., pH 2-3 in the study report). In the document with compiled batch information for Kathon, the active ingredient is 13.2% [10.13% CMI/ 3.85% MI] with 15.4% magnesium nitrate and 9.0% magnesium chloride. The dose levels were 0, 30, 100 and 300 ppm (equivalent to: 0, 2.0, 6.6, 17.2 mg a.i./kg-day in males and 0, 3.1, 9.8, 25.7 mg a.i./kg-day in females). There were no deaths and no treatment-related clinical signs. A concentration-dependent decrease in water consumption was seen in all treated groups throughout the study; the decreased ranged from 0-22% at a low dose, 3-30% at mid dose, and 15-40% at high-dose. These decreases appear to be due to the unpalatability of the CMI/MI and not its inorganic stabiliser salts since the water consumption in the salt control was comparable to the tap water control throughout the study. Based on the average daily water consumption, the high-dose was judged to be a maximum tolerated dose. Body weight and body weight gain were reduced in the high-dose groups throughout the study and may have been secondary to the reduction in water consumption in these animals. Ophthalmic examinations, haematological and clinical chemistry parameters, urinalysis, and organ weights were similar across all groups. Slight to moderate forestomach hyperplasia was seen in the mid- and high-dose animals, with gastric irritation being the primary effect. There were no other histopathological changes noted in the treated animals compared to the controls. The NOAEL for systemic toxicity is 300 ppm a.i. (17.2 to 25.7 mg/a.i./kg-day), the highest dose tested. The NOAEL for localised irritation (site-of-contact effects) is 30 ppm a.i. (2.0 to 3.1 mg a.i./kg-day) (EFSA, 2009).

### Inhalation

Male and female CD(SD)BR rats were exposed by inhalation to Kathon™ 886 (CMI/MI, 14% a.i.) aerosol 6 hours/day, 5 days/week for 13 weeks. The exposure concentrations were 0, 0.34, 1.15, or 2.64 mg a.i./m<sup>3</sup>. There were no deaths during the study. Body weights, body-weight gain, and food consumption were significantly decreased in the high-exposure group. The high-exposure group also exhibited clinical signs of chromorhinorrhea, rhinorrhea, eye squint, bradypnea, and dyspnea. Hematology and clinical chemistry parameters and urinalysis were similar across all groups. Serum protein levels were decreased in the high-exposure females, and spleen weights were decreased in the high-exposure males. Histopathologic effects were limited to the respiratory tract and indicative of irritation. The NOAEL for systemic toxicity is 2.64 mg a.i./m<sup>3</sup>. The NOAEL for localised irritation (site-of-contact effects) is 0.34 mg a.i./m<sup>3</sup> (EFSA, 2009).

### Dermal

Male and female SD rats received dermal applications of 0, 0.75, 3.75, or 18.75 mg/kg Acticide 14 (10.2% CMI/4% MI) once daily to the skin for 91 days. There were no treatment-related deaths or effects on body weight and feed consumption. Hematology and clinical chemistry parameters, urinalysis, ophthalmic examinations, and organ weights were similar across all groups. Histopathologic effects were limited to the skin, which included inflammation, parakeratosis, and acnathosis. The NOAEL for systemic toxicity is 18.75 mg/kg-day Acticide 14 (2.66 mg/kg-day a.i.) (EFSA, 2009).

## **F. Genotoxicity**

### In Vitro Studies

The *in vitro* studies conducted on MI and the CMI/MI mixture are presented below in Table 4.

**Table 4: *In Vitro* Genotoxicity Studies on MI and CMI/MI**

Test System	Test Substance	Results*	Reference
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>S. cerevisiae</i> )	CMI/MI	+ (TA100)	EFSA, 2009



Test System	Test Substance	Results*	Reference
Bacterial reverse mutation ( <i>S. typhimurium</i> )	CMI/MI	+ (TA100, -S9)	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> )	CMI/MI	+ (TA100, -S9)	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> )	CMI/MI	+ (TA100, only strain tested)	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> )	CMI/MI	+**	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>E. coli</i> )	CMI/MI	+ (TA100); - ( <i>E. coli</i> )	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> )	CMI	+ (TA100, -S9)	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> )	MI	-	EFSA, 2009
Bacterial reverse mutation ( <i>S. typhimurium</i> strains)	MI	-	EFSA, 2009
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	CMI/MI	+ ( $\pm$ S9)	EFSA, 2009
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	CMI/MI	+ ( $\pm$ S9)	EFSA, 2009
Chromosomal aberration (human lymphocytes)	CMI/MI	-	EFSA, 2009
Unscheduled DNA (UDS) assay (primary rat hepatocytes)	CMI/MI	-	EFSA, 2009

\*+, positive; -, negative

\*\*+ in TA98, TA100, TA102, TA15354, TA1537 (-S9); TA100 and TA102 (+S9)

### In vivo Studies

The *in vivo* studies conducted on CMI/MI are presented below in 5. All of the studies show that the mixture is not mutagenic or genotoxic.

**Table 5: In Vivo Genotoxicity Studies on CMI/MI**

Test System	Test Substance	Results*	Reference
Rat bone marrow chromosome aberration test	CMI/MI	-	EFSA, 2009
Mouse bone marrow chromosome aberration test	CMI/MI	--	EFSA, 2009
Mouse bone marrow chromosome aberration test	CMI/MI	-	EFSA, 2009
Mouse bone marrow chromosome aberration test	CMI/MI	-	EFSA, 2009
Mouse bone marrow micronucleus test	CMI/MI	-	EFSA, 2009
Mouse bone marrow micronucleus test	CMI/MI	-	EFSA, 2009
Mouse bone marrow micronucleus test	CMI/MI	-	EFSA, 2009
Unscheduled DNA Synthesis (UDS) test in rats	CMI/MI	-	EFSA, 2009
Unscheduled DNA Synthesis (UDS) test in rats	CMI/MI	-	EFSA, 2009
<i>Drosophila melanogaster</i> sex-linked recessive lethal test	CMI/MI	-	EFSA, 2009

\*+, positive; -, negative

## G. Carcinogenicity

### Oral

Male and female CRL:CDBR rats were given in their drinking water Kathon 886 (14.2% a.i., pH 2-3). In the document with compiled batch information for Kathon, the active ingredient is 13.2% [10.13% CMI/ 3.85% MI] with 15.4% magnesium nitrate and 9.0% magnesium chloride. The dose levels were 0, 30, 100 and 300 ppm (equivalent to: 0, 2.0, 6.6, 17.2 mg a.i./kg-day in males and 0, 3.1, 9.8, 25.7 mg a.i./kg-day in females). There were no deaths and no treatment-related clinical signs. Body weight and body weight gain were reduced in the high-dose groups throughout the study and may have been secondary to the reduction in water consumption in these animals as a result of palatability problems. There were no significant differences in tumour incidences between treated and control animals (EFSA, 2009).

No inhalation or dermal carcinogenicity studies were located.

## H. Reproductive Toxicity

A one-generation reproductive toxicity study was combined with the 13-week drinking water study reported above in the repeated dose toxicity section. In this study, male and female COBS CD(SD)BR rats were given in their drinking water Kathon 886 NAR (CMI/MI, 15.1% a.i.) at concentrations of 25, 75 or 225 ppm a.i. for three months (equivalent to an average intake of 2.38, 6.28 and 16.3 mg/kg/day in males and 4.06, 10.8, and 24.7 mg/kg-day in females). There were two additional groups of rats that were given tap water or tap water containing the inorganic ions present in the CMI/MI solution, at a concentration equal to that in the high-dose group (225 ppm). This solution is referred to as the ion control solution. There were treatment-related effects on the reproductive parameters measured. Litter size and survival at birth was also similar in all groups. One dam at the high concentration lost the entire litter by day 4 due to a lactation problem; this was not considered

treatment-related. Pups of the other high concentration group dams, except one, survived and to post-natal day 21. The NOAEL for reproductive and developmental toxicity is 225 ppm a.i. in drinking water (equivalent to 16.3 and 24.7 mg/kg-day in males and females, respectively) (EFSA, 2009).

In a two-generation reproductive toxicity study, male and female Crl: CDBR rats were given in their drinking water Kathon 886F (11.1% CMI, 3.7% MI) at concentrations of 0 (control), 0 (magnesium salt control), 30, 100 or 300 ppm a.i. For the P<sub>1</sub> generation, this was equivalent to 0, 2.8-4.4; 8.5-11.8, and 22.7-28.0 mg a.i./kg-day; and in the P<sub>2</sub> generation 0, 4.3-5.5, 13.4-16.0, and 35.7-39.1 mg a.i./kg-day. Survival, food consumption and clinical signs were similar across all groups. Body weight gain was initially reduced in the P<sub>1</sub> generation; this was thought to be linked to reduced water consumption since the significant dose-related reduction in water consumption was seen in all dosed groups in both parental generations, during the premating, gestation and lactation stages. Treatment-related histopathological changes were seen in the stomach in both parental generations ( $\geq 100$  ppm) and included erosions of the glandular mucosa, edema and inflammation in the submucosa of the glandular and nonglandular stomach, with hyperplasia and hyperkeratosis of the nonglandular stomach. There were other histopathological changes, but these were not considered to be treatment-related as they were not dose-dependent. There were no effects on fertility or fetal development at any dose level, the estrus cycles in both parental female groups at all dose levels were comparable to controls, as well as sperm motility, morphology, testicular sperm count or caudal epididymal reserves of parental males of both generations. The NOAEL for reproductive toxicity is 300 ppm (22.7-28.0 mg/kg-day in the P<sub>1</sub> animals; 35.7-39.1 mg/kg-day in the P<sub>2</sub> animals), the highest dose tested (EFSA, 2009).

## **I. Developmental Toxicity**

In a rat, oral gavage developmental toxicity study on Kathon 886 (13.9% a.i.), the developmental NOAEL for CMI/MI is  $>15$  mg a.i./kg-day during organogenesis (highest dose tested) (EFSA, 2009).

In a rat, oral gavage developmental toxicity study on Acticide 14 (10.2% CMI/4% MI), the NOAEL for maternal toxicity is  $<3.95$  mg a.i./kg-day; the NOAEL for teratogenicity is  $>19.6$  mg a.i./kg-day; and the NOAEL for embryotoxicity is  $>19.6$  mg a.i./kg-day (EFSA, 2009).

In a rabbit, oral gavage developmental toxicity study on Acticide 14 (10.2% CMI/ 4% MI), the developmental NOAEL is  $>5.49$  mg a.i./kg-day; the NOAELs for maternal toxicity and fetal toxicity are 1.41 mg a.i./kg-day (EFSA, 2009).

In a rabbit, oral gavage developmental toxicity study on Kathon MW (13.9% a.i.), the NOEL for maternal toxicity is 2 mg a.i./kg-day; the developmental NOEL is 8 mg a.i./kg-day, the highest dose based on severe maternal toxicity at 20 mg a.i./kg (EFSA, 2009).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for the CMI/MI mixture 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).

### **A. Non-Cancer**

#### Oral

A two-year drinking water study has been conducted in rats with a CMI/MI mixture (14.2% a.i.; 10.13% CMI/3.85% MI). No systemic toxicity was observed at doses up to 300 ppm a.i., although there was gastric irritation of the stomach at doses of 100 and 300 ppm a.i. The NOAEL for systemic

toxicity in this study is 300 ppm (corresponding to 17.2 and 25.7 a.i. mg/kg-day for males and females, respectively) (EFSA, 2009). The NOAEL of 17 mg/kg-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 17 / (10 \times 10 \times 1 \times 1 \times 1) = 17 / 100 = \underline{0.2 \text{ mg/kg-day}}$$

#### 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)

$$\text{Drinking water guidance value} = (0.2 \times 70 \times 0.1) / 2 = \underline{0.7 \text{ mg/L}}$$

### **B. Cancer**

A two-year drinking water study on a CMI/MI mixture (14.2% a.i.; 10.13% CMI/3.85% MI) showed no evidence of carcinogenicity. Thus, no cancer reference value was derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

The CMI/MI mixture does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

CMI/MI is highly toxic to aquatic organisms. It is moderately toxic to birds on an acute basis, and moderately toxic to practically non-toxic on a subacute dietary basis.

## B. Aquatic Toxicity

### Acute Studies

Table 6 lists the results of acute aquatic toxicity studies conducted on CMI/MI formulations.

**Table 6: Acute Aquatic Toxicity Studies on CMI/MI Mixtures**

Test Substance	Test Species	Endpoint	Results (µg/L)	Reference
CMI/MI	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	300	ECOTOX
CMI/MI	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	960	ECOTOX
CMI/MI	<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	2,130	ECOTOX
CMI/MI	<i>Sheepshead minnow</i>	96-hr LC <sub>50</sub>	360	ECOTOX
CMI/MI	<i>Sheepshead minnow</i>	96-hr LC <sub>50</sub>	480	ECOTOX
CMI/MI	<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	1,520	ECOTOX
CMI/MI	<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	253	ECOTOX
CMI/MI	<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	190	ECOTOX
CMI/MI	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	840	ECOTOX
CMI/MI	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	180	ECOTOX
CMI/MI	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	1,300	ECOTOX
CMI/MI	<i>Ceriodaphnia dubio</i>	48-hr EC <sub>50</sub>	13,000	ECOTOX
CMI/MI	<i>Pseudokirchneriella subcapitata</i>	96-hr EC <sub>50</sub>	62	ECOTOX
CMI/MI	<i>Pseudokirchneriella subcapitata</i>	120-hr EC <sub>50</sub>	22	ECOTOX

### Chronic Studies

The results of the chronic aquatic toxicity tests conducted on CMI/MI are presented in Table 7.

**Table 7: Chronic Aquatic Toxicity Studies on CMI/MI Mixtures**

Test Substance	Test Species	Endpoint	Results (µg/L)	Reference
CMI/MI	<i>Pimephales promelas</i>	36-d NOEC	20	ECOTOX
CMI/MI	<i>Oncorhynchus mykiss</i>	14-d NOEC	50	ECOTOX
CMI/MI	<i>Daphnia magna</i>	21-d NOEC	100	ECOTOX
CMI/MI	<i>Pseudokirchneriella subcapitata</i>	120-hr EC <sub>50</sub>	10	ECOTOX

## C. Terrestrial Toxicity

The results of the terrestrial toxicity tests conducted on CMI/MI are presented in Table 8.

**Table 8: Terrestrial Toxicity Studies on CMI/MI Mixtures**

Test Substance	Test Species	Endpoint	Results	Reference
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Test Substance	Test Species	Endpoint	Results	Reference
CMI/MI	Northern Bobwhite Quail	8-d LC <sub>50</sub>	1,000 ppm	ECOTOX
CMI/MI	Northern Bobwhite Quail	8-d LC <sub>50</sub>	>100 ppm	ECOTOX
CMI/MI	Northern Bobwhite Quail	8-d LC <sub>50</sub>	2,200 ppm	ECOTOX
CMI/MI	Northern Bobwhite Quail	21-d LD <sub>50</sub>	74.3 mg/kg-day	ECOTOX
CMI/MI	Northern Bobwhite Quail	14-d LD <sub>50</sub>	690 mg/kg-day	ECOTOX
CMI/MI	Northern Bobwhite Quail	14-d LD <sub>50</sub>	62.5 mg/kg-day	ECOTOX
CMI/MI	Northern Bobwhite Quail	8-d NOEL	88 ppm	ECOTOX
CMI/MI	Mallard Duck	8-d LC <sub>50</sub>	717 ppm	ECOTOX
CMI/MI	Mallard Duck	8-d LC <sub>50</sub>	100 ppm	ECOTOX
CMI/MI	Mallard Duck	8-d NOEL	139 ppm	ECOTOX

#### D. Calculation of PNEC

The PNEC calculations for the CMI/MI mixtures follow the methodology discussed in DEWHA (2009).

##### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (190 µg/L), *Daphnia* (180 µg/L), and algae (22 µg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 10 µg/L for algae. 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 long-term NOEC of 10 µg/L for invertebrates. The PNEC<sub>water</sub> is 1 µg/L or 0.001 mg/L.

##### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 5.3 µg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned}
 \text{PNEC}_{\text{sed}} &= (K_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\
 &= (6.75/1280) \times 1000 \times 1 \\
 &= 5.3
 \end{aligned}$$

Where:

$K_{\text{sed-water}}$  = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)  
 $\text{BD}_{\text{sed}}$  = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned}
 K_{\text{sed-water}} &= 0.8 + [(0.2 \times K_{\text{p}_{\text{sed}}})/1000 \times \text{BD}_{\text{solid}}] \\
 &= 0.8 + [(0.2 \times 12.4)/1000 \times 2400] \\
 &= 6.75
 \end{aligned}$$

Where:

$K_{\text{p}_{\text{sed}}}$  = solid-water partition coefficient (L/kg).  
 $\text{BD}_{\text{solid}}$  = bulk density of the solid phase (kg/m<sup>3</sup>) = 2,400 [default]

$$\begin{aligned} K_{p_{\text{sed}}} &= K_{oc} \times f_{oc} \\ &= 310 \times 0.04 \\ &= 12.4 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The sediment  $K_{oc}$  for CMI range is 310.

$F_{oc}$  = fraction of organic carbon in sediment = 0.04 [default].

#### PNEC soil

There are no toxicity data for soil organisms. Therefore, the  $PNEC_{\text{soil}}$  was calculated using the equilibrium partitioning method. The  $PNEC_{\text{soil}}$  is 0.4 µg/kg soil dry weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{\text{soil}} &= (K_{p_{\text{soil}}}/BD_{\text{soil}}) \times 1000 \times PNEC_{\text{water}} \\ &= (0.6/1500) \times 1000 \times 1 \\ &= 0.4 \end{aligned}$$

Where:

$K_{p_{\text{soil}}}$  = soil-water partition coefficient ( $\text{m}^3/\text{m}^3$ )

$BD_{\text{soil}}$  = bulk density of soil ( $\text{kg}/\text{m}^3$ ) = 1,500 [default]

$$\begin{aligned} K_{p_{\text{soil}}} &= K_{oc} \times f_{oc} \\ &= 30 \times 0.02 \\ &= 0.6 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The soil  $K_{oc}$  for CMI is 30 (the lower range of 30-144).

$F_{oc}$  = fraction of organic carbon in soil = 0.02 [default].

### **VIII. PBT ASSESSMENT**

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).

The half-lives of CMI and MI in a river water-sediment system were 17.3 hours and 9.1 hours, respectively. Thus, the CMI/MI mixture does not meet the criteria for persistence.

The experimental BCFs for CMI and MI in bluefish sunfish are 67-114 and 2.3, respectively. Thus, the CMI/MI mixture does not meet the criteria for bioaccumulation.

The lowest NOEL from the chronic aquatic toxicity studies on the CMI/MI mixture is <0.01 mg/L. Thus, the CMI/MI mixture meets the screening criteria for toxicity.

The overall conclusion is that the CMI/MI mixture is not a PBT substance.

### **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

#### **A. Classification**

- Acute Toxicity Category 3 [Oral]

- Acute Toxicity Category 2 [Dermal]
- Acute Toxicity Category 2 [Inhalation]
- Skin Corrosion Category 1
- Eye Damage Category 1
- Skin Sensitiser Category 1
- Acute Aquatic Toxicity Category 1
- Chronic Aquatic Toxicity Category 1

The appropriate hazard statements corresponding the GHS classifications are to be added to the SDS, including the non-GHS hazard statement “AUH071: Corrosive to the Respiratory Tract”.

The aquatic toxicity classification is not required for Australia GHS.

## B. Labelling

Danger

## C. Pictogram



## X. SAFETY AND HANDLING

### Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

### Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention immediately.

### Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or another proper respiratory medical device. Give artificial respiration if the victim is not breathing. Get medical attention immediately.

### Ingestion

Rinse mouth and lips with plenty of water if a person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if the victim had ingested the substance. Obtain medical attention immediately if ingested.



### Notes to Physician

Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

## **A. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Use dry chemical, carbon dioxide, water spray or fog, or foam.

### Specific Exposure Hazards

This material will not burn until the water has evaporated. The residue is combustible. May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: oxides of nitrogen (NO<sub>x</sub>) and sulfur (SO<sub>x</sub>) under fire conditions.

### Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

## **B. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Restrict access to the area as appropriate until clean-up operations are complete. Ventilate enclosed areas. Do not walk through spilt material. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing.

### Environmental Precautions

Prevent entry into waterways, sewers, basements or confined areas.

### Steps to be Taken if Material is Released or Spilt

As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorised personnel away. Stay upwind. Keep out of low areas. Soak up the spill with absorbent material. Rinse the spill area with a 5% bleach/5% sodium bicarbonate in water "deactivation solution" (Dow, 2010). Let stand for 30 minutes and then rinse with water. Dispose in accordance with all local, state, and federal regulations.

## **C. STORAGE AND HANDLING**

### General Handling

Handle and open container with care. Use only with adequate ventilation. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

## Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis. Do not store above 40°C/104°F. The active ingredients can decompose violently at temperatures >50°F (122°F). Generation of gases (hydrogen chloride, nitrogen oxides, sulfur oxides) can cause rapid pressure build-up in closed systems. Avoid contact with amines, mercaptans, oxidizers, and reducing agents.

## **D. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for CMI or MI. Consult the SDS for any recommended occupational exposure standard from the manufacturer.

### Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

### Personal Protection Equipment

*Respiratory Protection:* If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much is based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

*Hand Protection:* Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

*Skin Protection:* Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling hydrochloric acid.

*Eye Protection:* Wear chemical splash goggles and face shield.

*Other Precautions:* Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

## **E. TRANSPORT INFORMATION**

### Australian Dangerous Goods

UN3265, CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Mixture of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1))  
Class 8

Packing Group: II

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Bashir, M. (1998a). Ready biodegradability of 14C-RH-651: Modified Sturm Test. Covance Laboratories Inc., Madison, WI. Rohm and Haas Technical Report No. TR-97-15; cited in Madsen et al., 2001.

Bashir, M. (1998b). Ready biodegradability of 14C-RH-573: Modified Sturm Test. Covance Laboratories Inc., Madison, WI. Rohm and Haas Technical Report No. TR-97-076; cited in Madsen et al., 2001.

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.

Dow (2010). Product Safety Assessment: DOW™ 5-Chloro-2-methyl-2H-Isothiazol-3-one/2-Methyl-2H-Isothiazol-3-one (CMIT/MIT)-Based Antimicrobial Products. The Dow Chemical Company. Available at: [http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh\\_094d/0901b8038094d3f5.pdf?filepath=productsafety/pdfs/noreg/233-00791.pdf&fromPage=GetDoc](http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_094d/0901b8038094d3f5.pdf?filepath=productsafety/pdfs/noreg/233-00791.pdf&fromPage=GetDoc)

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

ECOTOX. U.S. Environmental Protection Agency (EPA) ECOTOX Database: <http://cfpub.epa.gov/ecotox/>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

Erikson, U., Johnson, A., and Törnlund, M. (1995). Risk Assessment of Slimicides. KEMI Report No. 9/95. The Swedish National Chemicals Inspectorate, Solna, Sweden; cited in Madsen et al., 2001.

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

EU SCCS (2009). Opinion on the mixture of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-2H-isothiazol-3-one [3:1], Colipa N° P56, Scientific Committee on Consumer Safety, SCCS/1238/09.

HSDB. U.S. National Library of Medicine Hazardous Substance Data Bank (HSDB). Available at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSD>

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.

Madsen, T., Boyd, H.B., Nylén, D., Pdersen, A.R., Petersen, G.I., and Simonsen, F. (2001). Environmental and Health Assessment of Substances in Household Detergents and Cosmetic Detergent Products. Environmental Project No. 615, Danish Environmental Protection Agency. Accessed at: <http://www.miljøstyrelsen.dk/udgiv/publications/2001/87-7944-596-9/pdf/87-7944-597-7.pdf>.

Reynolds, J.L. (1994a). Aerobic aquatic metabolism of 14C-RH-651. Rohm and Haas Technical Report No. 34-94-64. XenoBiotic Laboratories, Inc., Plainsboro, NJ. United States; cited in Madsen et al., 2001.

Reynolds, J.L. (1994b). Aerobic aquatic metabolism of 14C-RH-573. Rohm and Haas Technical Report No. 34-94-122. XenoBiotic Laboratories, Inc., Plainsboro, NJ. United States; cited in Madsen et al., 2001

U.S. EPA (1998). Reregistration Eligibility Decision (RED) for Methylisothiazolinone. EPA738-R-38-012 Office of Prevention, Pesticides and Toxic Substances, United States Environmental Protection Agency, October 1998. Available at: <https://archive.epa.gov/pesticides/reregistration/web/pdf/3092.pdf>.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre

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mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## PROPRIETARY MIXTURE D1

This dossier on Proprietary Mixture D1 does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Proprietary Mixture D1 in its use in water treatment. The information presented in this dossier was obtained primarily from the U.S. EPA Reregistration Eligibility Decision (RED) document on Proprietary Mixture D1 (EPA, 1994). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Proprietary Mixture D1

**CAS RN:** PolymerA-CASRn

**Molecular formula:**

**Molecular weight:** 241.87

**Synonyms:** Proprietary Mixture D1

**SMILES:**

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Proprietary Mixture D1**

Property	Value	Reference
Physical state at 20°C and 101.3 kPa	White to “off white” colour crystalline solid	EPA, 1994
Melting Point	123 – 126°C	EPA, 1994
Boiling Point	Decomposes at 190°C	EPA, 1994
Density	2.375 g/ml @ 21°C	EPA, 1994
Vapour Pressure	9.0 x 10 <sup>-4</sup> mm Hg @ 25°C	EPA, 1994
Partition Coefficient (log K <sub>ow</sub> )	0.80 @ pH 5 0.80 @ pH 7 0.82 @ pH 9	EPA, 1994
Water Solubility	1.5 g/100 ml	EPA, 1994
Henry’s Law Constant	6.24 x 10 <sup>-9</sup> Pa m <sup>3</sup> /mol (estimated)	EPA, 2016

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

The dominant degradation pathway under use conditions involves reaction with nucleophilic substances or organic material that is found in water. Other degradation pathways include pH-dependent hydrolysis, reaction with soil, and breakdown via exposure to ultraviolet radiation. Proprietary Mixture D1 is not readily biodegradable, but in an aerobic metabolism study, the half-life was <4 hours. If released to water, Proprietary Mixture D1 is not expected to adsorb to suspended solids and sediments. If released to soil, Proprietary Mixture D1 is expected to have high mobility. The estimated Henry’s Law constant indicates that volatilisation from moist soil surfaces or water is not expected to be an important environmental fate pathway. Soil degradation half-lives in seven different soils (pH 4.8 – 7.5) ranged from 4 to 25 hours. Proprietary Mixture D1 has a low potential for bioaccumulation.

## **B. Abiotic Degradation**

The dominant degradation pathway under use conditions involves reaction with nucleophilic substances or organic material that is found in water (Dow, 2002).

### Hydrolysis

The hydrolysis half-life of Proprietary Mixture D1 decreases as the pH increases: the hydrolysis  $t_{1/2}$  values are 67 days, 63 days, and 73 minutes at pH 5, 7, and 9, respectively (EPA, 1994). The major degradation from hydrolysis is dibromoacetic acid (30.6% of applied) at pH 5, dibromoacetoneitrile (54.5%) at pH 7, and dibromoacetoneitrile (38.6%) at pH 9 (EPA, 1994).

The disappearance of Proprietary Mixture D1 was measured in various soils. The half-lives in hours were: 4 for sandy loam (pH 7.5); 12 for loam (pH 4.8); 15 for silty loam (pH 5.8); 15 sandy loam (pH 6.5); 6 for loamy sand (pH 5.8); 25 for silty clay loam (pH 5.1); and 15 for loam (pH 4.8). When solutions of Proprietary Mixture D1 were in contact with soil, Proprietary Mixture D1 disappeared at a much faster rate than in aqueous solutions of similar pH (Exner et al., 1973).

### Photolysis

Dilute aqueous Proprietary Mixture D1 was maintained in a sealed tube in an outdoor environment for 28 days at pH 4. Less than 1% of the Proprietary Mixture D1 remained, and more than 95% of the theoretical amount of bromide ion was formed. The half-life was estimated to be 7 days under ambient conditions (Dow, 2002).

## **C. Biodegradation**

In an MITI test, there was 0% degradation of Proprietary Mixture D1 after 28 days; thus, Proprietary Mixture D1 was not readily biodegradable in this test (HSDB).

Proprietary Mixture D1 degrades with a half-life of <4 hours in aerobic and anaerobic aquatic metabolism studies. The six degradates detected were oxalic acid, 2-cyanoacetamide, bromoacetamide, dibromoacetic acid, bromoacetic acid, and dibromoacetoneitrile (EPA, 1994).

## **D. Environmental Distribution**

### Adsorption/desorption

No experimental values were found. Using KOCWIN in EPISuite™ v. 4.11 (EPA, 2016), the estimated  $K_{oc}$  value from a  $K_{ow}$  value of 0.82 is 58 L/kg.

## **E. Bioaccumulation**

No experimental values were found. Based on the octanol-water coefficients (log  $K_{ow}$ ) of 0.80-0.82 and a BCF of three estimated from BCFBAF in EPISuite™ v. 4.11 (EPA, 2016), Proprietary Mixture D1 is not expected to bioaccumulate.

## **IV. HUMAN HEALTH HAZARD ASSESSMENT**

### **A. Summary**

Proprietary Mixture D1 is acutely toxic by the oral and inhalation routes, but not by the dermal route. It is corrosive to the skin and eyes. Proprietary Mixture D1 is a skin sensitiser. Inhalation exposure of an aerosol or mist can cause respiratory irritation. Repeated oral exposures in rats showed some

evidence of kidney toxicity. There was no evidence of systemic toxicity following repeated dermal exposures. It is not genotoxic. In a rabbit study, possible delayed development (retarded skeletal ossification) was seen in the fetuses at a lower oral dose than those that caused maternal toxicity.

## **B. Acute Toxicity**

The oral LD<sub>50</sub> values in rats are 235 mg/kg for males and 178 mg/kg for females (EPA, 1994). In another study, the oral LD<sub>50</sub> in rats was 375 mg/kg for males and 284 mg/kg for females (EPA, 1994). The oral LD<sub>50</sub> is 118 mg/kg in guinea pigs and 118 mg/kg in rabbits (EPA, 1994).

The dermal LD<sub>50</sub> in rabbits is >2,000 mg/kg; no deaths were reported at this dose level (EPA, 1994).

The 4-hour LC<sub>50</sub> in rats is 0.32 mg/L (EPA, 1994).

## **C. Irritation**

Application of 0.5 g to the skin of rabbits for four hours produced erythema and edema with exfoliation after five days (EPA, 1994). In the acute dermal toxicity study, encrustation and exfoliation of the skin were observed (EPA, 1994).

Proprietary Mixture D1 is corrosive to the eyes of rabbits (EPA, 1994).

## **D. Sensitisation**

Proprietary Mixture D1 was a weak dermal sensitizer when tested in guinea pig sensitization tests (EPA, 1994).

## **E. Repeated Dose Toxicity**

### Oral

Rats were dosed by oral gavage with 0, 5, 13, or 30 mg/kg Proprietary Mixture D1 for 90 days. At  $\geq 13$  mg/kg, dyspnea was seen in the treated animals, as well as weight loss and some deaths. The NOAEL for this study is 5 mg/kg-day (EPA, 1994).

Male and female SD Spartan rats were given in their drinking water at pH 4 or 8 0, 20, 100, or 500 ppm Proprietary Mixture D1 for 90 days. Proprietary Mixture D1 is unstable at pH 8 and the objective of the study was to investigate the effect of the breakdown products of Proprietary Mixture D1. Minimal cytoplasmic swelling and vacuolization were seen in the kidneys of the 500 ppm females at pH 8. No other treatment-related effects were noted. The NOAEL is 100 ppm, which corresponded to a daily intake of 8 and 15.9 mg/kg-day in males and females, respectively (HSDB).

Male and female CD-1 mice were given in their feed 0, 3, 10, 100, 300, 600, or 1,000 mg/kg-day Proprietary Mixture D1 (nominal doses) for 90 days. The actual average daily intakes were: 0, 1.58, 4.4, 44, 133, 267, or 447 mg/kg-day for males; and 0, 1.57, 4.5, 45, 137, 269, or 450 mg/kg-day for females. Decreased food consumption and body weight gain were noted in the  $\geq 600$  mg/kg males and  $\geq 300$  mg/kg females. Haemoglobin concentration and hematocrit were decreased in the 1,000 mg/kg males; red blood cell counts were decreased in the  $\geq 300$  mg/kg males, and serum chloride was increased in the  $\geq 600$  mg/kg males and  $\geq 300$  mg/kg females. Relative liver and spleen weights were increased and absolute brain and testes weights were decreased in the 1,000 mg/kg males, and heart weights were decreased in the 1,000 mg/kg females. Histopathologic examination showed no treatment-related effects. The NOAEL was reported to be 100 mg/kg-day (HSDB).



Male and female F344 rats were given in their feed 0, 3, 10, 100, 300, 600, or 1,000 mg/kg-day Proprietary Mixture D1 (nominal doses) for 90 days. The actual average daily intakes were: 0, 1.22, 4.6, 45, 133, 254, or 388 mg/kg-day for males; and 0, 1, 1.17, 4.3, 44, 130, 251, or 392 mg/kg-day for females. The discrepancy between nominal doses and the actual test material uptake was due to the poor stability of the test material in the dietary preparations despite the diets being prepared weekly. The 1,000 mg/kg males were euthanized on day 38 and the 600 mg/kg males and the 1,000 mg/kg females were euthanized on day 73. These groups were terminated prior to the end of the study because of minimal body weight gain and a concern that a large number of the animals would not survive to the end of the 90-day treatment period. At the end of 90 days, the mean body weights of the 300 mg/kg males and the 600 mg/kg females were significantly lower than controls. There was a significant decrease in the mean red blood cell count for the 300 mg/kg males and the mean haemoglobin concentration in the 100 and 300 mg/kg males were increased. Serum chloride levels were increased in the  $\geq 100$  mg/kg animals (both sexes), as well as a dose-related increase in urinary ketone content. Organ weight changes included: heart, kidney liver, brain, testes and epididymides, spleen, adrenal glands, ovaries, thymus, and uterus. Histopathologic examination showed possible adverse effects, such as axonal degeneration in the optic chiasma, optic nerve, and retinal atrophy in the eye. Specifically, the effects were: very slight vacuolization in the cortex of the adrenal gland (100 and 300 mg/kg males); very slight or slightly diffuse hyperplasia of erythroid cells in the bone marrow (300 mg/kg males and 600 mg/kg females); focal or multifocal axonal degeneration optic chiasma in the brain (300 mg/kg males) and in conjunction with this lesion slight or moderate unilateral axonal degeneration of the optic nerve and moderate unilateral retinal atrophy in the eye (300 mg/kg males); increased incidence of very slight or slight multifocal unilateral axonal degeneration of the optic nerve (600 mg/kg females); unilateral or bilateral multifocal degeneration of the seminiferous tubules in the testes (300 mg/kg males); slight atrophy of the cervix and ovaries (600 mg/kg females); and very slight atrophy of the thymal cortex (600 mg/kg females). The NOAEL was reported to be 10 mg/kg-day (4.6 and 4.3 mg/kg-day for males and females, respectively) based on the incidence of vacuolization in the adrenal gland of the 100 mg/kg males and increased incidence of extramedullary hematopoiesis in the spleen and increased absolute spleen weights in the 100 mg/kg females (HSDB).

### Inhalation

No inhalation studies were located.

### Dermal

Male and female rats received dermal applications of 0, 103, 309, or 1,031 mg/kg Proprietary Mixture D1 6 hours/day, 5 days/week for 90 days. At 1,031 mg/kg, triglyceride levels were lower in males than controls; in females, cholesterol levels were lower, and serum alkaline phosphatase levels were higher than controls. The urinary pH was  $\geq$  in some males. Dermal irritation was transient in several male and female rats at  $\geq 309$  mg/kg. The NOAEL for systemic toxicity in this study is 309 mg/kg-day (EPA, 1994).

## **F. Genotoxicity**

### **In Vitro Studies**

Proprietary Mixture D1 was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537, and TA1538 in the absence or presence of metabolic activation (EPA, 1994). Proprietary Mixture D1 was not mutagenic to CHO cells in an HGPRRT assay with or without metabolic activation (EPA, 1994). A weak positive response was seen in an *in vitro* chromosomal aberration test using human lymphocytes (EPA, 1994). Two separate *in vitro* unscheduled DNA synthesis (UDS) test using rat hepatocytes were negative (EPA, 1994).

### In Vivo Studies

No studies were located.

### **G. Carcinogenicity**

No carcinogenicity studies were located.

### **H. Reproductive Toxicity**

No reproductive toxicity studies were located.

### **I. Developmental Toxicity**

Pregnant female rabbits were dosed by oral gavage with 0, 2, 10, 30, or 60 mg/kg Proprietary Mixture D1 during GD 7-19. There were deaths in the 60 mg/kg dosed does, as well as reduced body weight gain and feed consumption. In the  $\geq 30$  mg/kg dose groups, retarded ossification of several fetal skeletal elements, indicating possible delayed development. The NOAELs for maternal and developmental toxicity are 30 and 10 mg/kg-day, respectively (EPA, 1994).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for Proprietary Mixture D1 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).

### **A. Non-Cancer**

#### Oral

The lowest NOAEL is from a 90-day oral gavage study that reported mortality, weight loss, and dyspnea in rats dosed with 13 and 30 mg/kg-day Proprietary Mixture D1. The NOAEL for this study is 5 mg/kg-day (EPA 1994). The NOAEL from this study will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 10

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 5 / (10 \times 10 \times 1 \times 10 \times 1) = 5 / 1000 = \underline{0.005 \text{ mg/kg-day}}$$

#### 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 = (0.005 x 70 x 0.1)/2 = 0.02 mg/L

## B. Cancer

No carcinogenicity studies were located; thus, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Proprietary Mixture D1 does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Proprietary Mixture D1 is very toxic to aquatic organisms. Proprietary Mixture D1 is also acutely toxic to birds.

### B. Aquatic Toxicity

#### Acute Studies

Table 2 lists the results of the acute aquatic toxicity studies conducted on Proprietary Mixture D1.

**Table 2: Acute Aquatic Toxicity Studies on Proprietary Mixture D1**

Test Species	Active ingredient	Endpoint	Results (mg/L)	Reference
Bluegill sunfish	100	96-hr LC <sub>50</sub>	2.3	EPA, 1994
Bluegill sunfish	Technical	96-hr LC <sub>50</sub>	1.3	EPA, 1994
Rainbow trout	Technical	96-hr LC <sub>50</sub>	1.0	EPA, 1994
Rainbow trout	100	96-hr LC <sub>50</sub>	2.3	EPA, 1994
Fathead minnow	99.1	96-hr LC <sub>50</sub>	1.8	EPA, 1994
Sheepshead minnow	99.5	96-hr LC <sub>50</sub>	3.4	EPA, 1994
Sheepshead minnow	95	96-hr LC <sub>50</sub>	1.7	EPA, 1994
<i>Daphnia magna</i>	95	48-hr EC <sub>50</sub>	0.9	EPA, 1994
<i>Daphnia magna</i>	100	48-hr EC <sub>50</sub>	0.86	EPA, 1994

## Chronic Studies

Table 3 lists the results of the chronic aquatic toxicity studies conducted on Proprietary Mixture D1.

**Table 3: Chronic Aquatic Toxicity Studies on Proprietary Mixture D1**

Test Species	Active ingredient	Endpoint	Results (µg/L)	Reference
<i>Onchorhynchus mykiss</i>	98%	85-d NOEC	470	ECOTOX
<i>Daphnia magna</i>	100%	28-d NOEC	50	ECETOX

## C. Terrestrial Toxicity

Table 4 lists the results of the chronic aquatic toxicity studies conducted on Proprietary Mixture D1.

**Table 4: Terrestrial Acute Toxicity Studies on Proprietary Mixture D1**

Test Species	% Active Ingredient (a.i.)	Results (mg/kg)	Reference
Mallard Duck	Technical grade	205	EPA, 1994
Bobwhite Quail	Technical grade	150	EPA, 1994
Bobwhite Quail	100%	354	EPA, 1994

**Table 5: Terrestrial Subacute Toxicity Studies on Proprietary Mixture D1**

Test Species	% Active Ingredient (a.i.)	Results (ppm)	Reference
Mallard Duck	95%	>10,000	EPA, 1994
Mallard Duck	100%	>5,620	EPA, 1994
Bobwhite Quail	95%	>10,000	EPA, 1994
Mallard Duck	100%	>5,620	EPA 1994

## D. Calculation of PNEC

The PNEC calculations for Proprietary Mixture D1 follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for two trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (1,000 µg/L) and *Daphnia* (860 µg/L). Results from chronic studies are also available for two trophic levels, with the lowest NOEC being 50 µg/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 50 has been applied to the lowest reported long-term NOEC of 50 µg/L for invertebrates. The PNEC<sub>water</sub> is 1 µg/L or 0.001 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 1.5 µg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (\text{K}_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (1.91/1280) \times 1000 \times 1 \\ &= 1.5 \end{aligned}$$

Where:

$\text{K}_{\text{sed-water}}$  = suspended matter-water partition coefficient ( $\text{m}^3/\text{m}^3$ )  
 $\text{BD}_{\text{sed}}$  = bulk density of sediment ( $\text{kg}/\text{m}^3$ ) = 1,280 [default]

$$\begin{aligned} \text{K}_{\text{sed-water}} &= 0.8 + [(0.2 \times \text{Kp}_{\text{sed}})/1000 \times \text{BD}_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 2.32)/1000 \times 2400] \\ &= 1.91 \end{aligned}$$

Where:

$\text{Kp}_{\text{sed}}$  = solid-water partition coefficient (L/kg).  
 $\text{BD}_{\text{solid}}$  = bulk density of the solid phase ( $\text{kg}/\text{m}^3$ ) = 2,400 [default]

$$\begin{aligned} \text{Kp}_{\text{sed}} &= \text{K}_{\text{oc}} \times f_{\text{oc}} \\ &= 58 \times 0.04 \\ &= 2.32 \end{aligned}$$

Where:

$\text{K}_{\text{oc}}$  = organic carbon normalised distribution coefficient (L/kg). The estimated  $\text{K}_{\text{oc}}$  for Proprietary Mixture D1 is 58.  
 $f_{\text{oc}}$  = fraction of organic carbon in sediment = 0.04 [default].

### PNEC soil

There are no toxicity data for soil organisms. Therefore, the  $\text{PNEC}_{\text{soil}}$  was calculated using the equilibrium partitioning method. The  $\text{PNEC}_{\text{soil}}$  is 0.77  $\mu\text{g}/\text{kg}$  soil dry weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{soil}} &= (\text{Kp}_{\text{soil}}/\text{BD}_{\text{soil}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (1.16/1500) \times 1000 \times 1 \\ &= 0.77 \end{aligned}$$

Where:

$\text{Kp}_{\text{soil}}$  = soil-water partition coefficient ( $\text{m}^3/\text{m}^3$ )  
 $\text{BD}_{\text{soil}}$  = bulk density of soil ( $\text{kg}/\text{m}^3$ ) = 1,500 [default]

$$\begin{aligned} \text{Kp}_{\text{soil}} &= \text{K}_{\text{oc}} \times f_{\text{oc}} \\ &= 58 \times 0.02 \\ &= 1.16 \end{aligned}$$

Where:

$\text{K}_{\text{oc}}$  = organic carbon normalised distribution coefficient (L/kg). The estimated  $\text{K}_{\text{oc}}$  for Proprietary Mixture D1 is 58.  
 $f_{\text{oc}}$  = fraction of organic carbon in soil = 0.02 [default].

## VIII. PBT ASSESSMENT

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).

The half-life of Proprietary Mixture D1 in an aerobic aquatic metabolism study was <4 hours. In soil studies, the half-life of the disappearance of Proprietary Mixture D1 in various soils ranged from 4 to 25 hours. Thus, Proprietary Mixture D1 does not meet the criteria for persistence.

The estimated BCF for Proprietary Mixture D1 is 3 L/kg, and the experimental log  $K_{ow}$  value is 0.8. Thus, Proprietary Mixture D1 does not meet the screening criteria for bioaccumulation.

The lowest NOEL from the chronic aquatic toxicity studies on Proprietary Mixture D1 is <0.01 mg/L. Thus, Proprietary Mixture D1 meets the screening criteria for toxicity.

The overall conclusion is that the Proprietary Mixture D1 is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

- Acute Toxicity Category 3 [Oral]
- Acute Toxicity Category 2 [Inhalation]
- Skin Corrosion Category 1
- Eye Damage Category 1
- Skin sensitisation Category 1
- Acute Aquatic Toxicity Category 1

Note: Aquatic toxicity classification is not required for Australia GHS.

### B. Labelling

Danger

### C. Pictogram



## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

Wash immediately and continuously with flowing water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Obtain prompt medical consultation, preferably from an ophthalmologist. Eye wash fountain should be located in immediate work area.

### Skin Contact

Take off contaminated clothing. Wash skin with soap and plenty of water for 15-20 minutes. Call a poison control centre or doctor for treatment advice. Wash clothing before reuse. Shoes and other leather items which cannot be decontaminated should be disposed of properly. Safety shower should be located in immediate work area.

### Inhalation

Move person to fresh air. If a person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask, etc.). Call a poison control centre or doctor for treatment advice. If breathing is difficult, oxygen should be administered by qualified personnel.

### Ingestion

Call a poison control centre or doctor immediately for treatment advice. If the person is fully alert and cooperative, have the person rinse mouth with plenty of water. Do not induce vomiting unless told to do so by the poison control centre. Never give anything by mouth to an unconscious person.

### Notes to Physician

Chemical eye burns may require extended irrigation. Obtain prompt consultation, preferably from an ophthalmologist. If the burn is present, treat as any thermal burn, after decontamination. Due to irritant properties, swallowing may result in burns/ulceration of mouth, stomach and lower gastrointestinal tract with subsequent stricture. Aspiration of vomitus may cause lung injury. Suggest endotracheal/oesophageal control if lavage is done. Probable mucosal damage may contraindicate the use of gastric lavage. No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the Safety Data Sheet, and if available, the product container or label with you when calling a poison control centre or doctor, or going for treatment.

### Emergency Personnel Protection

First-aid responders should pay attention to self-protection and use the recommended protective clothing (chemical resistant gloves, splash protection). If the potential for exposure exists, refer to section 8 on the SDS for specific personal protective equipment.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Use water fog, carbon dioxide, dry chemical or foam to extinguish combustible residues of this product

### Specific Exposure Hazards

This material will not burn until the water has evaporated. Residue can burn. Some components of this product may decompose under fire conditions. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include and are not limited to Nitrogen oxides, Hydrogen bromide, Carbon monoxide, Carbon dioxide.

### Special Protective Equipment for Firefighters

Wear positive-pressure self-contained breathing apparatus (SCBA) and protective firefighting clothing (includes firefighting helmet, coat, trousers, boots, and gloves). Avoid contact with this material during firefighting operations. If contact is likely, change to full chemical resistant firefighting clothing with self-contained breathing apparatus. If this is not available, wear full chemical resistant clothing with self-contained breathing apparatus and fight the fire from a remote location.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Evacuate area. Keep upwind of the spill. Use appropriate safety equipment. Ventilate area of leak or spill. Only trained and properly protected personnel must be involved in clean-up operations.

### Environmental Precautions

Spills or discharge to natural waterways is likely to kill aquatic organisms. Prevent from entering into soil, ditches, sewers, waterways and/or groundwater.

### Steps to be Taken if Material is Released or Spilt

Contain spilt material if possible. Methods and materials for containment and cleaning up: contain spilt material if possible. Attempt to neutralise by adding materials such as sodium bisulphite, sodium metabisulfite. Neutralise with approximately 17.2 grammes sodium bisulfite ( $\text{NaHSO}_3$ ) or 15.7 grammes sodium metabisulphite ( $\text{Na}_2\text{S}_2\text{O}_5$ ) for every 100 grammes biocidal product. Absorb with materials such as dirt, sand, vermiculite, Zorb-all®, Hazorb®. Collect in suitable and properly labelled containers. [Information was obtained from the SDS for The Dow Chemical Company product BIOBAN™ DB 20 AntiMicrobial (dated: 08/18/2015), which contains 20% Proprietary Mixture D1 and 46.5-54.5% PEG, <3% dibromoacetone, and <4% sodium bromide.]

## **D. STORAGE AND HANDLING**

### General Handling

Do not get in eyes, on skin, on clothing. Avoid breathing mist. Avoid prolonged or repeated contact with skin. Do not swallow. Keep container closed. Use with adequate ventilation. Wear goggles, protective clothing and butyl or nitrile gloves. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

### Other Handling Precautions

Do not spray or aerosolise the undiluted form of the product. Full personal protective equipment (including skin covering and full-face SCBA respirator) is required for dilutions or mixtures of the product used in a spray application.

### Storage

Store in original container. Keep container tightly closed. Do not store in aluminium, brass, copper, copper alloys, mild steel, or stainless steel (Dow, 2002). Use within 12 months and at storage temperatures of <35°C. (Dow, 2002).



## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Proprietary Mixture D1. Consult the SDS for any recommended occupational exposure standard from the manufacturer.

### Engineering Controls

Use local exhaust ventilation or other engineering controls to maintain airborne below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, general ventilation should be sufficient for most operations.

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection should be worn when there is potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, wear respiratory protection when adverse effects, such as respiratory irritation or discomfort have been experienced. Use an approved particulate respirator in misty atmospheres. The following should be effective types of air-purifying respirators: organic vapour cartridge with a particulate pre-filter.

If engineering controls and work practices cannot keep exposure below occupational exposure limit requirements or guidelines or if exposure is unknown, wear an NIOSH-certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or another qualified professional. Full-Face piece Respirator with Organic vapour cartridge with particulate pre-filter.

*Hand Protection:* Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

*Skin Protection:* Use protective clothing chemically resistant to this material. Consult the SDS for appropriate protective material.

Eye protection: Splash proof chemical mono-goggles or safety glasses with side shield in conjunction with a face shield. Do NOT wear contact lenses.

*Other Precautions:* Eye wash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

### Australia Dangerous Goods

UN 3265, Corrosive Liquid, Acidic, Organic, N.O.S. (Proprietary Mixture D1)  
Class 8  
Packing Group III

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

ECOTOX. U.S. Environmental Protection Agency (EPA) ECOTOX Database: <http://cfpub.epa.gov/ecotox/>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

Exner, J.H., Burk, G.A., and Kyriacou, D. (1973). Rates and products of decomposition of Proprietary Mixture D1.

HSDB. U.S. National Library of Medicine Hazardous Substance Data Bank (HSDB). Available at: <https://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSD>

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.

The Dow Chemical Company [Dow] (2002). DOW Antimicrobial 7287 and DOW Antimicrobial 8536: The fast-acting, broad-spectrum biocides with low environmental impact. Available at: [http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh\\_0043/0901b80380043c9e.pdf?filepath=biocides/pdfs/noreg/253-01464.pdf&fromPage=GetDoc](http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0043/0901b80380043c9e.pdf?filepath=biocides/pdfs/noreg/253-01464.pdf&fromPage=GetDoc)

U.S. Environmental Protection Agency [EPA] (2016). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: <https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface>

## **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute

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DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## PROPRIETARY ESTER A

This dossier on Proprietary Ester A does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Proprietary Ester A in its use in water treatment. 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), and from the OECD-SIDS documents on the Phosphonic Acid Compounds Group 2 category, which includes Proprietary Ester A (OECD, 2004a,b). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** (Proprietary Ester A)

**CAS RN:** EsterA-CASRn

**Molecular formula:**

**Molecular weight:** 206.03

**Synonyms:** Proprietary Ester A

**SMILES:**

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Proprietary Ester A**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Syrup	2	ECHA
Melting Point	198-199°C; 228°C (decomposition)	2	ECHA
Boiling Point	Decomposes before boiling	2	ECHA
Density	1.45 @ 20°C	4	ECHA
Vapor Pressure	~0 Pa	2	ECHA
Partition Coefficient (log P <sub>ow</sub> )	-3.5	2	ECHA
Water Solubility	Very soluble	2	ECHA
Dissociation constants	Four pKa values (at 0.1 M ionic strength potassium nitrate: 1.6, 2.7, 6.9, 11	4	OECD, 2004a,b

Proprietary Ester A is a diphosphonic acid. The properties of Proprietary Ester A and its salts are profoundly directed by its ionisation behavior. Proprietary Ester A can ionise by the loss of a hydrogen ion up to five times to give the corresponding anion. The fifth ionisation (of the hydroxyl group) cannot be attained under normal aqueous conditions. As a consequence of ionisation, Proprietary Ester A is a strong complexing agent and is high hydrophilic (OECD, 2004a,b).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Proprietary Ester A is not readily biodegradable. There is evidence for partial degradation over short time periods, and with evidence of mineralisation, particularly in light, over long periods. It strongly adsorbs to inorganic surfaces, sediment and soils. Proprietary Ester A has a low potential for bioaccumulation.

#### B. Biodegradation

In a closed bottle test, there was 0% degradation after 30 days (OECD, 2004). In an OECD ready biodegradation test, 10% of Proprietary Ester A was degraded after 28 days (ECHA) [Kl. score = 2]. In another OECD ready biodegradation test, 1-3% of Proprietary Ester A was degraded after 28 days (HERA, 2004).

In a Zahn-Wellens inherent biodegradability test, the percentage of DOC removal after 28 days was 33% (HERA, 2004; ECHA) [Kl. score = 4]. Biodegradation of radiolabelled Proprietary Ester A was 1.9 to 6.7% over a 210-day period in an SCAS test (HERA, 2004).

In non-sterile natural water, the ultimate biodegradation ( $^{14}\text{CO}_2$  evolution) of Proprietary Ester A was 2% in the dark and 2.7% in the sunlight after 60 days (HERA, 2004) [Kl. score = 4]. In the presence of sediment, the biodegradation was faster, with 7.1% degradation in 50 days (HERA, 2004) [Kl. score = 4].

In soils, there was 3 to 47% degradation of Proprietary Ester A after 119 to 148 days (HERA, 2004) [Kl. score = 4].

#### C. Environmental Distribution

Adsorption/desorption

A log  $K_{oc}$  of 4.22 was determined experimentally (ECHA; OECD, 2004a,b). [Kl. score = 2]

#### D. Bioaccumulation

The BCF values of Proprietary Ester A in a carp (*Cyprinus carpio*) were determined to be <7 for the whole body and 71 for the non-edible portions (0.06 mg/L). At 0.6 mg/L, the BCF values were <2 for the whole body and 31 for the non-edible portions of the fish (ECHA). [Kl score = 2]

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Proprietary Ester A has low to moderate acute toxicity by the oral and dermal routes. Proprietary Ester A is severely irritating to the eyes. It is not a skin sensitizer. Repeated exposure of Proprietary Ester A in rats by the oral route showed effects primarily related to its ability to chelate metal ions and affect calcium and iron homeostasis. Lifetime studies in rats showed no carcinogenic effects when Proprietary Ester A was given in the diet. In a rat study, high oral doses of Proprietary Ester A was toxic to the developing fetus at levels that did not cause maternal toxicity; no teratogenic effects were noted. No developmental effects were seen in a rabbit study.

## **B. Acute Toxicity**

The oral LD<sub>50</sub> for Proprietary Ester A is 3,500 mg/kg (ECHA) [Kl. score = 2]. The oral LD<sub>50</sub> of an aqueous solution of 60% Proprietary Ester A is 3,130 mg/kg [equivalent to 1,878 mg Proprietary Ester A/kg] (ECHA) [Kl. score = 2].

The dermal LD<sub>50</sub> for an aqueous solution of 60% Proprietary Ester A is >10,000 mg/kg [equivalent to 6,000 mg Proprietary Ester A/kg] (ECHA). [Kl. score = 2]

## **C. Irritation**

There are no reliable dermal irritation studies; however, the data suggests that that Proprietary Ester A is not irritating to the skin (OECD, 2004).

Two studies have shown that instillation of 0.1 ml of an aqueous solution of 60% Proprietary Ester A and 0.02% HCl into the eyes of rabbits were severely irritating to the eyes (HERA, 2004). [Kl. scores = 2]

## **D. Sensitization**

Proprietary Ester A was not a skin sensitizer in a guinea pig maximisation test (ECHA). [Kl. score = 2]

## **E. Repeated Dose Toxicity**

### Oral

Male and female CD rats were given in their feed Proprietary Ester A for 90 days. The average daily intakes were: 0, 154, 524, or 1,583 mg/kg-day for males; and 0, 166, 545, and 1724 mg/kg-day for females. The effect was seen only in the high-dose animals. Body weight gain was decreased in both males and females, with feed intake slightly decreased in the males only. Changes in haematological parameters were: increased erythrocyte counts (males), decreased haemoglobin concentration (both sexes), and decreased leukocyte counts (females after 84 days only). These changes were thought to be due to reduced availability of iron and consequent alterations in iron homeostasis. Liver weights were decreased in the high-dose group. Histopathological effects included bilateral mineralized microconcentrations in kidney tubules in some males and extramedullary hematopoiesis in the spleen of some females. These effects were thought to be due to altered calcium homeostasis and were not considered to be toxicologically significant. The NOAEL for this study was considered to be 1,583 mg/kg-day for males and 1,724 mg/kg-day for females (ECHA). [Kl. score = 2]

Male and female SD rats were given in their feed 0, 500, 2,000, or 10,000 ppm disodium etidronate (sodium salt of Proprietary Ester A) for 104 weeks. The estimated daily intakes were: 0, 19, 78, or 384 mg/kg-day for males; and 0, 24, 96, or 493 mg/kg-day for females. There was no treatment-related effect on survival, clinical signs, feed and water consumption, ophthalmoscopy, gross or histopathological effects. The NOAEL for this study is 384 mg/kg-day in males and 493 mg/kg-day in females (ECHA). [Kl. score = 2]

### Inhalation

No studies were located.

### Dermal

No studies were located.

## **F. Genotoxicity**

### In Vitro Studies

Disodium Proprietary Ester A was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537, or TA1538 in the absence or presence of metabolic activation (ECHA) [Kl. score = 2]. Proprietary Ester A was not mutagenic in a mouse lymphoma assay in the absence or presence of metabolic activation (ECHA) [Kl. score = 1].

### In Vivo Studies

Male and female CF-1 mice were given an intraperitoneal injection of 0, 18.75, or 150 mg/kg disodium Proprietary Ester A on two consecutive days. There were no significant increases in micronuclei of bone marrow cells at either dose (ECHA). [Kl. score = 2]

Disodium Proprietary Ester A was tested in a mouse dominant lethal assay at doses of 0, 20, 200, and 1,000 mg/kg. There was no evidence of mutagenicity (ECHA). [Kl. score = 2]

## **G. G. Carcinogenicity**

### Oral

Male and female SD rats were given in their feed 0, 500, 2,000, or 10,000 ppm disodium etidronate (sodium salt of Proprietary Ester A) for 104 weeks. The estimated daily intakes were: 0, 19, 78, or 384 mg/kg-day for males; and 0, 24, 96, or 493 mg/kg-day for females. Survival was similar across all groups. There were no significant differences in tumour incidences between treated and control animals (ECHA). [Kl. score = 2]

No inhalation or dermal studies were located.

## **H. Reproductive Toxicity**

Proprietary Ester A was given in feed either continuously to male and female rats or pregnant female rats on GD 5-15. The doses were 0, 0.1, or 0.5% in feed, which was estimated to be 0, 112, or 447 mg/kg-day. The F<sub>0</sub> females were allowed to deliver two litters (F<sub>1a</sub>, F<sub>1b</sub>) while a third was used for a teratology evaluation (see next section). The F<sub>1a</sub> litters were discarded after weaning, and the F<sub>1b</sub> litters were used for breeding the F<sub>2</sub> generation. The F<sub>2a</sub> litters were discarded after weaning, and the F<sub>2b</sub> litters were used for the teratology evaluation (see next section). The pregnancy rate was unaffected by treatment. The NOAEL for reproductive toxicity is 447 mg/kg-day (ECHA). [Kl. score = 4]

## **I. Developmental Toxicity**

Pregnant female rats were given in their diet 0, 112, or 447 mg/kg disodium Proprietary Ester A during GD 5 to 15. There was no maternal toxicity. Litter size was decreased in the dams given 0.5% in the diet on GD 5-15, indicating fetotoxicity. No teratogenic effects were noted. The NOAELs for maternal and developmental toxicity are 447 and 112 mg/kg-day, respectively (ECHA). [Kl. score = 4]

Pregnant female New Zealand rabbits were given in their diet 0, 25, 50, or 100 mg/kg disodium Proprietary Ester A during GD 2 to 19. There was no maternal or developmental toxicity. The NOAELs for maternal and developmental toxicity is 100 mg/kg-day (ECHA). [Kl. score = 4]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for Proprietary Ester A 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).

### A. Non-Cancer

#### Oral

A two-year chronic dietary study has been conducted on disodium Proprietary Ester A. There were no treatment-related effects at dietary levels up to 10,000 ppm. The NOAELs were 384 and 493 mg/kg-day for males and females, respectively. The lowest NOAEL of 384 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 384 / (10 \times 10 \times 1 \times 1 \times 1) = 384 / 100 = \underline{4 \text{ mg/kg-day}}$$

#### 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)

$$\text{Drinking water guidance value} = (4 \times 70 \times 0.1) / 2 = \underline{14 \text{ mg/L}}$$

### B. Cancer

No carcinogenic effects were seen in rats in a chronic dietary study; thus, no cancer reference value was derived.



## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Proprietary Ester A does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Proprietary Ester A are of low acute toxicity to fish and invertebrates; it does exhibit moderate toxicity concern to algae, which may be due to the complexation of DEHP with essential trace metals.

### B. Aquatic Toxicity

#### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on Proprietary Ester A.

**Table 2: Acute Aquatic Toxicity Studies on Proprietary Ester A**

Test Species	Endpoint	Results* (mg/L)	Klimisch score	Reference
<i>Onychorhynchus mykiss</i>	96-hr LC <sub>50</sub>	195	1	ECHA
<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	2,180	2	ECHA
<i>Ictalurus punctatus</i>	96-hr LC <sub>50</sub>	695	2	ECHA
<i>Lepomis macrochirus</i>	96-hr LC <sub>50</sub>	868	2	ECHA
<i>Onychorhynchus mykiss</i>	96-hr LC <sub>50</sub>	368	2	ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	527	2	ECHA
<i>Pseudokirchnerella subcapitata</i>	96-hr EC <sub>50</sub>	7.23 (biomass)	2	ECHA
<i>Pseudokirchnerella subcapitata</i>	96-hr EC <sub>50</sub> NOEC	3 (biomass) 14 (growth rate)	2	ECHA

\*Active acid or active ingredient.

The toxicity of DEHP to algae may be the consequence of nutrient limitation caused by the complexation of DEHP with essential trace metals and not true toxicity (OECD, 2004).

#### Chronic Studies

The 28-day NOEC from a 28-day *Daphnia magna* reproduction toxicity study is 6.75 mg Proprietary Ester A /L (ECHA). [Kl. score = 2]

The 14-d NOEC to *Pseudokirchnerella subcapitata* was 14 mg Proprietary Ester A /L (growth rate) (ECHA). [Kl. score = 2]

## C. Terrestrial Toxicity

The 14-day LC<sub>50</sub> value to the earthworm *Eisenia foetida* was >1,000 mg Proprietary Ester A /kg dw soil (ECHA). [Kl. score = 2]

The 14-day EC<sub>50</sub> and NOEC of Proprietary Ester A to the growth of *Avena sativa* were >960 mg Proprietary Ester A /kg dw soil (HERA 2004). [Kl. score = 4]

The 96-hr LC<sub>50</sub> values for the mallard duck (*Anas platyhynchos*) and the bobwhite quail (*Colinus virginianus*) are >284 mg Proprietary Ester A /kg (ECHA). [Kl. scores = 2]

## D. Calculation of PNEC

The PNEC calculations for Proprietary Ester A follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (195 mg/L), *Daphnia* (527 mg/L), and algae (3 mg/L). Chronic toxicity data are available for two trophic levels, with the lowest NOEC being 6.75 mg/L for algae. On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest NOEC of 6.75 mg/L. The PNEC<sub>water</sub> is 0.14 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 59 mg/kg wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (\text{K}_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (320/1280) \times 1000 \times 0.10 \\ &= 25 \end{aligned}$$

Where:

$\text{K}_{\text{sed-water}}$  = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)  
 $\text{BD}_{\text{sed}}$  = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned} \text{K}_{\text{sed-water}} &= 0.8 + [(0.2 \times \text{Kp}_{\text{sed}})/1000 \times \text{BD}_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 664)/1000 \times 2400] \\ &= 320 \end{aligned}$$

Where:

$\text{Kp}$  = solid-water partition coefficient (L/kg).  
 $\text{BD}_{\text{solid}}$  = bulk density of the solid phase (kg/m<sup>3</sup>) = 2,400 [default]

$$\begin{aligned} \text{Kp} &= \text{K}_{\text{oc}} \times f_{\text{oc}} \\ &= 16,596 \times 0.04 \\ &= 664 \end{aligned}$$

Where:

$\text{K}_{\text{oc}}$  = organic carbon normalised distribution coefficient (L/kg). The  $\text{K}_{\text{oc}}$  for Proprietary Ester A is 16,596.

$F_{oc}$  = fraction of organic carbon suspended sediment = 0.04 [default].

#### PNEC soil

Experimental results are available for two trophic levels. An acute  $LC_{50}$  value is available for earthworms (>1,000 mg/kg dw soil). Results are available for one trophic, with the NOEC of 960 mg/kg dw soil for plants (*Avena sativa*). On the basis that the data consists of a short-term result from one trophic level and a long-term result from one trophic level, an assessment factor of 100 has been applied to the lowest NOEC of 960 mg/kg dw soil. The  $PNEC_{water}$  is 9.6 mg/kg dw soil.

### **VIII. PBT ASSESSMENT**

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).

Proprietary Ester A is not readily biodegradable; thus it meets the screening criteria for persistence.

The BCF values in fish for Proprietary Ester A are <2 to 71. Thus, Proprietary Ester A does not meet the criteria for bioaccumulation.

The lowest chronic aquatic NOEC is >0.1 mg/L. Thus, Proprietary Ester A does not meet the criteria for toxicity.

The overall conclusion is that Proprietary Ester A is not a PBT substance.

### **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

#### **A. Classification**

Metal Corrosion Category 1

Acute Toxicity Category 4 [Oral]

Eye Damage Category 1

#### **B. Labelling**

Danger

#### **C. Pictogram**



## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

#### Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

### **B. FIRE FIGHTING INFORMATION**

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: phosphorus oxides, phosphine, carbon monoxide, carbon dioxide.

#### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

### **C. ACCIDENTAL RELEASE MEASURES**

#### Personal Precautions

Use appropriate protective equipment.

#### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Pick up with absorbent material. Use a neutralising agent: sodium carbonate or lime. Dispose of contaminated material as prescribed.

## **D. STORAGE AND HANDLING**

### General Handling

Provide adequate ventilation. Do not breathe vapours.

### Other Handling Precautions

Avoid eye and skin contact.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Proprietary Ester A.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Australian Dangerous Goods

UN 3265, CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (ETIDRONIC ACID)

Class 8

Packing Group III

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

HERA (2004). Human & Environmental Risk Assessment on ingredients of European household cleaning products: Phosphonates (CAS No. 6419-19-8; 2809-21-4; 15827-60-8). Draft. Available at: <http://www.heraproject.com/files/30-F-04-%20HERA%20Phosphonates%20Full%20web%20wd.pdf>

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.

Nolen, G.A., and Buehler, E.V. (1971). The effects of disodiumetidronate on the reproductive functions and embryology of albino rats and New Zealand rabbits. Toxicol. Appl. Pharmacol. 18: 548-561.

OECD (2004a). SIDS Dossier on Etidronic acid (CAS No. 2809-21-4). Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=263D00E3-7331-4A39-9164-2CB1AD7C216F](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=263D00E3-7331-4A39-9164-2CB1AD7C216F)

OECD (2004b). SIDS Initial Assessment Report on Phosphonic Acid Compounds Group 2. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=263D00E3-7331-4A39-9164-2CB1AD7C216F](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=263D00E3-7331-4A39-9164-2CB1AD7C216F)

## **XIV. ACRONYMS AND GLOSSARY**

°C                      degrees Celsius

ADWG                Australian Drinking Water Guidelines

API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## **HOMOPOLYMER OF MALEIC ACID [POLYMALEIC ACID]**

This dossier on the homopolymer of maleic acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of homopolymer of maleic acid in its use in water treatment systems. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### **I. SUBSTANCE IDENTIFICATION**

**Chemical Name (IUPAC):** Polymaleic anhydride, hydrolyzed (HPMA)

**CAS RN:** 26099-09-2

**Molecular formula:**  $(C_4H_4O_4)_x$ -

**Molecular weight:** 400 - 800

**Synonyms:** Homopolymer of maleic acid; polymaleic acid; polymaleic anhydride, hydrolyzed (HPMA); 2-Butenedioic acid, (Z)-, homopolymer

### **II. PHYSICO-CHEMICAL PROPERTIES**

No information is available.

The homopolymer of maleic acid would be expected to be acidic in solution.

### **III. ENVIRONMENTAL FATE PROPERTIES**

No information is available.

### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

No information is available.

### **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

No toxicological reference value or drinking water guidance value was derived.

### **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

The homopolymer of maleic acid is unlikely to exhibit the following properties:

- Explosivity
- Flammability
- Oxidizing potential

### **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

#### **A. Aquatic Toxicity**

No studies are available.



## **B. Terrestrial Toxicity**

No studies are available.

## **C. Calculation of PNEC**

PNEC values were not derived.

## **VIII. PBT ASSESSMENT**

A PBT assessment was not determined.

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

No information can be provided. The homopolymer of maleic acid is supplied to the Santos water and brine treatment plant (Leewood) in a product mixture called Hydrex 9209. See a GHS-compliant Veolia Water Solutions & Technologies Australia Safety Data Sheet on Hydrex 9209 for any GHS classification and labelling for the homopolymer of maleic acid.

## **X. SAFETY AND HANDLING**

No information is provided. The homopolymer of maleic acid is supplied to the Santos water and brine treatment plant (Leewood) in a product mixture called Hydrex 9209. See a GHS-compliant Veolia Water Solutions & Technologies Australia Safety Data Sheet on Hydrex 9209 for any safety and handling information concerning this product.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

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.

## **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment

HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## HYDROCHLORIC ACID

This dossier on hydrochloric acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of hydrochloric acid in its use in drilling muds and in water treatment. The majority of information presented in this dossier was obtained from OECD-SIDS documents (OECD, 2002a,b), and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Chlorane

**CAS RN:** 7647-01-0

**Molecular formula:** HCl

**Molecular weight:** 36.46

**Synonyms:** Hydrochloric acid, HCl, chlorane, hydrogen chloride, muriatic acid, chlorohydric acid,

**SMILES:** Cl

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Hydrochloric Acid**

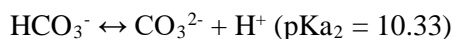
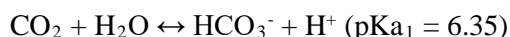
Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colourless to slightly yellow gas of fuming liquid with pungent, irritating odour.	2	ECHA
Melting Point	-114.22°C	2	ECHA
Boiling Point	-85°C	4	ECHA
Density	1.639 g/L @ 0°C (gas) 1.194 g/mL @ 26°C (liquid)	4	ECHA
Vapour Pressure	4,104 kPa 4,723 kPa @ 25°C	4	ECHA
Partition Coefficient (log P <sub>ow</sub> )	Not applicable		
Water Solubility	Very soluble	4	ECHA
Viscosity	1.7 x 10 <sup>-6</sup> m <sup>2</sup> s @ 20°C	1	ECHA

Hydrochloric acid can exist in a gaseous phase at room temperature and pressure. Hydrochloric acid is also very soluble in water and is a strong acid that dissociates completely in water to hydrogen (H<sup>+</sup>) and chloride (Cl<sup>-</sup>) ions.

### III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, hydrochloric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H<sup>+</sup>) and chloride (Cl<sup>-</sup>) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of hydrochloric acid to an aquatic ecosystem may decrease the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between  $\text{CO}_2$ ,  $\text{HCO}_3^-$  and  $\text{CO}_3^{2-}$ :



A release of hydrochloric acid into the aquatic environment from the use of HCl could potentially increase the chloride concentration and decrease the pH in the aquatic environment. Table 2 shows the amount of hydrochloric acid that would need to be added to bicarbonate solutions to obtain pH values of 6.0 and 4.0. The UNEP (1995) study reported that the 10<sup>th</sup> percentile, mean, and the 90<sup>th</sup> percentile of bicarbonate concentrations in 77 rivers in North America, South America, Asia, Africa, Europe, and Oceania were 20, 106, and 195 mg/L, respectively. The data show that the decrease in pH depends on the buffer capacity (bicarbonate concentration) of the receiving water. The calculated values in Table 2 were confirmed experimentally.

**Table 2: Buffer capacity to maintain the pH based on bicarbonate concentration from UNEP monitoring data (de Groot and van Dijk, 2002; taken from OECD, 2002b)**

Initial concentration of $\text{HCO}_3^-$	Final pH	Concentration of HCl required to obtain the final pH value
		Calculated [mg/L]
20 mg/L $\text{HCO}_3^-$ (10 <sup>th</sup> percentile 77 rivers)	6.0	8.28
	4.0	11.9
106 mg/L $\text{HCO}_3^-$ (mean value of 77 rivers)	6.0	43.9
	4.0	63.2
195 mg/L $\text{HCO}_3^-$ (90 <sup>th</sup> percentile 77 rivers)	6.0	80.7
	4.0	116.3

$\text{H}^+$  and  $\text{Cl}^-$  ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002a,b).

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

Hydrochloric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of hydrochloric acid (HCl) are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapours from aqueous solutions of HCl can cause respiratory irritation. HCl is not a skin sensitizer. Subchronic inhalation studies show localised irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some *in vitro* genotoxicity studies, which are considered to be the result of the pH change in the test system. A lifetime inhalation study showed no carcinogenic in rats exposed to HCl. No adequate reproductive or developmental studies have been conducted on HCl.

##### B. Acute Toxicity

The oral  $\text{LD}_{50}$  values in rats were reported to be 238 to 277 mg/kg and 700 mg/kg (OECD, 2002a,b). [Kl. scores = 2 and 4, respectively]

The lethal dose by dermal exposure is >5,010 mg/kg for rabbits (OECD 2002a,b). [Kl. score = 4]

The LC<sub>50</sub> values in rats for HCl gas are 40,989 and 4,701 ppm for 5 and 30 minutes, respectively (ECHA) [Kl. score = 2]. The LC<sub>50</sub> values in rats for HCl aerosol are 31,008 and 5,666 ppm (45.6 and 8.3 mg/L) for 5 and 30 minutes, respectively (ECHA) [Kl. score = 2].

### C. Irritation

Application of a 37% aqueous solution of HCl for 1 or 4 hours was corrosive to the skin of rabbits (OECD, 2002a,b) [Kl. score = 2]. Application of 0.5 mL of a 17% solution of aqueous solution of HCl for 4 hours was corrosive to the skin of rabbits (OECD, 2002a,b) [Kl. score = 3]. Moderate skin irritation was observed in rabbits following an application of 0.5 mL of a 3.3% aqueous solution of HCl for five days; no irritation was observed with 0.5 mL of a 1% aqueous solution (OECD, 2002a,b) [Kl. score = 2]. In humans, an aqueous solution of 4% of HCl was slightly irritating, while a 10% solution was sufficiently irritating to be classified as a skin irritant (OECD, 2002a,b).

Instillation of 0.1 mL of a 10% aqueous solution of HCl to the eyes of rabbits resulted in severe eye irritation (ECHA) [Kl. score = 2]. Instillation of 0.1 mL of a 5% solution of HCl produced corneal opacity, iridial lesions, conjunctival redness and chemosis in 3/3 animals at 1 hour and at day one post-instillation. There was no recovery in any animal and the study was terminated on day two (ECHA) [Kl. score = 1].

### D. Sensitisation

Hydrochloric acid was not a skin sensitiser in a guinea pig maximisation test (ECHA). [Kl. score = 2]

### E. Repeated Dose Toxicity

#### Oral

No adequate studies were located.

#### Inhalation

Male and female SD rats and F344 rats were exposed by inhalation to 0, 10, 20, or 50 ppm 6 hours/day, 5 days/week for up to 90 days. Clinical signs were mainly indicative of the irritant/corrosive nature of HCl. Body weights were significantly decreased in the 50-ppm male F344 rats. There were no treatment-related effects on the haematology or clinical chemistry parameters or urinalysis. At study termination, heart, kidney and testes weights were increased in the 100 and/or 50 ppm groups; these changes were considered to be mainly related to the treatment-related effect on body weight. Histopathological examination showed minimal to mild rhinitis in the  $\geq 20$  ppm dose groups of both strains of rats (both sexes). The NOAELs for systemic toxicity and localised irritation (site-of-contact) are 20 and 10 ppm, respectively (ECHA). [Kl. score = 1]

Male and female B6C3F<sub>1</sub> mice were exposed by inhalation to 0, 10, 20, or 50 ppm HCl, 6 hours/day, 5 days/week for up to 90 days. Clinical signs were mainly indicative of the irritant/corrosive nature of HCl. Body weights were significantly decreased in the 50 ppm groups. At study termination, absolute liver weights were decreased in the 50 ppm males. Histopathologic examination showed only eosinophilic globules in the nasal epithelium in the 50 ppm animals. The NOAEL for this study is 20 ppm (ECHA). [Kl. score = 1]

Male SD rats were exposed by inhalation to 0 or 10 ppm HCl 6 hours/day, 5 days/week for 128 weeks. Survival and body weights were similar between treated and control groups. There was a

higher incidence of hyperplasia of the larynx compared to control, but no serious irritating effects of the nasal epithelium (ECHA). [Kl. score = 2]

### Dermal

No studies were located.

## **F. Genotoxicity**

### In Vitro Studies

Table 3 presents the in vitro genotoxicity studies conducted on hydrochloric acid.

**Table 3: In Vitro Genotoxicity Studies on Hydrochloric Acid**

Test System	Results <sup>a</sup>		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>E. coli</i> strains)	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	+	2	ECHA
Chromosomal aberration (CHO cells)	+	+	2	ECHA
<i>Saccharomyces cerevisiae</i> (mitotic recombination)	-	-	2	ECHA
<i>E. coli</i> W3110 (pol A+) and P3078 (pol A-) repair assay	-	-	2	ECHA

a+, positive; -, negative

In the mouse lymphoma assay, the mutant frequency increased as the pH was lowered to 6.5 to 6.0 (from increased HCl) in the presence of metabolic activation. A decrease in pH from the addition of HCl to the medium also resulted in clastogenic effects to CHO cells in the absence or presence of metabolic activation. The positive findings in these two studies are considered to be the result of the pH change in the test media.

### In Vivo Studies

No adequate studies were located.

## **G. Carcinogenicity**

### Oral

No studies were located.

### Inhalation

Male SD rats were exposed by inhalation to 0 or 10 ppm HCl 6 hours/day, 5 days/week for 128 weeks. Survival and body weights were similar between treated and control groups. There was a higher incidence of hyperplasia of the larynx compared to control, but no serious irritating effects of the nasal epithelium. There was no increased incidence of tumours in the HCl-treated rats compared to controls (ECHA). [Kl. score = 2]

## H. Reproductive Toxicity

No studies were located.

## I. Developmental Toxicity

No adequate studies were located.

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Repeated dose, reproductive, and developmental toxicity studies by the oral route have not been conducted on hydrochloric acid. These toxicity studies would have questionable usefulness because of the corrosive/irritating nature of hydrochloric acid, which would limit the amount of absorbed HCl. Hydrochloric acid dissociates to hydrogen and chloride ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, an oral toxicological reference and drinking water guidance values were not derived from hydrochloric acid.

The Australian drinking water guideline values for pH (6.5 to 8.5) and chloride (250 ppm, aesthetics) may be applicable (ADWG, 2011).

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Hydrochloric acid does not exhibit the following physico-chemical properties:

- • Explosivity
- • Flammability
- • Oxidising potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

The hazard of hydrochloric acid for aquatic organisms is caused by the hydrogen ion ( $H^+$ ). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.

### B. Aquatic Toxicity

#### Acute Studies

Acute aquatic toxicity studies conducted on hydrochloric acid are listed in Table 4.

**Table 4: Acute Aquatic Toxicity Studies on Hydrochloric Acid**

Test Species	E n d p o i n t	Results	Klimisch score	Reference

Test Species	E n d p o i n t	Results	Klimisch score	Reference
<i>Oncorhynchus mykiss</i>	9 6 - h  L C 5 0	pH 4.12 (hard water) pH 3.98 (soft water)	2	ECHA; OECD 2002a,b
<i>Lepomis macrochirus</i>	9 6 - h  L C 5 0	pH 3.25 – 3.5	2	ECHA; OECD 2002a,b
<i>Daphnia magna</i>	4 8 - h r  E C 5 0	pH 4.92	1	ECHA
<i>Chlorella vulgaris</i>	7 2 - h r  E C 5 0  7 2 - h r  N O E C	pH 4.7 [growth rate] pH 4.82 [biomass] pH 5 [yield/growth rate]	1	ECHA



### Chronic Studies

No chronic studies were located.

### **C. Terrestrial Toxicity**

No studies were located.

### **D. Calculation of PNEC**

PNEC values were not derived from hydrochloric acid because factors such as the buffer capacity, the natural pH, and the fluctuation of the pH are very specific for a certain ecosystem.

## **VIII. PBT ASSESSMENT**

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).

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

Hydrogen and chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, hydrochloric acid is not expected to bioaccumulate.

No chronic toxicity data exist on hydrochloric acid; however, the acute E(L)C<sub>50</sub> values are >0.1 mg/L in fish, invertebrates and algae. Thus, hydrochloric acid does not meet the screening criteria for toxicity.

The overall conclusion is that hydrochloric acid is not a PBT substance.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

For HCl concentrations of >25%:

- Metal Corrosive Category 1
- Skin Corrosive 1B
- STOT SE Category 3

In addition to the hazard statements corresponding the GHS classifications, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

### **B. Labelling**

Danger

**C. Pictogram****X. SAFETY AND HANDLING****A. FIRST AID**Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention immediately.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or another proper respiratory medical device. Give artificial respiration if the victim is not breathing. Get medical attention immediately.

Ingestion

Rinse mouth and lips with plenty of water if a person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if the victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician

Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

**B. FIRE FIGHTING INFORMATION**Extinguishing Media

Use dry chemical, carbon dioxide, water spray or fog, or foam.

### Specific Exposure Hazards

Containers may explode when heated. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: halogenated compounds, may release dangerous gases (chlorine).

### Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Ventilate enclosed areas. Do not walk through spilt material. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breathe mist, vapours, or spray. Do not get in eyes, on skin, or on clothing.

### Environmental Precautions

Prevent entry into waterways, sewers, basements or confined areas.

### Steps to be Taken if Material is Released or Spilt

ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorised personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

## **D. STORAGE AND HANDLING**

### General Handling

Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent the release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breathe mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

### Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis. Do not store above 49°C/120°F.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

The workplace exposure standard for hydrochloric acid in Australia is 5 ppm (7.5 mg/m<sup>3</sup> as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

### Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

### Personal Protection Equipment

*Respiratory Protection:* If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much is based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

*Hand Protection:* Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

*Skin Protection:* Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling hydrochloric acid.

*Eye Protection:* Wear chemical splash goggles and face shield.

*Other Precautions:* Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

## **F. TRANSPORT INFORMATION**

### Australian Dangerous Goods

UN1789, Hydrochloric acid  
Class 8  
Packing Group: II

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

De Groot, W.A., and van Dijk, N.R.M. (2002). Addition of hydrochloric acid to a solution with sodium bicarbonate to a fixed pH. Solvay Pharmaceuticals, Study No. A SOL.S.027; cited in OECD 2002a,b.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

OECD (2002a). IUCLID Data Set for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.

OECD (2002b). Screening Information Dataset (SIDS) Initial Assessment Report for Hydrogen chloride (CAS No. 7647-01-0), UNEP Publications.

UNEP (1995). Water quality of world river basins. UNEP Environment Library No. 14, Nairobi, Kenya; cited in OECD, 2002a,b.

## **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals

HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## MAGNESIUM NITRATE

This dossier on magnesium nitrate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of magnesium nitrate in its use in drilling muds and in water treatment. 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Magnesium dinitrate

**CAS RN:** 10377-60-3

**Molecular formula:**  $\text{Mg}(\text{NO}_3)_2$  or  $\text{MgN}_2\text{O}_6$

**Molecular weight:** 148.31

**Synonyms:** Magnesium nitrate; magnesium dinitrate; nitric acid, magnesium salt

**SMILES:** [N+](=O)([O-])[O-].[N+](=O)([O-])[O-].[Mg+2]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Magnesium Nitrate**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline solid	2	ECHA
Melting Point	ca. 95°C (as hexahydrate)	2	ECHA
Boiling Point	-	-	-
Density	1.464 (as hexahydrate)	2	ECHA
Vapor Pressure	Negligible	1	ECHA
Partition Coefficient (log Pow)	Not applicable	-	-
Water Solubility	Soluble (as dehydrate) Very soluble (as hexahydrate)		

Magnesium nitrate or  $\text{Mg}(\text{NO}_3)_2$  is a hygroscopic salt that quickly forms the hydrate  $(\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O})$  in air.

### III. ENVIRONMENTAL FATE PROPERTIES

$\text{Mg}(\text{NO}_3)_2$  dissociates completely in aqueous solutions to magnesium ( $\text{Mg}^{++}$ ) and nitrate ( $\text{NO}_3^-$ ) ions. Biodegradation is not applicable to magnesium nitrate. Magnesium nitrate and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment or to bioaccumulate.

#### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

##### **A. Summary**

Magnesium nitrate exhibits a low order of toxicity by the oral and dermal route. It is not a skin or eye irritant; nor is it a skin sensitizer. Magnesium nitrate is not mutagenic. The Australian drinking water guideline value for nitrate (as nitrate) is 50 mg/L. The guideline will protect bottle-fed infants under 3 months from methemoglobinemia. Adults and children over 3 months can safely drink water with up to 100 mg/L nitrate.

##### **B. Acute Toxicity**

The acute oral LD<sub>50</sub> in rats is >2,000 mg/kg (ECHA). [Kl. score = 1]

The dermal LD<sub>50</sub> in rats is >5,000 mg/kg (ECHA). [Kl. score = 2]

##### **C. Irritation**

No skin irritation studies on magnesium nitrate were located. A dermal rabbit irritation study on ammonium nitrate showed no evidence of irritation when 0.5 g was applied to the skin for 4 hours under occlusive conditions (ECHA). [Kl. score = 2]

Instillation of 0.1 mL (57.5 mg) of magnesium nitrate to the eyes of rabbits was not irritating (ECHA). [Kl. score = 1]

##### **D. Sensitization**

Magnesium nitrate was not considered a skin sensitizer in a mouse Local Lymph Node Assay (LLNA) (ECHA). [Kl. score = 1]

##### **E. Repeated Dose Toxicity**

No studies on magnesium nitrate were located.

##### **F. Genotoxicity**

###### In Vitro Studies

Magnesium nitrate hexahydrate was not mutagenic to *Salmonella typhimurium* strains TA98, TA100, TA1535, TA 1537 or to *Escherichia coli* WP2 *uvr* A with or without metabolic activation (ECHA) [Kl. score = 1].

###### In Vivo Studies

No studies on magnesium nitrate were located.

##### **G. Carcinogenicity**

No studies on magnesium nitrate were located.

##### **H. Reproductive Toxicity**

No studies on magnesium were located.



## I. Developmental Toxicity

No studies on magnesium nitrate were located.

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The Australian drinking water guideline value for nitrate (as nitrate) is 50 mg/L (ADWG, 2011). The guideline will protect bottle-fed infants under 3 months from methemoglobinemia. Adults and children over 3 months can safely drink water with up to 100 mg/L nitrate.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Magnesium nitrate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Aquatic Toxicity

No studies were located on magnesium nitrate.

In developing a water quality guideline for nitrate, ANZECC reviewed the literature on both potassium nitrate and sodium nitrate. The summary of the data measured as mg NO<sub>3</sub>/L are as follows:

#### Freshwater Fish

The 48-96 hour LC<sub>50</sub> values for six species were 99-10,000 mg/L. The chronic NOEC from a 9-day study with Australian *Mogurnda adspersa* was 14 mg/L.

#### Freshwater Crustaceans

The 48-96 hour LC<sub>50</sub> values to *Daphnia magna* were 23-4,206 mg/L.

#### Freshwater molluscs

The 96-hour LC<sub>50</sub> for *Lymnaea* species is 664 mg/L.

#### Freshwater insects

The 72-96 LC<sub>50</sub> values for two species were 430-930 mg/L.

#### Freshwater Hydra

The chronic NOEC from a 6-day study with the Australian *Hydra viridissima* was 9 mg/L based on population growth.

Algae studies were not included in the data used by ANZECC for deriving a trigger value since nitrates are known stimulants for algal growth at low concentrations.

## B. Terrestrial Toxicity

No studies were located.

## C. Calculation of PNEC

### PNEC water

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of “trigger values” for nitrate. The guideline summary for freshwaters is: *“A freshwater moderate reliability trigger value for nitrate toxicity as NO<sub>3</sub> (nitrate) of 700 µg/L was calculated using the statistical distribution method 95% protection and the default ACR.”*

### PNEC sediment

No experimental toxicity data on sediment organisms are available. Magnesium nitrate dissociates completely in water, and its environmental distribution is dominated by its high water solubility.  $K_{ow}$  and  $K_{oc}$  parameters do not readily apply to inorganics, such as magnesium nitrate. Thus, the equilibrium partitioning method cannot be used to calculate the  $PNEC_{sed}$ . Based on its properties, no absorption of magnesium nitrate to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### PNEC Soil

No experimental toxicity data on soil organisms are available. The environmental distribution of magnesium nitrate is dominated by its water solubility. Sorption of magnesium nitrate should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound.  $K_{oc}$  and  $K_{ow}$  parameters do not readily apply to inorganics, such as magnesium nitrate. Thus, the equilibrium partitioning methods cannot be used to calculate the  $PNEC_{soil}$ . Based on its properties, magnesium nitrate is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Magnesium nitrate is an inorganic salt that dissociates completely to magnesium and nitrate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both magnesium and nitrate 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.

As magnesium nitrate dissociates to magnesium and nitrate ions, neither magnesium nitrate nor its dissociated ions are expected to accumulate.

Limited chronic aquatic toxicity data exist on magnesium; however, the acute  $E(L)C_{50}$ s are >0.1 mg/L in fish, invertebrates and algae. Thus, magnesium nitrate does not meet the screening criteria for toxicity.

The overall conclusion is that magnesium nitrate is not a PBT substance.

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

### **A. Classification**

Not classified.

### **B. Labelling**

No signal word.

### **C. Pictogram**

None

## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

### **B. FIRE FIGHTING INFORMATION**

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

No data are available.

#### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for magnesium nitrate.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye Protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Magnesium nitrate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

ANZECC & ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

## **XIV. ACRONYMS AND GLOSSARY**

°C degrees Celsius

ADWG Australian Drinking Water Guidelines

API American Petroleum Institute

DEWHA Department of the Environment, Water, Heritage and the Arts

EC effective concentration

ECHA European Chemicals Agency

EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## ETHYLENEDIAMINETETRAACETIC ACID TETRASODIUM SALT [Na<sub>4</sub>EDTA]

This dossier on Na<sub>4</sub>EDTA does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Na<sub>4</sub>EDTA in its use in drilling muds and water treatment systems. The information presented in this dossier was obtained primarily from the EU Risk Assessment Report on Na<sub>4</sub>EDTA, and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Tetrasodium{[2-bis-carboxymethyl-amino)-ethyl]-carboxymethyl-amino}-acetate

**CAS RN:** 64-02-8

**Molecular formula:** C<sub>10</sub>H<sub>12</sub>N<sub>2</sub>O<sub>8</sub>Na<sub>4</sub>

**Molecular weight:** 380.2

**Synonyms:** Tetrasodium ethylenediaminetetraacetate; ethylenediaminetetraacetic acid tetrasodium salt; ethylene dinitrilotetraacetic tetrasodium salt; Edetic acid tetrasodium salt; Na<sub>4</sub>EDTA or EDTA tetrasodium; Edetate sodium or Sodium edetate; N,N'-1,2-Ethanediybis[N-(carboxymethyl)glycine]tetrasodium salt; tetrasodium 2,2',2'',2'''-(ethane-1,2-diyldinitrilo)tetraacetate

**SMILES:** C(CN(CC(=O)[O-])CC(=O)[O-])N(CC(=O)[O-])CC(=O)[O-].[Na+].[Na+].[Na+].[Na+]

The tetrahydrate salt of EDTA (C<sub>10</sub>H<sub>12</sub>N<sub>2</sub>O<sub>8</sub>Na<sub>4</sub> • 4H<sub>2</sub>O) has the CAS No. 13235-36-4.

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Na<sub>4</sub>EDTA**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White powder	2	ECHA
Melting Point	>150°C; >300°C; decomposition may occur at >150°C	2	ECHA
Boiling Point	-	-	-
Density	1.67 g/cm <sup>3</sup>	2	ECHA
Vapor Pressure	-	-	-
Partition Coefficient (log P <sub>ow</sub> )	-	-	-
Water Solubility	Very soluble	2	ECHA
Flash Point	-	-	-
Auto flammability	>200°C @ 1,013 hPa	2	ECHA

The most important property of EDTA is to form complexes (usually 1:1-complexes) with multivalent metal ions (EU, 2004).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

EDTA is not readily biodegradable, but it can under certain conditions (*i.e.*, alkaline pH) be degraded. It is not expected to adsorb to soil or sediment. EDTA has a low potential for bioaccumulation.

#### B. Abiotic Degradation

##### Hydrolysis

EDTA is resistant to hydrolysis (EU, 2004).

EDTA degradation rates measured in aerobically incubated sediments after 4 weeks and total degradation after 10 weeks are as follows: Wintergreen Lake, 3.6% and 11.3%; Clear Lake, 5.6% and 15.2%; and Mill Pond, 3.2% and 9.1%. The results were similar in soil (Tiedje, 1975; EU, 2004).

#### C. Biodegradation

There have been many degradation tests conducted on EDTA; in most cases, the acid or the sodium salt was tested, but not EDTA in its complexed form. EDTA is not readily biodegradable. (EU, 2004). In a 28-day Sturm test, there was only 10% degradation (measured as CO<sub>2</sub>) after 28 days (EU, 2004). In a Closed Bottle test, degradation was 3% and 0% of TOD after 28 days in two separate tests (EU, 2004). Inherent biodegradability tests have shown variable results, ranging from 0 to 37% biodegradation rates (EU, 2004).

EDTA can be degraded under alkaline conditions. A Closed Bottle test was conducted to investigate the potential of samples from a river, a ditch and a lake to degrade CaNa<sub>2</sub>EDTA (8 mg/L) at pH values 6.5 – 8.0. There was little to no biodegradation (2-12%) at pH 6.5 within the first 28 days and 60-83% after 49 days. At pH 8, rates of 53, 62, and 72% were seen after 28 days and 75-89% after 35 days (van Ginkel, 1999). The pH values of lakes and river water range from 7.7 to 8.5; however, EDTA is preferably complexed with heavy metal ions (EU, 2004).

EDTA can be biodegraded in soil under aerobic conditions. After four weeks, biodegradation of EDTA was between 4.8 and 7.9% at 30°C was determined in agriculture soil of mid-Michigan (EU, 2004). Another study showed primary degradation of 53 to 60% after 173 days at 22°C. Additional 39% of the substance was assumed to be eliminated by sorption and abiotic degradation (EU, 2004).

#### D. Environmental Distribution

##### Adsorption/desorption

No adsorption to the organic fraction of soils or sediments is expected under environmental relevant pH conditions due to the ionic structure of Na<sub>4</sub>EDTA.

The mobility of EDTA in soil was investigated by eluting solutions of H<sub>4</sub>EDTA and ZnEDTA through cores of two various surface soils. H<sub>4</sub>EDTA was slightly adsorbed and moved quite readily through both soils. The EDTA from ZnEDTA also moved readily through the soils (EU, 2004).

#### E. Bioaccumulation

BCF values of 1.8 (0.08 mg/L EDTA) and 1.1 (0.76 mg/L EDTA) were determined in a 28-day bioaccumulation test on *Lepomis macrochirus* (EU, 2004).



## IV. HUMAN HEALTH HAZARD ASSESSMENT

### A. Summary

Na<sub>4</sub>EDTA exhibits low acute toxicity by the oral route. It is irritating to the eyes. Data on other sodium salts of EDTA show that these substances are not skin sensitizers. Exposures of sodium EDTA salts to rats in their diet for up to two years showed no systemic or carcinogenic effects. No systemic effects were seen in rats exposed by inhalation to a sodium EDTA salt for 13 weeks, although there were some localised (site-of-contact) effects seen in the respiratory tract. Sodium EDTA salts are not considered to be genotoxic. No reproductive toxicity was seen in a multi-generation rat study with a sodium EDTA salt. There was no developmental toxicity when Na<sub>4</sub>EDTA, as well as other sodium EDTA salts, were given by oral gavage to pregnant female rats. However, other studies had shown specific fetotoxic and teratogenic effects when high doses of sodium EDTA salts were given to pregnant females; these effects appear to be caused by zinc deficiency. The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism. In general, complexed and non-complexed EDTA has a low toxicity concern for fish and invertebrates. EDTA is highly toxic to algae in tests using standard media; the effect is probably caused by nutritional deficiency. If nutrient metal concentrations are increased, then EDTA has a low toxicity concern for algae; this is more likely scenario in the environment.

### B. Acute Toxicity

For Na<sub>4</sub>EDTA, the oral LD<sub>50</sub> values in rats for from three different studies range from 1,700 to 1,913 mg/kg; two additional limit studies reported the oral LD<sub>50</sub> values to be >2,000 mg/kg (EU, 2004).

No acute inhalation studies have been conducted on Na<sub>4</sub>EDTA. In a study on Na<sub>2</sub>EDTA (CAS No. 139-33-3), male Wistar rats were exposed nose-only to an aerosol of 0, 30, 300, or 1,000 mg/m<sup>3</sup> for 6 hours on five consecutive days. Exposure to 1,000 mg/m<sup>3</sup> for one day (6 hours) resulted in deaths of 6 out of 20 animals (ECHA). [Kl. score = 1]

No dermal toxicity studies on Na<sub>4</sub>EDTA are available.

### C. Irritation

Application of 0.5 g (in 80% water) of Na<sub>2</sub>EDTA to the skin of rabbits for 4 hours under occlusive conditions was not irritating. The mean of the 24, 48, and 72 hours erythema scores was 0.4. The mean of the 24, 48, and 72-hour edema scores was 0 (ECHA) [Kl. score = 1]. Application of a 40% solution of Na<sub>4</sub>EDTA in water (CAS No. 67401-50-7) with a pH 11 to the skin of rabbits for up to 20 hours under occlusive conditions was not irritating (ECHA) [Kl. score = 2].

Instillation of 50 mg of Na<sub>4</sub>EDTA into the eyes of rabbits was irritating. The mean 24 and 72-hour scores were: 1.25 for corneal lesions; 1.75 for conjunctival redness; 1.25 for chemosis; and 0 for iridial lesions (ECHA) [Kl. score = 2].

### D. Sensitization

No sensitization studies have been conducted on Na<sub>4</sub>EDTA. Na<sub>3</sub>EDTA was not a dermal sensitizer in a guinea pig sensitization study (ECHA) [Kl. score = 2].

Na<sub>2</sub>EDTA was not a dermal sensitizer in a guinea pig maximisation test. The intradermal injection was 0.5% in corn oil; the topical applications were 30% in corn oil, and the challenge dose was 30% in corn oil (ECHA) [Kl. score = 1].

## E. Repeated Dose Toxicity

### Oral

Male Holtzman rats were given in their diet 0, 1, 5, or 10% (0, 500, 2,500, or 5,000 mg/kg-day) Na<sub>2</sub>EDTA for 90 days. There was mortality in the mid- and high-dose groups: 20% and 60%, respectively. Body weights and food consumption were significantly lower in the mid- and high-dose groups compared to controls. The animals in these two groups also had diarrhea and were emaciated, and water consumption was increased. The 10% group showed intermittent decreases in hematocrit and haemoglobin levels, and the livers appeared pale when examined at necropsy. Histopathologic evaluation showed no treatment-related effects. The NOAEL is 500 mg/kg-day (Wynn, 1970; ECHA). [Kl. score = 2]

Male and female F344 rats were administered in their feed 0, 3,750 or 7,500 ppm (0, 248, or 495 mg/kg-day) Na<sub>3</sub>EDTA. There were no clinical signs; survival and body weights were similar between treated and control groups throughout the study. There was no evidence of adverse effects in the gross necropsy and histopathologic examinations. The NOAEL is 495 mg/kg-day (EU, 2004). [Kl. score = 2]

Male and female B6C3F<sub>1</sub> mice were administered in their feed 0, 3,750 or 7,500 ppm (0, 469, or 938 mg/kg-day) Na<sub>3</sub>EDTA. There was no clinical signs and survival was similar across all groups. Body weights in the high-dose males showed a significant decrease in body weights throughout the study. There was no evidence of adverse effects in the gross necropsy and histopathologic examinations. The NOAEL is 938 mg/kg-day (EU, 2004). [Kl. score = 2]

### Inhalation

Male and female Wistar rats were exposed nose-only to 0, 0.5, 3, or 15 mg/m<sup>3</sup> Na<sub>2</sub>EDTA (as an aerosol dust) 6 hours/day, 5 days/week for 13 weeks. The MMAD of the particles for the respective groups were: 2.3 - 2.8 µm, 2.0 - 2.4 µm, and 2.3 - 2.5 µm. There were no clinical signs of toxicity or any effects on the haematology and clinical chemistry parameters. Histopathological examination showed some effects on the larynx in the 15 mg/m<sup>3</sup> females, but not evidence of systemic toxicity. The NOAEC for systemic toxicity in this study is 15 mg/m<sup>3</sup>. The NOAEC for localized (site-of-contact) effects is 3 mg/m<sup>3</sup> (ECHA). [Kl. score = 1]

### Dermal

No dermal studies are available.

## F. Genotoxicity

### In Vitro Studies

There are no *in vitro* genotoxicity studies on Na<sub>4</sub>EDTA; however, studies have been conducted on Na<sub>2</sub>EDTA and Na<sub>3</sub>EDTA (Table 2).

**Table 2: *In Vitro* Genotoxicity Studies on Na<sub>2</sub>EDTA and Na<sub>3</sub>EDTA**

Test System	Test Substance	Results*		Klimisch Score	Reference
		-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>E. coli</i> strains)	Na <sub>3</sub> EDTA	-	-	2	ECHA

Test System	Test	Results*		Klimisch	Reference
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Na <sub>2</sub> EDTA	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Na <sub>3</sub> EDTA	-	-	2	ECHA
Chromosomal aberration (CHO cells)	Na <sub>3</sub> EDTA	-	-	2	ECHA
Cell transformation assay (Syrian hamster embryos)	Na <sub>2</sub> EDTA	N/A	-	1	ECHA
Cell transformation assay (Syrian hamster embryos)	Na <sub>3</sub> EDTA	N/A	-	2	ECHA

\*+, positive; -, negative; N/A, not applicable.

### In Vivo Studies

There are no *in vivo* genotoxicity studies on Na<sub>4</sub>EDTA. Studies conducted on other sodium salts of EDTA are summarised below.

Male NMRI mice were dosed by oral gavage with 0, 500, 1,000, or 2,000 mg/kg Na<sub>2</sub>EDTA once daily for two consecutive days. There were no increased frequencies of micronuclei in the normochromatic erythrocytes of the bone marrow in the treated animals compared to controls (ECHA). [Kl. score = 1]

Male Balb/c mice were given a single intraperitoneal injection of 0, 93 or 186 mg/kg Na<sub>2</sub>EDTA and the spermatocytes were examined 6 hours and 5 days later for aneuploidy. There were no significant increases in aneuploidy in the primary and secondary spermatocytes at both time points (Zordan et al., 1990; ECHA). [Kl. score = 2]

Male Balb/c mice were given a single intraperitoneal injection of 0 or 186 mg/kg Na<sub>2</sub>EDTA, and the frequency of micronuclei was analysed in the Golgi and Cap phase, which represents the two earliest phases of spermatid development. The sampling time points were 24 and 48 hours post-dosing. Micronuclei were induced in the Golgi phase spermatids at both time points; there was no increase in micronuclei in the Cap phase (Russo and Lewis, 1992; ECHA). [Kl. score = 2]

No chromosomal aberrations were noted in male Balb/c mouse spermatogonia following a single intraperitoneal dose of 186 mg/kg Na<sub>2</sub>EDTA (Russo and Lewis, 1992; ECHA). [Kl. score = 2]

In summary, Na<sub>2</sub>EDTA did not induce genotoxicity in bone marrow cells in mice. In germ cells of mice, Na<sub>2</sub>EDTA did not induce chromosomal aberrations in spermatogonia, aneuploidy in primary and secondary spermatocytes, but micronuclei were induced at a specific phase of spermatogenesis. The dose of Na<sub>2</sub>EDTA used to induce micronuclei in these spermatids is an extremely high dose; given that the induction of aneuploidy is based on a threshold mode-of-action, it is unlikely that this effect will occur in humans exposed to sodium salts of EDTA. Overall, the sodium salts of EDTA are not genotoxic (EU, 2004).

## **G. Carcinogenicity**

### Oral

No studies are available on Na<sub>4</sub>EDTA.

Male and female F344 rats were administered in their feed 0, 3,750 or 7,500 ppm (0, 248, or 495 mg/kg-day) Na<sub>3</sub>EDTA. There were no clinical signs; survival and body weights were similar between

treated and control groups throughout the study. Tumour incidences were similar across all groups, indicating no evidence of carcinogenicity from chronic exposure to Na<sub>3</sub>EDTA (EU, 2004). [Kl. score = 2]

Male and female B6C3F<sub>1</sub> mice were administered in their feed 0, 3,750 or 7,500 ppm (0, 469, or 938 mg/kg-day) Na<sub>3</sub>EDTA. There was no clinical signs and survival was similar across all groups. Body weights in the high-dose males showed a significant decrease in body weights throughout the study. Tumour incidences were similar across all groups, indicating no evidence of carcinogenicity from chronic exposure to Na<sub>3</sub>EDTA (EU, 2004). [Kl. score = 2]

No inhalation or dermal carcinogenicity studies were located.

## **H. Reproductive Toxicity**

No studies are available on Na<sub>4</sub>EDTA.

Male and female Wistar rats were given in their feed 0, 50, 125, or 250 mg/kg-day CaNa<sub>2</sub>EDTA (CAS No. 62-33-9) for two years. The study included reproductive and lactation components in four successive generations. There were no significant differences between treated and controls groups in behaviour, clinical signs, survival, body weight gain in any generation. The high-dose group showed no treatment-related organ weight changes or histopathologic effects in any of the organs examined, including the testes. There were no consistent treatment-related effects on reproductive performance or developmental effects in any of the four generations examined. The NOAEL for reproductive toxicity is 250 mg/kg-day, the highest dose tested (Oser et al., 1963; ECHA). [Kl. score = 2]

## **I. Developmental Toxicity**

Pregnant female rats were dosed by oral gavage with 0 or 1,000 mg EDTA/kg during GD 7-14. The salts of EDTA (Na<sub>2</sub>EDTA, Na<sub>3</sub>EDTA, CaNa<sub>2</sub>EDTA, and Na<sub>2</sub>EDTA) were also included in this study and were tested on an equimolar basis. For Na<sub>4</sub>EDTA, the dose is 1,374 mg/kg-day which was given as equally divided doses twice daily. There was diarrhea in 90% of the dams after each daily dosing and which disappeared after the last day of dosing. There was also reduced feed intake and reduced weight gain during the treatment period; both recovered during the post-treatment period. There was no developmental toxicity in any of the treatment groups compared to controls. The NOAEL for maternal and developmental toxicity for Na<sub>4</sub>EDTA is 1,374 mg/kg-day (Schardein et al. 1981; ECHA)

The toxicity and teratogenicity of Na<sub>2</sub>EDTA were studied in pregnant female CD rats following different routes of administration during GD 7-14. When Na<sub>2</sub>EDTA was administered in the diet at 3% (average dose of 954 EDTA/kg-day), the dams had reduced feed intake, severe diarrhea, and severe weight loss. There was a significant proportion of fetal deaths (~33% resorptions/litter), significantly lower average fetal weight and gross external, internal, and skeletal malformations in about 71% of the surviving fetuses. When Na<sub>2</sub>EDTA was administered by oral gavage at doses of 1,250 or 1,500 mg EDTA/kg-day, there was severe toxicity to the dams: 3/8 and 7/8 deaths in the 1,250 and 1,500 mg/kg-day groups, respectively; significantly reduced weight gain, and diarrhea in the 1,250 mg/kg-day group. There was a significantly higher proportion of malformed surviving fetuses. When administered subcutaneously with 375 mg EDTA, the dams showed signs of severe pain (vocalisations and shock) and 24% of them died; there was also a significant reduction in body weight and feed intake. Fetal toxicity included about 32% resorptions/litter and significant reduction of fetal body weight, and about a 4% malformed survivors/litter (Kimmel 1977; ECHA)

Pregnant female CD rats were given in their diet 0, 2, or 3% Na<sub>2</sub>EDTA; in addition, a group was fed 3% Na<sub>2</sub>EDTA supplemented with 1,000 ppm zinc (Zn). Exposures were as follows: 2% (GD 0-21), 3% (GD 0-21, GD 6-14, or GD 6 to 21); 3% + Zn (GD 6-21). The dietary doses of 2% and 3%

Na<sub>2</sub>EDTA correspond to approximately 1,000 and 1,500 mg/kg-day, respectively. All of the dams had moderate to severe diarrhea. In the 2% Na<sub>2</sub>EDTA group, all rats had living young at term; the litter size was normal; the young were slightly small than controls, and 7% of the fetuses were malformed. In the 3% Na<sub>2</sub>EDTA (GD 0-21), reproduction was severely disturbed, and none of the females had grossly visible implantation sites. In the 3% Na<sub>2</sub>EDTA (GD 6-14 and 6-21), almost all females had implantation sites; half of the sites had dead or resorbed fetuses; 100% of the fetuses were malformed in the GD 6-21 group. In the 3% Na<sub>2</sub>EDTA + Zn group, there was a normal reproduction, and none of the young was malformed. It was suggested by the study authors that the congenital abnormalities caused by EDTA were due specifically to zinc deficiency (Swenerton et al., 1977).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

Toxicological reference values were not derived for Na<sub>4</sub>EDTA.

The Australian drinking water guidance value for EDTA is 0.25 mg/L (ADWG, 2011).

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Na<sub>4</sub>EDTA does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Details on the aquatic toxicity studies on EDTA and its sodium salts can be found in the EU Risk Assessment Report (RAR) on Na<sub>4</sub>EDTA (EU, 2004). The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism; hence the complex formation properties of EDTA need to be taken into account.

Uncomplexed EDTA will only be present in the test media of aquatic toxicity studies when present in an excess amount relative to the calcium and magnesium ions, as well some level of heavy metal ions, which are present mainly as trace nutrients. Complexes with the heavy metals predominant because the formation constants are several orders of magnitude higher than those of the calcium and magnesium ions. After addition of EDTA (as an acid or sodium salt), the concentration of uncomplexed trace metals will decrease considerably, and if there is a surplus of EDTA, there will also be complexing with the calcium and magnesium ions.

EDTA and its sodium salts appear to be more toxic in an uncomplexed form in the acute toxicity studies. Most of the acute fish studies have LC<sub>50</sub> values that are much greater than 100 mg/L, with the exception of two studies tested with H<sub>4</sub>EDTA in soft and very soft water: the LC<sub>50</sub> values were 41 and 59.8 mg/L, respectively. It is thought that there was an excess of uncomplexed EDTA in the test media of these two studies due to the low levels of magnesium and calcium ions in soft water; this, however, is an unlikely scenario in the environment.

The EU Risk Assessment Report (EU, 2004) considered the most relevant chronic fish toxicity study to be an early-life stage test on zebrafish; the NOEC was >26.8 mg/L H<sub>4</sub>EDTA (CaNa<sub>2</sub>EDTA was the test substance) (EU, 2004).

The acute toxicity tests on *Daphna magna* reported 24-hr EC<sub>50</sub> values of 480 to 790 mg/L (EU, 2004). The 21-day NOEC from a *Daphnia* reproduction test was 22 mg/L (EU, 2004).

Essential trace metal bioavailability seems to be the critical factor in algal toxicity from EDTA exposure. The ratio of the EDTA concentration to the metal cations is a critical element to algal growth and not the absolute EDTA concentration. H<sub>4</sub>EDTA concentrations up to 310 mg/L will not cause any effect on algal growth if there is sufficient trace metals present. Since there is a considerable amount of metal ions present in the environment, EDTA is not expected to have an intrinsic toxic effect on plants. In a study with *Scenedesmus subspicatus*, an EC<sub>10</sub> value of 0.37 mg/L was obtained (EU, 2004). The EU RAR considered that the effect was probably due to nutrient deficiency because essential metals (Cu, Zn, Co) are largely complexed to the EDTA, resulting in considerably reduced concentrations. In another study with *Pseudokirchnerella subcapitata* conducted according to OECD TG 201, the EC<sub>50</sub> and EC<sub>10</sub> of Fe(III)EDTA were >100 mg/L; the NOEC values were 79.4 and 48.4 mg/L, respectively, when based on mean measured concentrations.

## B. Terrestrial Toxicity

No relevant studies are available. The only test results that are available are those that have investigated the decrease of heavy metal toxicity caused by EDTA.

## C. Calculation of PNEC

The PNEC calculations for Na<sub>4</sub>EDTA follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 22 mg/L for algae (EU, 2004). 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 long-term NOEC of 22 mg/L for invertebrates. The PNEC<sub>water</sub> is 2.2 mg/L.

### PNEC sediment

No experimental toxicity data on sediment organisms are available. The equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub> because EDTA is not expected to adsorb to sediment. The assessment of this compartment will be covered by the aquatic assessment.

### PNEC soil

No experimental toxicity data on soil organisms are available. The equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub> because EDTA is not expected to adsorb to soil. The assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Na<sub>4</sub>EDTA is not readily biodegradable. Thus, it does not meet the screening criteria for persistence.

The experimental BCF of EDTA in fish is 1.1 – 1.8. Thus, Na<sub>4</sub>EDTA does not meet the criteria for bioaccumulation.



The lowest NOEC from chronic aquatic toxicity studies is >0.1 mg/L. Thus, Na<sub>4</sub>EDTA does not meet the screening criteria for toxicity.

The overall conclusion is that Na<sub>4</sub>EDTA is not a PBT substance.

## IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)

### A. Classification

Acute Toxicity Category 4 [oral]

Acute Toxicity Category 4 [inhalation]

Eye Damage Category 1

### B. Labelling

Danger

### C. Pictogram



## X. SAFETY AND HANDLING

### A. First Aid

#### Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

#### Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, nitrogen oxides.

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical protective clothing.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing. Eliminate all sources of ignition.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Take precautionary measures against static discharges by bonding and grounding equipment.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Na<sub>4</sub>EDTA.



## Engineering Controls

None

## Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Na<sub>4</sub>EDTA is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

EU (2004). European Union Risk Assessment Report for Tetrasodium ethylenediamineacetate (CAS No. 64-02-8), Volume 51. Available at: <https://echa.europa.eu/documents/10162/415c121b-12cd-40a2-bd56-812c57c303ce>

- European Chemicals Agency [ECHA] (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Kimmel, C.A. (1977). Effect of route of administration on the toxicity and teratogenicity of EDTA in the rat. *Toxicol. Appl. Pharmacol.* 40: 299-306.
- 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.
- Oser, B.L., Oser, M., and Spencer, H.C. (1963). Safety evaluation studies of calcium EDTA. *Toxicol. Appl. Pharmacol.* 5: 142-162.
- Russo, A., and Levis, A.G. (1992). Further evidence for the aneuploidogenic properties of chelating agents: Induction of micronuclei in mouse male germ cells by EDTA. *Environ. Mol. Mutagen.* 19: 125-131.
- Schardein, J.L., Sakowski, R., Petrere, J., and Humphrey, R.R. (1981). Teratogenesis studies with EDTA and its salts in rats. *Toxicol. Appl. Pharmacol.* 61: 423-428.
- Swenerton, H., and Hurley, L.S. (1971). Teratogenic effects of a chelating agent and their prevention by zinc. *Science* 173: 62-64.
- Wynn, J.E., van Riet, B., and Borcelleca, J.F. (1970). The toxicity and pharmacodynamics of EDTA: Oral administration to rats and comparison with EDTA. *Toxicol. Appl. Pharmacol.* 16: 807-817.
- Zordan, M., Russo, A., Costa, R., Bianco, N., Beltrame, C., and Levis, A.G. (1990). A concerted approach to the study of the aneuploidogenic properties of two chelating agents (EDTA and NTA) in the germ and somatic cell lines of *Drosophila* and the mouse. *Environ. Mutagen.* 15: 205-213.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
K1	Klimisch scoring system
LOAEL	lowest observed adverse effect level

mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## PROPRIETARY POLYMER A

This dossier on Proprietary Polymer A does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Proprietary Polymer A in water treatment. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

Chemical Name: Proprietary Polymer A

CAS RN: PolymerA-CASRn

Molecular formula:

Molecular weight: Variable

Synonyms: Proprietary Polymer A

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Proprietary Polymer A**

Property	Value	Reference
Physical state at 20°C and 101.3 kPa	Colorless liquid	BioLab Water Additives, 1999
Melting Point	-1 to -3°C	BioLab Water Additives, 1999
Boiling Point	101 to 103°C	BioLab Water Additives, 1999
Specific Gravity	1.20 to 1.24	BioLab Water Additives, 1999
pH	3.5 to 4.5	BioLab Water Additives, 1999
Viscosity	90-150 cSt @ 25°C	BioLab Water Additives, 1999
Water Solubility	Miscible	BioLab Water Additives, 1999

### III. ENVIRONMENTAL FATE PROPERTIES

In an OECD 301E test, Proprietary Polymer A degraded 20% in 28 days, indicating that it is not readily biodegradable (BioLab Water Additives, 1999).

As a polymer, Proprietary Polymer A is not expected to bioaccumulate, because its molecular weight will limit its bioavailability.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

There is very limited information on Proprietary Polymer A.

A technical data sheet on Belsperse® 164 Dispersant (active ingredient: CAS No. 71050-62-9) lists this product as having an acute oral LD<sub>50</sub> value of >5,000 mg/kg in rats. The product is non-irritating to the skin and eyes (BioLab Water Additives, 1999).

In a letter to the U.S. EPA, male and female rats dosed by oral gavage with a 40% solution of this polymer showed treatment-related signs of osteomalacia associated with hyperphosphaturia and calciuria by week 8 of a 90-day study (EPA, 2016a).

THE U.S. EPA TSCATS database also has a brief summary of a 4-week rat oral gavage conducted on the product BELSPERSE 164 (CAS No. 71050-62-9). At 5,000 mg/kg-day, there were adverse clinical signs, gross organ pathology and changes in blood biochemical parameters. The NOAEL was 2,000 mg/kg-day (EPA, 2016b).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicity information on Proprietary Polymer A is inadequate and/or unreliable for deriving toxicological reference and drinking water guidance values for this polymer.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Proprietary Polymer A does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Proprietary Polymer A exhibits low toxicity concern to aquatic organisms.

### **B. Aquatic Toxicity**

#### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on Proprietary Polymer A.

**Table 2: Acute Aquatic Toxicity Studies on Proprietary Polymer A**

Test Species	Endpoint	Results (mg/L)	Reference
Rainbow trout	96-hr LC <sub>50</sub>	>1,000	BioLab Water Additives, 1999
Zebra fish	96-hr LC <sub>50</sub>	>1,000	BioLab Water Additives, 1999
Daphnia	24-hr EC <sub>50</sub>	320	BioLab Water Additives, 1999
Algae	72-hr EC <sub>50</sub>	130	BioLab Water Additives, 1999

#### Chronic Studies

No studies were located.

### **C. Terrestrial Toxicity**

No studies were located.

### **D. Calculation of PNEC**

The PNEC calculations for Proprietary Polymer A follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (>1,000 mg/L), *Daphnia* (>320 mg/L), and algae (>130 mg/L). No long-term studies on Proprietary Polymer A are available. On the basis of the short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 130 mg/L for algae. The PNEC<sub>water</sub> is 0.13 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. The K<sub>ow</sub> and K<sub>oc</sub> have not been experimentally derived for Proprietary Polymer A; these values cannot estimate using QSAR models because of the high molecular weight of Proprietary Polymer A. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>.

### PNEC soil

There are no toxicity data for soil-dwelling organisms. The K<sub>ow</sub> and K<sub>oc</sub> have not been experimentally derived for Proprietary Polymer A; these values cannot estimate using QSAR models because of the high molecular weight of Proprietary Polymer A. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub>.

## **VIII. PBT ASSESSMENT**

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).

Proprietary Polymer A is not readily biodegradable. Thus, it meets the screening criteria for persistence.

Proprietary Polymer A is a high molecular weight polymer that is not expected to be bioavailable to aquatic or terrestrial organisms. Thus, it is not expected to bioaccumulate.

No chronic aquatic toxicity studies have been conducted on Proprietary Polymer A. The acute E(L)C<sub>50</sub> values are >0.1 mg/L. Thus, it does not meet the screening criteria for toxicity.

The overall conclusion is that Proprietary Polymer A is not a PBT substance.

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

### **A. Classification**

Not classified.

### **B. Labelling**

No signal word.

### **C. Pictogram**

None.

## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

### **B. FIRE FIGHTING INFORMATION**

#### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

#### Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, phosphorus oxides.

#### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

### **C. ACCIDENTAL RELEASE MEASURES**

#### Personal Precautions

Use appropriate protective equipment. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust.

#### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

#### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid creating or inhaling dust.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Proprietary Polymer A.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.

## **F. TRANSPORT INFORMATION**

Proprietary Polymer A is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.



### XIII. REFERENCES

- ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.
- BioLab Water Additives (1999). Belsperse® 164 Dispersant. General Product Information, <http://lpq.com.mx/pdf/BELSPERSE%20164.PDF>
- 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.
- 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.
- U.S. EPA [EPA] (2016). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88900000038; accessed October 2016.
- U.S. EPA [EPA] (2016b). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920001980; accessed October 2016.

### I. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight

NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## POLYACRYLAMIDE

This dossier on polyacrylamide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyacrylamide in its use in water treatment. The information presented in this dossier was obtained primarily from the Cosmetic Ingredient Review on polyacrylamide (CIR, 2005). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Poly(2-propenamide)

**CAS RN:** 9003-05-8

**Molecular formula:**  $(C_3H_5NO)_x$ -

**Molecular weight:** 30,000 to 12,000,000 (cosmetic grade)

**Synonyms:** Polyacrylamide; poly(2-propenamide); 2-propenamide, homopolymer; acrylamide homopolymer.

Polyacrylamide is the homopolymer from the polymerization of acrylamide monomers.

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Polyacrylamide**

Property	Value	Reference
Physical state at 20°C and 101.3 kPa	Solid; aqueous solutions; inverse emulsions (dispersions)	CIR, 2005
Density	1.122 g/mL @ 30°C	CIR, 2005
Partition Coefficient (log $P_{ow}$ )	Not applicable	-
Water Solubility	See note below.	CIR, 2005
pH	6.5 – 6.8 (1% solution); nonionic	CIR, 2005
Viscosity	Dynes/cm: 2% solution, 0.00031; 5% solution 0.0026; 8% solution, 0.0077	CIR, 2005

The polymerization of acrylamide at  $\geq$ pH 9 or higher forms water-soluble polymers; whereas, water-insoluble polymers are formed at  $\geq$ pH 2.5. The cross-linked form of polyacrylamide is not water-soluble, but it is defined as “water swollen” (CIR, 2005).

Polyacrylamide, as the homopolymer of acrylamide, is non-ionic. An anionic polyacrylamide polymer (pH >4) can be formed by the copolymerization of acrylamide and acrylic acid. Anionic polyacrylamide can also be formed from the hydrolysis of polyacrylamide.

Cationic polyacrylamide polymers can be formed by the copolymerization of acrylamide and cationic monomers such as diallyldimethylammonium chloride.

Acrylamide may be present in polyacrylamide as a residual.

### **III. ENVIRONMENTAL FATE PROPERTIES**

No studies on the environmental fate of polyacrylamide were located. As a high-molecular-weight polymer, it is not expected to biodegrade or bioaccumulate.

### **IV. HUMAN HEALTH HAZARD ASSESSMENT**

#### **A. Summary**

Polyacrylamide is not bioavailable when ingested. It is essentially non-toxic by the oral route, and it is not irritating to the skin or eyes. Lifetime dietary studies in rats showed no toxicity or carcinogenic effects. There were no indications of reproductive or developmental toxicity in rats given polyacrylamide in their feed over several generations.

#### **B. Toxicokinetics and Metabolism**

Three rats were given [ $^{14}\text{C}$ ]polyacrylamide as an oral gavage dose of 10 mg per 2 ml water, 37.5 mg per 3 ml water, or 75 mg per 4 ml water. The animals were then observed for 24 hours. None of the three rats had any absorbed radioactivity. A trace of radioactivity was found in the urine, but it was found to be the result of possible contamination. At the lower doses, the sum of the radioactivity recovered in the feces and gastrointestinal tract showed a 97.6% recovery of the total dose. It was concluded that the [ $^{14}\text{C}$ ]polyacrylamide (molecular weight not stated) was not absorbed; it was too large to pass through the walls of the gastrointestinal tract (CIR, 2005).

Rats were dosed by oral gavage with 250 or 500 mg/kg [ $^{14}\text{C}$ ]polyacrylamide. No radioactivity was observed in any of the animals. The sum of the radioactivity recovered in the feces and gastrointestinal tract was 98.2% of the administered dose (McCollister et al., 1965).

#### **C. Acute Toxicity**

No deaths were observed in rats either nonionic or anionic polyacrylamide at oral doses up to 4,000 mg/kg. The oral  $\text{LD}_{50}$  is >4,000 mg/kg (McCollister et al., 1965).

#### **D. Irritation**

Application of a 5% solution of polyacrylamide to the skin of rabbits was “well tolerated” (CIR, 2005). Polyacrylamide is non-irritating to slightly irritating to the eyes (CIR, 2005).

#### **E. Sensitization**

No studies were located.

#### **F. Repeated Dose Toxicity**

##### Oral

Male and female rats were given in their diet 0, 1, or 5% polyacrylamide for two years. The only effect noted was a slight decrease in body weight gain in the 5% animals. The NOAEL for this study is 5% in the diet (CIR, 2005).

Male and female rats were given in their diet 0, 2.5, 5, or 10% polyacrylamide for two years. There were no treatment-related effects. The NOAEL for this study is 10% in the diet (CIR, 2005).

Male and female rats were given in their diet 0, 1, or 5% polyacrylamide for two years. There were no treatment-related effects (McCollister et al., 1965).

#### Inhalation

No studies were located.

#### Dermal

No studies were located.

### **G. Genotoxicity**

No studies were located.

### **H. Carcinogenicity**

No evidence of carcinogenicity was reported in the two-year feeding studies on polyacrylamide (see repeated dose toxicity section).

### **I. Reproductive/Developmental Toxicity**

In an abstract, it was reported that rats fed up to 2,000 ppm polyacrylamide in feed in a three-generation reproductive toxicity study showed no reproductive, developmental, or parental toxicity (CIR, 2005).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for polyacrylamide 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).

### **A. Non-Cancer**

#### Oral

No adverse effects were reported in rats given polyacrylamide in their feed at doses up to 10% for two years (CIR, 2005). Using 0.05 as the fraction of body weight that is consumed per day as food for the rat, the NOAEL for this study is 5,000 mg/kg-day. The NOAEL of 5,000 mg/kg-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 5,000 / (10 \times 10 \times 1 \times 1 \times 1) = 5,000 / 100 = \underline{50 \text{ mg/kg-day}}$$

### 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 = (50 x 70 x 0.1)/2 = 175 mg/L

## **B. Cancer**

Polyacrylamide was not carcinogenic to rats when given in feed for two years; hence, a cancer reference value was not derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Polyacrylamide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

No aquatic or terrestrial toxicity studies were located. Polyacrylamide is expected to non-toxic to aquatic and terrestrial organisms due to its large molecular size; it is not expected to be bioavailable.

### **A. Calculation of PNEC**

PNEC values were not derived.

## **VIII. PBT ASSESSMENT**

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).

Polyacrylamide is a large molecular weight, water-soluble polymer. It is not expected to be readily biodegradable; thus, it meets the screening criteria for persistence.

Metabolism studies showed that polyacrylamide was not bioavailable to rats when ingested; this is most likely due to its large size (high molecular weight) and presumed resistance to breakdown in the gastrointestinal tract. Polyacrylamide is thus not expected to be bioavailable to aquatic or terrestrial organisms. It is not expected to meet the criteria for bioaccumulation.

No aquatic toxicity data were located on polyacrylamide. It is not expected to be bioavailable to aquatic organisms. Thus, it is not expected to meet the criteria for toxicity.

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

## **IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)**

### **A. Classification**

No classification

### **B. Labelling**

No signal word.

### **C. Pictogram**

None

## **X. SAFETY AND HANDLING**

### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

### Skin Contact

Wash thoroughly with soap and water.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

## **A. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, nitrogen oxides.

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **B. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **C. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid creating or inhaling dust.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **D. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for polyacrylamide.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.



## **E. TRANSPORT INFORMATION**

Polyacrylamide is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Cosmetic Ingredient Review [CIR] (2005). Amended final report on the safety assessment of polyacrylamide and acrylamide residues in cosmetics. Int. J. Toxicol. 24 (Suppl 2): 21-50.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

McCollister, D.D., Hake, C.L., Sadek, S.E., and Rowe, V.K. (1965). Toxicologic investigations of polyacrylamides. Toxicol. Appl. Pharmacol. 7: 639-651.

## **XIV. ACRONYMS AND GLOSSARY**

°C                      degrees Celsius

ADWG                Australian Drinking Water Guidelines

API                   American Petroleum Institute

DEWHA            Department of the Environment, Water, Heritage and the Arts

EC                    effective concentration

ECHA                European Chemicals Agency

EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## POLYDADMAC

### [POLYDIALLYLDIMETHYLAMMONIUM CHLORIDE]

This dossier on polyDADMAC does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyDADMAC in its use in water treatment. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

#### I. SUBSTANCE IDENTIFICATION

**Chemical Name:** Polydiallyldimethylammonium chloride

**CAS RN:** 26062-79-3

**Molecular formula:**  $(C_8H_{16}N.Cl)_x$

**Molecular weight:** Variable

**Synonyms:** PolyDADMAC; 2-Propen-1-aminium, N,N-dimethyl-N-2-propenyl-, chloride, homopolymer; Poly-2-propen-1-aminium, N,N-dimethyl-N-2-propenyl-, chloride; N-N-dimethyl-N-2-propenyl-2-propen-1-aminium chloride, homopolymer; poly-N,N-dimethyl-N-N-diallylammonium chloride; polyquaternium-6;

#### II. PHYSICO-CHEMICAL PROPERTIES

PolyDADMAC is a highly charged cationic homopolymer with high molecular weights; those used in water treatment may have molecular weights less than 500,000 (Lyons and Vasconcellos, 1997).

#### III. ENVIRONMENTAL FATE PROPERTIES

PolyDADMAC is a highly charged cationic polymer with high molecular weights. It is expected to be poorly biodegraded, and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility (Lyons and Vasconcellos, 1997). As a cationic polymer, polyDADMAC will rapidly react with many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays (Lyons and Vasconcellos, 1997).

Due to its physical properties (*i.e.*, molecular size), polyDADMAC is not expected to bioaccumulate.

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

PolyDADMAC is not acute toxic by the oral route; nor does it exhibit any systemic toxicity from repeated exposures through ingestion.

##### B. Acute Toxicity

There were no deaths in rats given a single oral dose of 5,000 mg/kg polyDADMAC. The oral LD<sub>50</sub> in rats is >5,000 mg/kg (EPA, 2016a).

##### C. Irritation

No studies were located.

**D. Sensitisation**

No studies were located.

**E. Repeated Dose Toxicity**Oral

Male and female SD rats were given in their diet 0, 1,000, or 2,000 mg/kg polyDADMAC for six months. There were no clinical signs of toxicity. Two low-dose males were sacrificed in a moribund condition, while one low-dose male and one high-dose male died during the exposure period. Feed consumption was significantly increased in the treated groups compared to controls. Body weight gain was significantly lower in the treated animals compared to the controls. Final body weights were significantly lower in all dose groups compared to controls (10.4% and 19.5% in males; 6.6% and 10% in females for the low- and high-dose groups, respectively). Hematology and clinical chemistry parameters and urinalysis showed no biologically significant differences between treated and control groups. Relative liver weights were decreased in the  $\geq 1,000$  mg/kg males and 2,000 mg/kg females. Relative heart weights were decreased in the 2,000 mg/kg (both sexes), and relative kidney weights were decreased in the 2,000 mg/kg males. The histopathologic examination showed no treatment-related changes in these organs. No other compound-related pathology was observed, although histopathologic effects were seen in the lungs and urinary tract in animals of all groups. The LOEL for this study is 1,000 mg/kg-day based on reduced body weights and body weight gain; a NOEL was not established (EPA, 2016b).

Inhalation

No studies were located.

Dermal

No studies were located.

**F. Genotoxicity**

No studies were located.

**G. Carcinogenicity**

No studies were located.

**H. Reproductive Developmental Toxicity**

No studies were located.

**V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for polyDADMAC 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).

## A. Non-Cancer

### Oral

PolyDADMAC has been tested in a six-month rat feeding study. No target organs were identified. However an NOAEL was not established. The LOAEL is 1,000 mg/kg-day based on reduced body weights and body weight gain. It is unclear from the limited data whether these changes in the treated animals are due to a direct or indirect effect of polyDADMAC. PolyDADMAC has a high molecular weight and would not be expected to be absorbed from the gastrointestinal tract. Feed consumption was significantly increased in the treated rats (both dose groups) even though body weights and body weight gain were reduced. A likely explanation for these findings is that the weight changes and feed consumption reflect the nutritional status of the treated animals due to the bulk presence of high levels of polymer in the feed and not to systemic toxicity. Given the absence of any other effects, it is proposed that the NOAEL for systemic toxicity in this study is 2,000 mg/kg-day, the highest dose tested.

The NOAEL of 2,000 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 10

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 2,000 / (10 \times 10 \times 1 \times 10 \times 1) = 2,000 / 1,000 = \underline{2 \text{ mg/kg-day}}$$

### 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)

$$\text{Drinking water guidance value} = (2 \times 70 \times 0.1) / 2 = \underline{7 \text{ mg/L}}$$

## B. Cancer

No carcinogenicity studies were located; thus, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

PolyDADMAC does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

PolyDADMAC exhibits a moderate toxicity concern to aquatic organisms.

### B. Aquatic Toxicity

#### Acute Studies

Table 1 lists the results of acute aquatic toxicity studies conducted on polyDADMAC.

**Table 1: Acute Aquatic Toxicity Studies on polyDADMAC**

Test Species	End point	Results (mg/L)	Reference
Bluegill	96-hr LC <sub>50</sub>	0.9	EPA, 2016c
Bluegill	96-hr LC <sub>50</sub>	0.32	EPA, 2016d

Test Species	E n d p o i n t	Results (mg/L)	Reference
Rainbow trout	9 6 - h r L C 5 0	0.32	EPA, 2016d
Rainbow trout	9 6 - h r L C 5 0	0.42	EPA, 2016e
Rainbow trout	9 6 - h r L C 5 0	0.77	EPA, 2016f
Fathead minnow	9 6 - h r L C 5 0	0.3	EPA, 2016g
Fathead minnow	9 6 - h r L C 5 0	6.51*	EPA, 2016g

Test Species	End point	Results (mg/L)	Reference
Fathead minnow	96-hr LC <sub>50</sub>	0.46	Cary et al., (1987)
Fathead minnow	96-hr LC <sub>50</sub>	6.5***	Cary et al., (1987)
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.23	EPA, 2016g
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	11.8**	EPA, 2016g
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.33	EPA, 2016h



Test Species	E n d p o i n t	Results (mg/L)	Reference
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	0.2	Cary et al., (1987)
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	7.4***	Cary et al., (1987)

\*10 mg/L humic acid in standard laboratory water.

\*\*10 mg/L TOC in standard laboratory water.

\*\*\*50 mg/L humic acid in standard laboratory water.

In standard acute aquatic toxicity tests, PolyDADMAC, as a highly charged cationic polymer, is very toxic to fish and *Daphnia*. The toxicity of cationic polymers to fish is from the binding of the polymer to gill tissue, disrupting gill structure and function. Physical damage to fish gill by cationic polymers has been shown by Beisinger and Stokes (1986).

Table 1 also shows the change in acute toxicity when suspended solids or Total Organic Carbon (TOC) is added to the standard laboratory water used in the toxicity tests. In the presence of humic acid or TOC, the E(L)C<sub>50</sub> values for fathead minnow and *Daphnia magna* increase by 21.7-fold and 51.3-fold, respectively. A similar effect of humic acid on the acute toxicity of polyDADMAC on fish and *Daphnia magna* was reported by Cary et al. (1987). The studies by Cary et al. (1987) also showed increases in varying amounts in the E(L)C<sub>50</sub> values for fathead minnow and *Daphnia magna* with bentonite, illite, kaolin, silica, tannic acid, lignin, lignosite, and fulvic acid. The concentrations of suspended solids and DOC in the studies by Cary et al. (1987) were considered to be low estimates of levels found in the natural environments. These findings demonstrate that toxicity tests conducted on cationic polymers, such as polyDADMAC, using water with no organic carbon will likely overestimate the toxicity of these polymers in the environment.

### Chronic Studies

No studies were located for polyDADMAC. The ratio of the acute toxicity to chronic toxicity for polyDADMAC is expected to be low. In 21-day *Daphnia magna* reproduction studies, three cationic polymers had 21-day threshold levels for survival that were higher by order of magnitude than the 48-hr TL<sub>50</sub> values. The test solutions in these studies were renewed several times along with food, which served as new organic matter. The cationic polymer bioavailability was likely reduced from the adsorption to the food (Biesinger et al., 1976). In another study, low acute to chronic ratios was

observed for a cationic polymer for *Ceriodaphnia dubia* and fathead minnows (Godwin-Saad et al., 1994).

It cannot be determined from the standard chronic tests if the adsorbed polymer is ingested or simply becomes unavailable by flocculating and/or settling. In any case, the low acute to chronic ratios of these cationic polymers appears to be best correlated with acute effects (Lyons and Vasconcellos, 1997).

### C. Terrestrial Toxicity

No studies were located.

### D. Calculation of PNEC

The PNEC calculations for polyDADMAC follow the methodology discussed in DEWHA (2009).

#### PNEC water

Experimental results are available for two trophic levels. Acute  $E(L)C_{50}$  values are available for fish (0.2 mg/L) and *Daphnia* (0.3 mg/L) in standard laboratory water; and for fish (6.5 mg/L) and *Daphnia* (11.8 mg/L) in standard laboratory water with the addition of humic acid or TOC. The PNEC water will be based on the  $E(L)C_{50}$  values from the acute toxicity tests conducted with humic acid in the dilution water because this most likely represents the environmental conditions for which this assessment is being conducted for. Furthermore, an assessment factor of 50 is proposed because chronic toxicity is expected to be similar to the acute toxicity of polyDADMAC (when tested in the presence of humic acid) because of the adsorption of the polymer to organic matter (food source) that would occur in standard test methods; hence, an assessment factor will be used for chronic testing for two trophic levels. An assessment factor of 50 has been applied to the  $LC_{50}$  value of 6.5 mg/L for fish. The  $PNEC_{water}$  is 0.13 mg/L.

#### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. The  $K_{ow}$  and  $K_{oc}$  have not been experimentally derived for polyDADMAC; these values cannot estimate using QSAR models because of the high molecular weight of polyDADMAC. Thus, the equilibrium partitioning method cannot be used to calculate the  $PNEC_{sed}$ .

#### PNEC soil

There are no toxicity data for soil-dwelling organisms. The  $K_{ow}$  and  $K_{oc}$  have not been experimentally derived for polyDADMAC; these values cannot estimate using QSAR models because of the high molecular weight of polyDADMAC. Thus, the equilibrium partitioning method cannot be used to calculate the  $PNEC_{soil}$ .

## VIII. PBT ASSESSMENT

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).

PolyDADMAC is a high molecular weight polymer; it is expected to be poorly biodegraded. Thus, it meets the screening criteria for persistence.

PolyDADMAC is a high molecular weight polymer that is not expected to be bioavailable to aquatic or terrestrial organisms. Thus, it is not expected to bioaccumulate.

No chronic aquatic toxicity studies have been conducted on polyDADMAC. The E(L)C<sub>50</sub> values of fish and *Daphnia* for acute toxicity tests conducted with humic acid or TOC in dilution water were >0.1 mg/L. thus, polyDADMAC does not meet the screening criteria for toxicity.

The overall conclusions are that polyDADMAC is not a PBT substance.

## **IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)**

### **A. Classification**

Chronic Toxicity Category 2

Note: Aquatic toxicity classification is not required for Australia GHS.

### **B. Labelling**

Warning

### **C. Pictogram**



## **X. SAFETY AND HANDLING**

### **A. FIRST AID**

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Carbon oxides, nitrogen oxides

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment. Slippery when wet.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Pump off product for large amounts. For residues, pick up with suitable absorbent material. Dispose of absorbed material in accordance with regulations.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for polyDDMAC.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.

## **F. TRANSPORT INFORMATION**

PolyDDMAC is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Beisinger, K.E., Lemke, A.E., Smith, W.E., and Tyo, R.M. (1976). Comparative toxicity of polyelectrolytes to selected aquatic animals. J. Water Poll. Control Fed. 48: 183-187.

Cary, G.A., McHahon, J.A., and Kuc, W.J. (1987). The effect of suspended solids and naturally occurring dissolved organics in reducing the acute toxicities of cationic polyelectrolytes to aquatic organisms. Environ. Toxicol. Chem. 6: 469-474.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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

- Godwin-Daad, E., Hall, W.S., and Hughes, D. (1994). An evaluation of the acute and chronic toxicity of a waste water treatment polymer to aquatic and terrestrial organisms. In: Proceedings of the Water, Environment Federation 67<sup>th</sup> Annual Conference and Exposition, Surface Water Quality and Ecology, Vol. 4, p. 249; cited in Lyons and Vasconcellos (1997).
- 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.
- Lyons, L.A., and Vasconcellos, S.R. (1997). Water treatment polymers. In: Ecological Assessment of Polymers. Strategies for Product Stewardship and Regulatory Programs (Hamilton, J.D. and R. Sutcliffe, Eds.), pp. 113-145, Wiley.
- U.S. EPA [EPA] (2016a). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88990000073; accessed October 2016.
- U.S. EPA [EPA] (2016b). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002746; accessed October 2016.
- U.S. EPA [EPA] (2016c). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002728; accessed October 2016.
- U.S. EPA [EPA] (2016d). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002760; accessed October 2016.
- U.S. EPA [EPA] (2016e). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002771; accessed October 2016.
- U.S. EPA [EPA] (2016f). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920000061; accessed October 2016.
- U.S. EPA [EPA] (2016g). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920000053; accessed October 2016.
- U.S. EPA [EPA] (2016h). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002752; accessed October 2016.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume

IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## PROPRIETARY MIXTURE D2

This dossier on the lower molecular weight Proprietary Mixture D2 does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyethylene glycols in its use in drilling muds and hydraulic fracturing fluids, and water treatment systems. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on the ethylene glycol category (OECD, 2004). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Proprietary Mixture D2

**CAS RN:** MixtureD2-CASRn

**Molecular formula:**

**Molecular weight:**

**Synonyms:** Proprietary Mixture D2

Proprietary Mixture D2 are water-soluble linear polymers formed by the addition reaction of ethylene oxide to an ethylene glycol equivalent. The general formula for Proprietary Mixture D2 is:  $\text{H-(OCH}_2\text{CH}_2)_n\text{-OH}$  where “n” is the average number of repeating oxyethylene groups.

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of the Low Molecular Weight Proprietary Mixture D2 <sup>1</sup>**

	Proprietary Mixture D2 200	Proprietary Mixture D2 300	Proprietary Mixture D2 400	Proprietary Mixture D2 600
Molecular weight range	190-210	285-315	380-420	570-630
Density (g/cm <sup>3</sup> )	@ 20°C	1.1249 @ 20°C	1.1255 @ 20°C	1.1258 @ 20°C
Melting Point	<65°C	-15 to -8°C	4 to 8°C	15-25°C
Solubility (20°C)	Complete	Complete	Complete	Complete
Viscosity (100°C)	4.3	5.8	7.3	10.8 cSt
Aver. # EO units	4.1	6.4	8.7	13.2
Flash Point (°C)	185/190	218/243	227/263	238/274
Physical Form	Liquid	Liquid	Liquid	Liquid

<sup>1</sup>Technical Data Sheets from The Dow Chemical Company (Dow 2011a,b,c,d).

All of the lower molecular weight Proprietary Mixture D2 are liquid at room temperature; Proprietary Mixture D2 with higher molecular weights exist as solids at room temperature.



### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

No data are available on the low molecular weight Proprietary Mixture D2. Data on some of the major constituents indicate that the low molecular weight Proprietary Mixture D2 are inherently biodegradable, have a low potential for bioaccumulation, and have a high mobility in soil.

#### B. Biodegradation

No information was located on the low molecular weight Proprietary Mixture D2.

Data are available on tetraEG and pentaEG, both being major constituents of Proprietary Mixture D2 200 (Bailey and Kolest, 1966; OECD, 2004). Both tetraEG and pentaEG are inherently biodegradable. For tetraEG, there was 22% degradation after 20 days in a BOD test and 40% degradation after 28 days in an OECD 301D test (Waggy et al., 1994). For pentaEG, there was 34% degradation after 20 days in a BOD test (OECD, 2004).

#### C. Bioaccumulation

The experimental value of the log  $K_{ow}$  for a low molecular weight Proprietary Mixture D2 was determined to be -0.958 (ECHA). [Kl. score = 1]

Using KOWWIN in EPISUITE™, the estimated log  $K_{ow}$  values for tetraEG and pentaEG, the major constituents of Proprietary Mixture D2 200, are -2.0228 and -2.2972, respectively (EPA 2016). The estimated BCF for both tetraEG and pentaEG using BCFBAF is 3.162.

Thus, the lower molecular weight Proprietary Mixture D2 are not expected to bioaccumulate.

#### D. Environmental Distribution

Adsorption/desorption

No experimental data are available for the low molecular weight Proprietary Mixture D2. Using KOCWIN in EPISUITE™, the estimated  $K_{oc}$  values from log  $K_{ow}$  for tetraEG and pentaEG, the major constituents of Proprietary Mixture D2, are 0.05 and 0.03 L/kg, respectively. The estimated  $K_{oc}$  values from the molecular connectivity index (MCI) for tetraEG and pentaEG, the major constituents of Proprietary Mixture D2, is 10 L/kg (EPA 2016).

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

The low molecular weight Proprietary Mixture D2 are partially absorbed from the small intestine; can undergo metabolism in the body, and both Proprietary Mixture D2 and its metabolites are excreted mainly in the urine. These polymeric compounds are non-toxic by the oral, dermal, and inhalation routes. Proprietary Polymer A are minimally irritating to the skin and eyes, and are not skin sensitizers. Repeated exposures to very high oral doses of Proprietary Mixture D2 400 produced slight kidney toxicity in rats. The overall evidence is that the low molecular weight Proprietary Mixture D2 polymers are not genotoxic. No developmental toxicity was observed in the animal studies.

## **B. Toxicokinetics and Metabolism**

Proprietary Mixture D2 of low molecular weight are partially absorbed in the proximal small intestine following oral administration. About 50-65% of Proprietary Mixture D2 400 was shown to be absorbed in humans (Shaffer et al., 1950).

Metabolism of Proprietary Mixture D2 to acidic metabolites may occur the following absorption. Proprietary Mixture D2 and its acidic metabolites appear to be excreted in the urine and bile, with the biliary route playing a major role in the higher molecular weight Proprietary Mixture D2 (Herold et al., 1982).

## **C. Acute Toxicity**

The oral LD<sub>50</sub> in rats was reported to range from 25,700 to 32,500 mg/kg (OECD, 2004) and 28,130 mg/kg (OECD, 2004).

The dermal LD<sub>50</sub> in rabbits ranges from 14,000 to 20,000 (OECD, 2004).

No deaths were reported in rats exposed to an aerosol of 2,516 mg/m<sup>3</sup> Proprietary Mixture D2 200 for 6 hours (OECD, 2004).

## **D. Irritation**

Proprietary Mixture D2 (molecular weights not specified) are not irritants (Cavender and Sowinski, 1994).

TetraEG was minimally irritating to human skin (OECD, 2004). PentaEG produced minor transient irritation to rabbit skin (OECD, 2004). Both tetraEG and pentaEG produced minimal transient irritation to the eyes of rabbits (OECD, 2004).

## **E. Sensitization**

Proprietary Mixture D2 (molecular weights not specified) are not skin sensitizers (Cavender and Sowinski, 1994).

TetraEG was not a skin sensitizer to guinea pigs or to humans (OECD, 2004).

## **F. Repeated Dose Toxicity**

### Oral

Male and female F344 rats were dosed by oral gavage with 0, 1,100, 2,800, or 5,600 mg/kg Proprietary Mixture D2 400 5 days/week for 13 weeks. An additional group of rats (0 and 5,600 mg/kg dose groups) were dosed for 13 weeks followed by a 6-week recovery period. There were no treatment-related deaths or changes in haematology and clinical chemistry parameters. There were loose feces in the mid- and high-dose animals; this was attributed to the bulk cathartic effects of Proprietary Mixture D2 400. Food consumption and body weights were slightly decreased in the mid- and high-dose animals; although this was attributed to the physical presence of Proprietary Mixture D2 400 in the gastrointestinal tract, a direct effect of Proprietary Mixture D2 400 could not be ruled out. Water consumption was increased in all treatment groups possibly due to an increase in serum osmolality due to the absorption of Proprietary Mixture D2 400. Urine N-acetyl-β-D-glucosaminidase (NAG) activity, osmolality, and specific gravity were increased in a dose-related manner in males of all dose groups. The magnitude of the changes in these parameters in the low-dose group was very slight (only the specific gravity was statistically significant). In females, urinary NAG activity was not significantly altered. Urinary

osmolality and specific gravity tended to be increased in females in all dose groups, but only specific gravity of the high-dosed females was statistically significant. Urine pH was decreased in all dosed males and in the mid- and high-dose females. The urinary concentrations of protein and bilirubin were all increased in males in all dose groups. Following the recovery period, there were no biologically significant changes in hematology, clinical chemistry, or urinalysis in either males or females. Small increases in relative kidney weights were seen in the treated animals and was attributed to the osmotic effect of Proprietary Mixture D2 400 and/or metabolites in the urine. There were no histopathologic effects noted in the kidneys or urinary bladder. The results suggest a slight, reversible kidney toxicity in the 2,800 mg/kg males and in the 5,600 mg/kg males and females, based on increased concentration of protein and bilirubin, urinary vascular cell findings, and NAG activity. The NOAEL for this study is 2,800 mg/kg-day (Hermansky et al., 1995; ECHA). [Kl. score = 2]

Male and female rats were fed in their diet 0, 2, 4, 8, 16, or 24% Proprietary Mixture D2 400 (0, 1,000, 2,000, 4,000, 8,000, or 12,000 mg/kg-day) for 90 days. No effects were seen in the rats at doses up to 8% in the diet. At 16% in the diet, liver and kidney weights were increased compared to the controls, and a decrease in body weight gain was observed. The NOAEL for this study is 8% in the diet or 4,000 mg/kg-day (Smyth et al., 1995; ECHA) [Kl. score = 4]

Male and female rats were fed in their diet 0, 1, 2, 4, or 8% Proprietary Mixture D2 400 (0, 500, 1,000, 2,000, or 4,000 mg/kg-day) for two years. The male rats in the 4% dose group grew slightly less than the control males. No other effects were reported. The NOAEL is 2% in the diet or 2,000 mg/kg-day (Smyth et al. 1995; ECHA) [Kl. score = 4]

#### Inhalation

No studies were located on the lower molecular weight Proprietary Mixture D2 .

#### Dermal

No studies were located on the lower molecular weight Proprietary Mixture D2 .

### **G. Genotoxicity**

No studies on Proprietary Mixture D2 400 or Proprietary Mixture D2 600 were located.

Proprietary Mixture D2 200 (containing ~29% tetraEG) was tested *in vitro* for genotoxicity in a Chinese hamster epithelial liver cell chromosomal aberration assay. A dose-related increase in chromosomal aberrations was observed (Biondi et al., 2002; OECD, 2004). Proprietary Mixture D2 200 (26% tetraEG) was also tested in an *in vivo* rat bone marrow chromosomal aberration test. A significant marginal increase was observed in the male rats at the 12-hour harvest time point at doses of 2,500 and 5,000 mg/kg; the increase was dose-related indicating a clear positive response.

Proprietary Mixture D2 200 contains diethylene glycol (DEG), triethylene glycol (TEG), tetraEG and pentaEG; all have been tested for genotoxicity. Proprietary Mixture D2 200 also contains several glycols of higher molecular weights, which have not been assessed for mutagenicity.

Mutagenicity studies in bacteria and *in vitro* mutagenicity studies in mammalian cells have been conducted for DEG and TEG, and the results have been uniformly negative (OECD, 2004). The results of *in vitro* assays of EG and DEG for chromosomal aberrations (CHO chromosomal aberration and sister chromatid exchange assays) have also been uniformly negative (OECD, 2004). DEG and TEG have not been tested *in vivo* for genotoxicity.

TetraEG has been found to cause chromosome aberrations *in vitro* (OECD, 2004); however, three assays for chromosome levels effects *in vivo* have been either negative or equivocal. These *in vivo*

studies include a negative rat dominant lethal test; a negative rat bone marrow chromosome aberration test; and an equivocal mouse peripheral blood micronucleus assay (OECD, 2004). A more recent statistical reanalysis of the rat chromosome aberration study (White and Douglas, 2003; OECD, 2004) judged the overall result to be equivocal because of a marginal association and dose-related trends for either sex but at different harvest times, and a significant effect of treatment limited to the lowest doses in females at the 24 hour harvest and males at the 12 hour harvest. However, inspection of the overall data from this assay show these two values to be isolated to the lowest exposure animals and the dose effect trends to be inverse, i.e. decreasing with increasing doses without evidence of cytotoxicity from treatments. The reason for the equivocal designation for the tetraEG mouse micronucleus test was a weak statistically significant increase in MN-PCE in males only at a single time point and without a dose-response.

PentaEG was not mutagenic in the Ames test or in mammalian cells *in vitro* in the CHO/HGPRT assay (OECD, 2004). A mouse bone marrow micronucleus test of crude pentaEG (70% pentaEG, 19% tetraEG) was assessed as negative by the original investigators but deemed to be equivocal after statistical reanalysis (White and Douglas, 2003; OECD, 2004) using non-parametric contingency table analyses and trend tests. However, inspection of the primary data reveals that this reanalysis was influenced by a single uncharacteristically low MN control value in one sex (females) at a single time point, indicating that the test result is biologically negative.

## **H. Carcinogenicity**

No studies were located.

## **I. Reproductive Toxicity**

No studies have been conducted on Proprietary Mixture D2.

Repeat dosing with tetraEG at doses up to 6,386 mg/kg-day for 14 days or 2,000 mg/kg-day for 4 weeks produced no notable changes in the histopathology of the testes and epididymides of rats (OECD, 2004).

## **J. Developmental Toxicity**

No developmental effects were seen in rats dosed orally up to 10,000 mg/kg-day Proprietary Mixture D2 200 (OECD, 2004).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for the lower molecular Proprietary Mixture D2 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).

### **A. Non-Cancer**

#### Oral

No toxicity was seen in rats given 2,000 mg/kg-day in their feed for two years. The NOAEL of 2,000 mg/kg-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

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 =  $2,000 / (10 \times 10 \times 1 \times 1 \times 1) = 2,000 / 100 = \underline{20 \text{ mg/kg-day}}$

#### 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 =  $(20 \times 70 \times 0.1) / 2 = \underline{70 \text{ mg/L}}$

### **B. Cancer**

There are no carcinogenicity studies on the low molecular weight Proprietary Mixture D2. Thus, a cancer reference value was not derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

The low molecular weight Proprietary Mixture D2 do not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

The low molecular weight Proprietary Mixture D2 polymers are not toxic to aquatic organisms.

### **B. Aquatic Toxicity**

#### Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on the low molecular weight Proprietary Mixture D2 and their major constituents.

**Table 2: Acute Aquatic Toxicity Studies on the Low Molecular Weight Proprietary Mixture D2 and Their Major Constituents**

Test Substance (CAS No.)	Test Species	Endpoint	Results (mg/L)	Reference
Proprietary Mixture D2 (molecular weight unknown)	<i>Poecilia reticulata</i>	96-hr LC <sub>50</sub>	>100	ECHA
TetraEG (112-60-7)	<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	>10,000	OECD, 2004; ECHA
PentaEG (4792-15-8)	<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	>50,000	OECD, 2004
TetraEG (112-60-7)	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	7,746	OECD, 2004; ECHA
PentaEG (4792-15-8)	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>20,000	OECD, 2004
PentaEG (4792-15-8)	<i>Pseudokirchneriella subcapitata</i>	72-hr EC <sub>50</sub> NOEC	>100 100	OECD, 2004

#### Chronic Studies

No chronic aquatic toxicity studies were located on the low molecular weight Proprietary Mixture D2. Table 3 lists the results of chronic aquatic toxicity studies on triethylene glycol, a constituent of Proprietary Mixture D2 200.

**Table 3: Chronic Aquatic Toxicity Studies on Triethylene Glycol**

Test Substance (CAS No.)	Test Species	Endpoint	Results (mg/L)	Reference
TEG (112-60-7)	<i>Pimephales promelas</i>	7-d NOEC	15,380 (weight)	Pillard, 1995; ECHA
TEG (112-60-7)	<i>Daphnia magna</i>	7-d NOEC	8,590 (reproduction)	Pillard, 1995; ECHA

### **C. Terrestrial Toxicity**

No studies were located.

### **D. Calculation of PNEC**

The PNEC calculations for the low molecular weight Proprietary Mixture D2 follow the methodology discussed in DEWHA (2009).

#### PNEC water

Experimental results are available for three trophic levels for low molecular weight Proprietary Mixture D2 and their major constituents. Acute E(L)C<sub>50</sub> values are available for fish (>100 mg/L), *Daphnia* (7,746 mg/L), and algae (>100 mg/L). Chronic toxicity data are available on triethylene glycol (fish and invertebrates) and pentaEG (algae), with the lowest NOEL being 100 mg/L for algae. On the basis that the data consists of short-term results from three trophic levels and long-term results of three trophic

levels, an assessment factor of 10 has been applied to chronic NOEL of 100 mg/L for algae. The  $PNEC_{\text{water}}$  is 10 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the  $PNEC_{\text{sed}}$  was calculated using the equilibrium partitioning method. The  $PNEC_{\text{sed}}$  is 7.7 mg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{\text{sed}} &= (K_{\text{sed-water}}/BD_{\text{sed}}) \times 1000 \times PNEC_{\text{water}} \\ &= (0.99/1280) \times 1000 \times 10 \\ &= 7.7 \end{aligned}$$

Where:

$K_{\text{sed-water}}$  = suspended matter-water partition coefficient ( $\text{m}^3/\text{m}^3$ )  
 $BD_{\text{sed}}$  = bulk density of sediment ( $\text{kg}/\text{m}^3$ ) = 1,280 [default]

$$\begin{aligned} K_{\text{sed-water}} &= 0.8 + [(0.2 \times K_{\text{p}_{\text{sed}}})/1000 \times BD_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 0.4/1000 \times 2400)] \\ &= 0.99 \end{aligned}$$

Where:

$K_{\text{p}_{\text{sed}}}$  = solid-water partition coefficient ( $\text{L}/\text{kg}$ ).  
 $BD_{\text{solid}}$  = bulk density of the solid phase ( $\text{kg}/\text{m}^3$ ) = 2,400 [default]

$$\begin{aligned} K_{\text{p}_{\text{sed}}} &= K_{\text{oc}} \times f_{\text{oc}} \\ &= 10 \times 0.04 \\ &= 0.4 \end{aligned}$$

Where:

$K_{\text{oc}}$  = organic carbon normalized distribution coefficient ( $\text{L}/\text{kg}$ ). The  $K_{\text{oc}}$  for tetraEG and pentaEG, major constituents of Proprietary Mixture D2 200, is 10  $\text{L}/\text{kg}$ .  
 $f_{\text{oc}}$  = fraction of organic carbon in sediment = 0.04 [default].

### PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the  $PNEC_{\text{soil}}$  was calculated using the equilibrium partitioning method. The  $PNEC_{\text{soil}}$  is 1.3 mg/kg soil dry weight.

The calculations are as follows:

$$\begin{aligned} PNEC_{\text{soil}} &= (K_{\text{p}_{\text{soil}}}/BD_{\text{soil}}) \times 1000 \times PNEC_{\text{water}} \\ &= (0.2/1500) \times 1000 \times 10 \\ &= 1.3 \end{aligned}$$

Where:

$K_{\text{p}_{\text{soil}}}$  = soil-water partition coefficient ( $\text{m}^3/\text{m}^3$ )  
 $BD_{\text{soil}}$  = bulk density of soil ( $\text{kg}/\text{m}^3$ ) = 1,500 [default]

$$\begin{aligned} K_{\text{p}_{\text{soil}}} &= K_{\text{oc}} \times f_{\text{oc}} \\ &= 10 \times 0.02 \\ &= 0.2 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for tetraEG and pentaEG, major constituents of Proprietary Mixture D2, is 10 L/kg.

$F_{oc}$  = fraction of organic carbon in soil = 0.02 [default].

## VIII. PBT ASSESSMENT

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).

No information is available on the low molecular weight Proprietary Mixture D2; however, constituents tetraEG and pentaEG are inherently, but not readily, biodegradable. Thus, the low molecular weight Proprietary Mixture D2 are expected to meet the screening criteria for persistence.

No information is available on the low molecular weight Proprietary Mixture D2; however, constituents tetraEG and pentaEG have log  $K_{ow}$  values of -2.0 and -2.3, respectively. Thus, the low molecular weight Proprietary Mixture D2 are not expected to meet the screening criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on the low molecular weight Proprietary Mixture D2; however, the NOECs from chronic aquatic toxicity studies conducted on constituents TEG and pentaEG are >0.1 mg/L. Thus, the low molecular weight Proprietary Mixture D2 are not expected to meet the screening criteria for toxicity.

The overall conclusion is that the low molecular weight Proprietary Mixture D2 are not PBT substances.

## IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)

### A. Classification

Not classified.

### B. Labelling

No signal word.

### C. Pictogram

None.

## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.



### Inhalation

If inhaled, remove from area to fresh air.

### Ingestion

Rinse mouth with water and then drink plenty of water. Do not induce vomiting. Never give anything by mouth to an unconscious person. Seek medical attention.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray or fog, carbon dioxide, dry powder.

### Specific Exposure Hazards

Burning produces harmful and toxic fumes.

### Special Protective Equipment for Firefighters

Wear a self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

No special precautions are necessary. Ensure adequate ventilation.

### Environmental Precautions

Do not discharge into drains, sewers, or waterways.

### Steps to be Taken if Material is Released or Spilt

For large amounts: dike spillage and pump off the product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

## **D. STORAGE AND HANDLING**

### General Handling

Handle in accordance with good industrial hygiene and safety practice.

### Other Handling Precautions

Protect against fire and explosion: prevent electrostatic charge; sources of ignition should be kept well clear, and fire extinguishers should be kept handy.

### Storage

Keep container tightly closed and dry. Protect against heat. Store below 25°C.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Occupational exposure standards for the low molecular weight Proprietary Mixture D2 have not been established.

### Engineering Controls

Provide local exhaust ventilation to control vapours and mists.

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection in case of vapours/aerosol release. Wear a certified organic vapour/particulate respirator.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

## **F. TRANSPORT INFORMATION**

The low molecular weight Proprietary Mixture D2 are not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

Cavender, F.L., smf Sowinski, E.J. (1994). Glycols. In: Patty's Industrial Hygiene and Toxicology, Fourth Edition, Volume 2, Part F, Ed. By G.D. Clayton and F.E. Clayton, pp. 4645-4719, John Wiley & Sons, Inc.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

U.S. Environmental Protection Agency [EPA] (2016). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: <https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface>

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration

OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## SODIUM DODECYL SULFATE

This dossier on sodium dodecyl sulfate (SDS) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium dodecyl sulfate in water treatment. The information presented in this dossier was obtained primarily from the OECD category on alkyl sulfates, alkane sulfonates and  $\alpha$ -olefin sulfonates (OECD 2007), and 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Sodium dodecyl sulfate

**CAS RN:** 151-21-3

**Molecular formula:**  $C_{12}H_{25}O_4S.Na$

**Molecular weight:** 288.38

**Synonyms:** Sodium dodecyl sulfate; sodium lauryl sulfate

**SMILES:** CCCCCCCCCCCCOS(=O)(=O)[O-].[Na+]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Sodium Dodecyl Sulfate**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White granules or powder	2	ECHA
Melting Point	205°C	2	ECHA
Boiling Point	ca. 216°C	1	ECHA
Density	0.63 mg/L	2	ECHA
Vapor Pressure	$\leq 0.18$ Pa @ 20°C (calculated)	2	ECHA
Partition Coefficient (log $P_{ow}$ )	0.83 @ 22°C	2	ECHA
Water Solubility	Very soluble	2	ECHA
Flash Point	170-180°C	2	ECHA
Auto flammability	310.5°C	2	ECHA
Henry's Law Constant	0.019 Pa m <sup>3</sup> /mol (calculated)	2	ECHA

Sodium dodecyl sulfate is a white, granular or powdered solid. The powdered form is highly flammable (BASF, 2012).

### III. ENVIRONMENTAL FATE PROPERTIES

#### A. Summary

Sodium dodecyl sulfate is readily biodegradable. It exhibits moderate sorption to sediments and has a low potential for bioaccumulation.

#### B. Biodegradation

Sodium dodecyl sulfate is readily biodegradable in standard ready tests (OECD 301D) that show 94-97% (OECD, 2007) and approximately 85% (Fischer and Gerike, 1975) removal after 28 and 30 days, respectively. The 10-window was fulfilled in both tests.

#### C. Environmental Distribution

Adsorption/desorption

Sodium dodecyl sulfate exhibits moderate sorption potential to sediments. The experimentally derived sediment-water coefficient ( $K_d$ ) and sorption coefficient ( $K_{oc}$ ) for sodium lauryl sulfate are 70.2 – 99.1 and 316 – 446, respectively (Marchesi et al., 1991).

#### D. Bioaccumulation

The bioaccumulation of sodium dodecyl sulfate is considered to be low based on the results of several studies. The BCFs for freshwater fish *Cyprinus carpio* and *Carassius auratus* were 2.1-5.3 (Wakabayashi et al., 1978, 1980, 1981) and approximately 1.5 (Tovell et al., 1975), respectively.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Sodium dodecyl sulfate exhibits moderate acute toxicity by the oral and dermal routes. It is irritating to the skin and severely irritating to the eyes. Sodium dodecyl sulfate is not a skin sensitizer. Repeated dose toxicity studies have shown liver effects in rats given sodium dodecyl sulfate (or similar compounds) in the diet; these effects have been considered to be adaptive changes (*i.e.*, metabolism) and not toxicity. Sodium dodecyl sulfate is not genotoxic, and similar compounds to sodium dodecyl sulfate were not carcinogenic to rats when tested in lifetime dietary studies. There is no indication that sodium dodecyl sulfate is a reproductive toxicant. Developmental toxicity was seen at high doses that cause maternal toxicity; however, there were no malformations.

#### B. Acute Toxicity

The acute oral LD<sub>50</sub> for sodium dodecyl sulfate in rats was reported to be 1,200 mg/kg (OECD, 2007). The acute dermal LD<sub>50</sub> of a 33% solution of sodium dodecyl sulfate was reported to be 600 mg/kg; this corresponds to 200 mg active substance/kg (OECD, 2007). However, another acute dermal studies on 25% solutions of potassium C<sub>12-13</sub> alkyl sulfate, ammonium C<sub>10-16</sub> alkyl sulfate, and magnesium C<sub>10-16</sub> alkyl sulfate showed no mortality in rabbits from an application dose of 2 ml/kg, which corresponds to about 500 mg active substance/kg (OECD, 2007).

#### C. Irritation

A 25% solution of sodium dodecyl sulfate was severely irritating to the skin of rabbits when applied for 4 hours under occlusive conditions (OECD, 2007). A 5% solution of sodium dodecyl sulfate was moderately to strongly irritating to the skin of rabbits when applied for 4 hours under semi-occlusive

conditions (OECD, 2007). In a human repeated 4-hour patch test, a 20% solution of sodium lauryl sulfate was considered moderately irritating to the skin (OECD, 2007). Sodium dodecyl sulfate, as a 25% solution, was severely irritating to the eyes of rabbits (OECD 2007).

#### **D. Sensitization**

Sodium dodecyl sulfate has tested positive in two out of three mouse local lymph node assays or LLNAs (Ikarashi et al., 1993; Basketter et al., 1994; Montelius et al., 1994). The positive response in the LLNA is thought to be due to a mechanism associated with the irritation potential of sodium dodecyl sulfate and not due to an allergic response (Montelius et al., 1994; Basketter et al., 1994, 2002). Ammonium dodecyl sulfate did not show any allergic response in a human repeat insult patch test (OECD, 2007), and other structurally related alkyl sulfates also tested negative in human repeat insult patch tests (OECD, 2007). There have been a few reported contact sensitization cases seen under conditions where also other, possibly sensitising agents were used or on the compromised skin (OECD, 2007).

#### **E. Repeated Dose Toxicity**

##### Oral

Male and female rats were given 0, 40, 200, 1,000 or 5,000 ppm (corresponding to 3, 17, 86 or 430 mg/kg-day) sodium dodecyl sulfate in their feed for 90 days. There were increased liver weights in the high-dose females animals; no other adverse effects were observed. The NOAEL for this study is 1,000 ppm (86 mg/kg/day) (Walker et al., 1967).

Male and female rats were given by oral gavage 0, 30, 100 or 300/600 mg/kg of a 90% aqueous solution of sodium dodecyl sulfate for 28 days. The high-dose of 300 mg/kg was changed to 600 mg/kg after 10 days of treatment. At the high-dose, feed intake and body weight were reduced, and water intake was increased. There were bleeding and ulceration of the stomach and transient alterations of the tongue and myocard. Haematological findings included increased leucocytes and alanine aminotransferase (ALT) activity, and decreased hematocrit and erythrocyte volume (MCV). Relative weights of adrenals, kidneys, brain, gonads and liver were increased; the relative thymus weight was decreased. There were no effects at the 100 mg/kg dose level. The NOAEL for this study is 90 mg/kg-day (90% of the 100 mg/kg dose level) (OECD, 2007).

A sodium C<sub>12-15</sub> alkyl sulfate was investigated in 13-week rat dietary study. The dietary concentrations were 0, 0, 0.07, 0.14, 0.28, 0.56, 1.13 or 2.25% (0, 58, 1134, 228, 470, 961, or 1,944 mg/kg-day for males; 0, 66, 131, 261, 506, 1,070 or 2,218 mg/kg-day for females). The LOAEL for this study was 0.28% (245 mg/kg-day) based on hypertrophy of the liver, and the NOAEL was 0.14% (122 mg/kg-day) (OECD, 2007).

In two separate studies, male and female Wistar rats were given 0, 0.015, 0.15 or 1.5% sodium C<sub>12-15</sub> alkyl sulfate in their diet (approximately 0, 11, 113 or 1,125 mg/kg-day) for two years. The findings in both studies were very similar. The survival rate in the high-dose animals for both studies was about 70%. Animals dosed with 1.5% showed decreased growth rates, with also decreases in food and water intake. In the high-dose animals, there was increased absolute and relative liver weights, changes in serum liver enzymes, hypertrophy of the liver parenchyma, and a decrease in the incidence and severity of chronic nephropathy and nephrocalcinosis. The NOAEL for these two studies were considered to be 113 mg/kg-day (OECD, 2007; ECHA). [Kl. score = 2]

##### Inhalation

No studies are available.

## Dermal

Male and female mice received derma applications of 0.2 ml of 0, 5, 10, 12.5, or 15% aqueous solution of C<sub>12-15</sub>ASO<sub>4</sub> sodium salt twice a week for 13 weeks. The applied doses were estimated to 0, 200, 400, 500, or 600 mg/kg-day. One mouse died in the 12.5% dose group; otherwise, the animals were healthy throughout the study. Changes in organ weights (liver, kidney, and heart) were seen in the  $\geq 12.5\%$  dose groups. Water consumption was increased in the  $\geq 10\%$  dose groups and may have reflected the accelerated loss of water through the altered epidermis. Cytotoxic effects were seen in the epidermis at  $\geq 12.5\%$ . The NOAEL for this study was considered to be 400 mg/kg-day (OECD, 2007). [Kl. score = 2]

## F. Genotoxicity

Sodium dodecyl sulfate was not genotoxic in a variety of *in vitro* and *in vivo* tests.

### In Vitro Studies

The results of the *in vitro* genotoxicity studies in Table 2 show that sodium dodecyl sulfate is not genotoxic under the conditions of the *in vitro* tests.

**Table 2: In Vitro Genotoxicity Studies on Sodium Dodecyl Sulfate**

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> strains)	-	-	2	ECHA
Bacterial reverse mutation ( <i>E. coli</i> WP2 <i>uvr A</i> )	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	2	ECHA

a+, positive; -, negative

### In Vivo Studies

The *in vivo* studies conducted on sodium dodecyl sulfate are presented below in Table 3. All of the studies show that it is not mutagenic or genotoxic.

**Table 3: In Vivo Genotoxicity Studies on Sodium Dodecyl Sulfate**

Test System	Results*	Klimisch Score	Reference
Mouse dominant lethal assay	-	2	ECHA
Mouse bone marrow micronucleus assay (single dose)	-	2	ECHA
Mouse bone marrow micronucleus assay (single dose)	-	2	ECHA
Rat bone marrow micronucleus assay (90-day exposure)	-	2	ECHA

\*+, positive; -, negative



## **G. Carcinogenicity**

### Oral

In two separate studies, male and female Wistar rats were given 0, 0.015, 0.15 or 1.5% sodium C<sub>12-15</sub> alkyl sulfate in their diet (approximately 0, 11, 113 or 1,125 mg/kg-day) for two years. The findings in both studies were very similar. The survival rate in the high-dose animals for both studies was about 70%. There were no increased incidence of tumours that were considered treatment-related (OECD, 2007; ECHA). [Kl. score = 2]

No inhalation or dermal studies were located.

## **H. Reproductive Toxicity**

In a dominant lethal study, male Swiss albino mice were fed either 1 % sodium dodecyl sulfate for 2 weeks or with 0.1 % sodium dodecyl sulfate for 6 weeks. Body weights were significantly decreased at the 1% dose level, while the treatment caused no adverse effects on fertility (*i.e.*, impairment of epididymal spermatozoa) (OECD, 2007; ECHA) [Kl. score = 4]. In the 13-week oral toxicity study with sodium C<sub>12-15</sub> alkyl sulfates (CAS No. 68890-70-0), there were no indications of adverse effects on the reproductive organs (OECD, 2007).

## **I. Developmental Toxicity**

Pregnant female rats were dosed by oral gavage with 0, 0.2, 2, 300 or 600 mg/kg sodium dodecyl sulfate during gestational days 6-15. Mortality (3/20 dams) occurred at 600 mg/kg. There was slight to moderate maternal toxicity at >300 mg/kg. No developmental toxicity was noted at any dose level. The maternal and developmental NOAELs were 2 and 600 mg/kg-day, respectively (Palmer et al., 1975).

Pregnant female mice were dosed by oral gavage with 0, 0.2, 2, 300 or 600 mg/kg sodium dodecyl sulfate during gestational days 6-15. There were 4/20 maternal deaths at 600 mg/kg, and 1/20 maternal deaths at 300 mg/kg. At 600 mg/kg, there was total resorption and/or increased incidence of litter loss. At <300 mg/kg, there were no adverse effects on fetal morphogenesis. The maternal and developmental NOAELs were 2 and 300 mg/kg-day, respectively (Palmer et al., 1975).

Pregnant female rabbits were dosed by oral gavage with 0, 0.2, 2, 300 or 600 mg/kg sodium dodecyl sulfate during gestational days 6-18. There were 11/13 maternal deaths at 600 mg/kg, and 1/13 maternal deaths at 300 mg/kg. Maternal toxicity at 300 mg/kg included diarrhea, anorexia, weight loss, cachexia, and fetal loss. Developmental effects were seen at 600 mg/kg and included abortion, total resorption and/or increased incidence of litter loss. At 300 mg/kg, there were no adverse effects on fetal morphogenesis. The maternal and developmental NOAELs were 2 and 300 mg/kg/day, respectively (Palmer et al., 1975).

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

The toxicological reference values developed for sodium dodecyl sulfate 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).

## A. Non-Cancer

### Oral

Two chronic rat dietary studies were conducted on sodium C<sub>12-15</sub> alkyl sulfate, an alkyl sulfate that overlaps in chain length with sodium dodecyl sulfate (OECD, 2007; ECHA). The findings in both studies were very similar. The LOAEL for these two studies was 1,125 mg/kg-day based on liver effects. The NOAELs are 113 mg/kg-day.

The NOAEL of 113 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

UF<sub>A</sub> (interspecies variability) = 10

UF<sub>H</sub> (intraspecies variability) = 10

UF<sub>L</sub> (LOAEL to NOAEL) = 1

UF<sub>Sub</sub> (subchronic to chronic) = 1

UF<sub>D</sub> (database uncertainty) = 1

$$\text{Oral RfD} = 113 / (10 \times 10 \times 1 \times 1 \times 1) = 113 / 100 = \underline{1 \text{ mg/kg-day}}$$

### 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)

$$\text{Drinking water guidance value} = (1 \times 70 \times 0.1) / 2 = \underline{3.5 \text{ mg/L}}$$

## B. Cancer

Alkyl sulfates (sodium C<sub>12-15</sub> alkyl sulfate) with overlapping chain length with sodium dodecyl sulfate were not carcinogenic to rats in chronic dietary studies. Thus, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium dodecyl sulfate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability

- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Sodium dodecyl sulfate is of moderate concern for toxicity to aquatic organisms.

### B. Aquatic Toxicity

#### Acute Studies

Table 4 lists the results of acute aquatic toxicity studies conducted on sodium dodecyl sulfate.

**Table 4: Acute Aquatic Toxicity Studies on Sodium Dodecyl Sulfate**

Test Species	Endpoint	Results (mg/L)	Klimsich score	Reference
<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	29	1	ECHA
<i>Pimephales promelas</i>	96-hr LC <sub>50</sub>	31.9	2	ECHA
<i>Oryzias latipes</i>	96-hr LC <sub>50</sub>	12.5	2	ECHA
<i>Ceriodaphnia dubia</i>	48-hr EC <sub>50</sub>	5.55	2	ECHA
<i>Desmodesmus subspicatus</i>	72-hr EC <sub>50</sub> NOEC	>120 (growth) 53 (biomass) 30	1	OECD, 2007; ECHA
<i>Pseudokirchneriella subcapitata</i>	96-hr EC <sub>50</sub> EC <sub>10</sub>	117 (growth rate) 12	2	OECD, 2007; ECHA

#### Chronic Studies

The chronic aquatic toxicity studies conducted on sodium dodecyl sulfate are listed in Table 5.

**Table 5: Chronic Aquatic Toxicity Studies on Sodium Dodecyl Sulfate**

Test Species	Endpoint	Results (mg/L)	Klimsich score	Reference
<i>Pimephales promelas</i>	42-d NOEC	>1.36	2	OECD 2007; Belanger et al., 1995
<i>Ceriodaphnia dubia</i>	7-d NOEC	0.88	2	OECD 2007; Dyer et al., 1997

### C. Terrestrial Toxicity

No studies were located.

### D. Calculation of PNEC

The PNEC calculations for sodium dodecyl sulfate follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (12.5 mg/L), *Daphnia* (5.56 mg/L), and algae (53 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 0.88 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 long-term NOEC of 0.88 mg/L for invertebrates. The PNEC<sub>water</sub> is 0.09 mg/L.

### PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the PNEC<sub>sed</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>sed</sub> is 0.48 mg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{sed}} &= (\text{K}_{\text{sed-water}}/\text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (6.87/1280) \times 1000 \times 0.09 \\ &= 0.48 \end{aligned}$$

Where:

$\text{K}_{\text{sed-water}}$  = suspended matter-water partition coefficient (m<sup>3</sup>/m<sup>3</sup>)

$\text{BD}_{\text{sed}}$  = bulk density of sediment (kg/m<sup>3</sup>) = 1,280 [default]

$$\begin{aligned} \text{K}_{\text{sed-water}} &= 0.8 + [(0.2 \times \text{Kp}_{\text{sed}})/1000 \times \text{BD}_{\text{solid}}] \\ &= 0.8 + [(0.2 \times 12.64)/1000 \times 2400] \\ &= 6.87 \end{aligned}$$

Where:

$\text{Kp}_{\text{sed}}$  = solid-water partition coefficient (L/kg).

$\text{BD}_{\text{solid}}$  = bulk density of the solid phase (kg/m<sup>3</sup>) = 2,400 [default]

$$\begin{aligned} \text{Kp}_{\text{sed}} &= \text{K}_{\text{oc}} \times f_{\text{oc}} \\ &= 316 \times 0.04 \\ &= 12.64 \end{aligned}$$

Where:

$\text{K}_{\text{oc}}$  = organic carbon normalized distribution coefficient (L/kg). The  $\text{K}_{\text{oc}}$  for sodium dodecyl sulfate is 316 ( the lower range of 316 – 446).

$f_{\text{oc}}$  = fraction of organic carbon in sediment = 0.04 [default].

### PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the PNEC<sub>soil</sub> was calculated using the equilibrium partitioning method. The PNEC<sub>soil</sub> is 0.38 mg/kg soil dry weight.

The calculations are as follows:

$$\begin{aligned} \text{PNEC}_{\text{soil}} &= (\text{Kp}_{\text{soil}}/\text{BD}_{\text{soil}}) \times 1000 \times \text{PNEC}_{\text{water}} \\ &= (6.32/1500) \times 1000 \times 0.09 \\ &= 0.38 \end{aligned}$$

Where:

$K_{p_{soil}}$  = soil-water partition coefficient ( $m^3/m^3$ )

$BD_{soil}$  = bulk density of soil ( $kg/m^3$ ) = 1,500 [default]

$$\begin{aligned} K_{p_{soil}} &= K_{oc} \times f_{oc} \\ &= 316 \times 0.02 \\ &= 6.32 \end{aligned}$$

Where:

$K_{oc}$  = organic carbon normalised distribution coefficient (L/kg). The  $K_{oc}$  for sodium dodecyl sulfate is 316 ( the lower range of 316 – 446).

$F_{oc}$  = fraction of organic carbon in soil = 0.02 [default].

## VIII. PBT ASSESSMENT

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).

Sodium dodecyl sulfate is readily biodegradable and thus does not meet the screening criteria for persistence.

The experimental BCFs in freshwater fish are in the range of 1.5 to 5.3. Thus, sodium dodecyl sulfate does not meet the criteria for bioaccumulation.

The lowest NOEC from a chronic invertebrate toxicity study is 0.88 mg/L. This value is >0.01 mg/L; thus, sodium dodecyl sulfate does not meet the screening criteria for toxicity.

The overall conclusion is that sodium dodecyl sulfate is not a PBT substance.

## IX. CLASSIFICATION AND LABELING (AUSTRALIA GHS)

### A. Classification

- Flammable Solid Category 1\*
- Acute Toxicity Category 4 [Oral]
- Skin Irritant Category 2
- Eye Damage Category 1
- STOT SE Category 3 [Respiratory Irritation]
- Aquatic Acute Category 2
- Aquatic Chronic Category 3

The aquatic toxicity classification is not required for Australia GHS.

Note that are concentration limits for classification of eye irritation:

- $\geq 10\%$  to  $< 20\%$ : Eye irritant Category 2
- $\geq 20\%$ : Eye Damage Category 1

\*Does not apply if sodium dodecyl sulfate is in granular form.

### B. Labelling

Danger

## C. Pictogram

### Powder



### Granular form



## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

#### Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention.

#### Inhalation

Move person to fresh air. Get medical attention if the patient shows signs of adverse health effects.

#### Ingestion

Do not induce vomiting. Rinse mouth and lips with plenty of water if a person is conscious. Get medical attention immediately.

#### Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray or fog, dry powder, foam.

### Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, sulfur oxides. This product is combustible.

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical protective clothing.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing.

### Environmental Precautions

Do not discharge into drains, surface waters, or groundwater.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

The product is capable of dust explosion. Avoid dust formation. Prevent electrostatic charge: sources of ignition should be kept well clear, and fire extinguishers should be kept handy. Use explosion-proof apparatus and fittings.

### Storage

Keep only in the original container. Keep container tightly sealed. Suitable materials for containers: low-density polyethylene (LDPE), high-density polyethylene (HDPE), paper. Keep away from oxidising agents, bases, and strong acids. Store at temperatures below 30°C.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia does not have an occupational exposure standard for sodium dodecyl sulfate.

### Engineering Controls

Local exhaust ventilation is preferred.

## Personal Protection Equipment

*Respiratory Protection:* Breathing protection if dust is formed. Wear a respirator as necessary.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Wear safety goggles (chemical goggles) if there is potential for airborne dust exposures.

*Other Precautions:* Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

## **F. TRANSPORT INFORMATION**

Australia Dangerous Goods

UN Number 1325, FLAMMABLE SOLID, ORGANIC, N.O.S. (sodium dodecyl sulfate)

Class 4.1

Packing Group III

This label may not apply if sodium dodecyl sulfate is in granular form.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

BASF (2012). GPS Safety Summary: Sodium dodecyl sulfate. Available at: <http://www.safety-summaries.basf.com/group/corporate/safety-summaries/de/literature-document:/GPS+Safety+Summaries--Sodium+dodecyl+sulfate-English.pdf>

Basketter, D.A., Scholes, E.W., and Kimber, I. (1994). The performance of the local lymph node assay with chemicals identified as contact allergens in the human maximisation test. Food Chem. Toxicol. 32: 543-547.

Basketter, D.A., York, M., McFadden, J.P. and Robinson, M.K. (2004). Determination of skin irritation potential in the human 4-h patch test. Contact Derm. 51: 1-4.



- Belanger, S.E., Rupe, K.L., and Bausch, R.G. (1995). Responses of invertebrates and fish to alkyl sulfate and alkyl thoxylate sulfate anionic surfactants during chronic exposure. *Bull. Environ. Contam. Toxicol.* 55: 751-758.
- 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.
- Dyer, S.D., Lauth, J.R., Morrall, S.W., Herzog, R.R., and Cherry, D.S. (1997). Development of a chronic toxicity structure-activity relationship for alkyl sulfates. *Environ. Toxicol. Water Qual.* 12: 295-303.
- ECHA. ECHA REACH database: <http://echa.europa.eu/information-on-chemicals/registered-substances>
- enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency [ECHA] (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Fischer, W.K., and Gerike, P. (1975). Biodegradability determinations via unspecific analyses (Chemical Oxygen Demand, Dissolved Organic Carbon) in coupled units of the OECD Confirmatory Test - II- Results. *Water Res.* 9: 1137-1141.
- Ikarashi, Y., Tsuchiya, T., and Nakamura, A. (1993). A sensitive mouse lymph node assay with two application phases for detection of contact allergens. *Arch. Toxicol.* 67: 629-636.
- 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.
- Marchesi, J.R., House, W.A., White, G.F., Russell, N.J., and Farr, I.S. (1991). A comparative study of the adsorption of linear alkyl sulfates and alkylbenzene sulfonates on river sediments. *Coll. Surfaces A.* 53: 63-78.
- Montelius, J., Wahlkvist, H., Boman, A., Fernstroem, P., Grabergs, L., and Wahlberg, J.E. (1994). Experience with the murine local lymph node assay: inability to discriminate between allergens and irritants. *Acta Derm. Venereol.* 74: 22-27.
- OECD (2007). Screening Information Dataset (SIDS) Initial Assessment Report for Category of Alkyl Sulfates, Alkane Sulfonates and  $\alpha$ -Olefin Sulfonates. Available at: [http://webnet.oecd.org/Hpv/UI/SIDS\\_Details.aspx?id=A6FFE5F3-0FC7-4394-8BFA-E5D50DB648FD](http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=A6FFE5F3-0FC7-4394-8BFA-E5D50DB648FD)
- Palmer, A.K., Readshaw, M.A., and Neuff, A.M. (1975). Assessment of the teratogenic potential of surfactants. Part II - AOS. *Toxicology* 3: 107-113.
- Tovell, P.W.A., Howes, D., and Newsome, C. (1975). Absorption, metabolism and excretion by goldfish of the anionic detergent sodium lauryl sulphate. *Toxicology* 4: 17-29.

- Wakabayashi, M., Kikuchi, M., Kojima, H., and Yoshida, T. (1978). Bioaccumulation profile of sodium linear alkylbenzene sulfonate and sodium alkyl sulfate in carp. *Chemosphere* 11: 917-924.
- Wakabayashi, M., Kikuchi, M., Kojima, H., and Yoshida, T. (1980). Effect of alkyl chain on the uptake, distribution, and excretion of <sup>35</sup>S-labeled alkyl sulfates in carp. *Ecotoxicol. Environ. Saf.* 4: 195-206.
- Wakabayashi, M., Kikuchi, M., Kojima, H., and Yoshida, T. (1981). The relationship between exposure concentration and bioaccumulation of surfactants. *Bull. Jpn. Soc. Sci. Fish* 47: 1383-1387.
- Walker, A.I.T., Brown, V.K.H., Ferrigan, L.W., Pickering, R.G., and Williams, D.A. (1967). Toxicity of sodium lauryl sulphate, sodium lauryl ethoxysulphate and corresponding surfactants derived from synthetic alcohols. *Food Cosmet. Toxicol.* 5: 763-769.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration

ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## SODIUM HYPOCHLORITE

This dossier on sodium hypochlorite does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium hypochlorite in its use in water treatment systems. 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Sodium hypochlorite

**CAS RN:** 7681-52-9

**Molecular formula:** NaClO

**Molecular weight:** 74.44

**Synonyms:** Sodium hypochlorite; hypochlorous acid, sodium salt; bleach; chlorine bleach

**SMILES:** [O-]Cl.[Na+]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Sodium Hypochlorite**

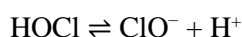
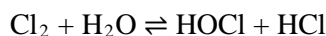
Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Yellow, limpid liquid with a chlorinated odour	1	ECHA
Melting Point	-28.9°C	1	ECHA
Boiling Point	>60.4°C (decomposition)	1	ECHA
Density	1.3 @ 21.2°C*	1	
Vapour Pressure	ca. 2.5 kPa @ 20°C	2	ECHA
Partition Coefficient (log Pow)	Not applicable	-	-
Water Solubility	Very soluble	-	ECHA
Flash Point	>111°C @ 101.3 kPa	1	ECHA
Auto flammability	-	-	-
Oxidizing properties	None	1	ECHA
pH (5% solution)	12.52 @ 19.1°C	1	ECHA
pH (1% solution)	10.30 @ 21.3°C		
Viscosity	1.4-1.6 mPa.s @ 20°C 1.4-1.6 mPa.s @ 40°C		ECHA

\*Sodium hypochlorite with 24.3% available chlorine.

In water, sodium hypochlorite (NaOCl) dissociates into the sodium (Na<sup>+</sup>) ion and the hypochlorite (ClO<sup>-</sup>) ion.

The hypochlorite ion ( $\text{ClO}^-$ ) is in equilibrium with hydrochlorous acid ( $\text{HOCl}$ ) in water and chlorine gas ( $\text{Cl}_2$ ), with the relative amounts determined by pH, temperature and ionic strength of the water. At very extremely low pH, chlorine gas ( $\text{Cl}_2$ ) is essentially un-hydrolyzed and it thus the dominant species of chlorine. Note that the term free chlorine refers to  $\text{Cl}_2$ . Between pH 2 and 7, hydrochlorous acid ( $\text{HOCl}$ ) is the dominant form; at pH 7.4 and  $20^\circ\text{C}$ , there is the equimolar contribution of  $\text{HOCl}$  and  $\text{ClO}^-$ .

The chemical reactions are as follows:



Free chlorine reacts with ammonia and certain nitrogen compounds to form N-chlorinated compounds. With ammonia, chlorine forms chloramines (monochloramine, dichloramine, and nitrogen chloride or trichloramine (APHA, 2012). These compounds constitute what is termed combined chlorine. These compounds are more persistent than the free chlorine. Monochloramine contributes significantly to the combined available chlorine in the water. N-chloramines are intentionally produced in water treatment to extend the effectiveness of chlorination.

Free chlorine and combined chlorine may be present simultaneously in a water sample. The term total chlorine or total residual chlorine (TRC) refers to the sum of free chlorine and combined chlorine that is present in a water sample.

### III. ENVIRONMENTAL FATE PROPERTIES

Sodium hypochlorite ( $\text{NaOCl}$ ) dissociates into the sodium ( $\text{Na}^+$ ) ion and the hypochlorite ( $\text{ClO}^-$ ) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride (OxyChem 2014). Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative.

### IV. HUMAN HEALTH HAZARD ASSESSMENT

#### A. Summary

Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes, and gastrointestinal tract, depending on the concentration. Inhalation of vapours for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitizer. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some *in vitro* genotoxicity studies, the *in vivo* studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant.

#### B. Acute Toxicity

The oral  $\text{LD}_{50}$  of a sodium hypochlorite solution (12.2% active chlorine) in rats was 8,830 mg/kg, which was calculated to be 1,100 mg/kg based on average  $\text{Cl}_2$  (ECHA) [Kl. score = 2]. The oral  $\text{LD}_{50}$  of undiluted sodium hypochlorite in rats was 8,910 mg/kg (ECHA [Kl. score = 2]). The oral  $\text{LD}_{50}$  of sodium hypochlorite (given as a 12.5% solution) was 5,230 mg/kg.

The dermal  $\text{LD}_{50}$  in rabbits is  $>20,000$  mg/kg (ECHA). [Kl. score = 2]

The 1-hour  $\text{LC}_{50}$  in rats is  $>10.5$  mg/L (ECHA). [Kl. score = 2]

## C. Irritation

A 12.5% solution of sodium hypochlorite was irritating to the skin of rabbits when 0.5 ml was applied for 24 hours under semi-occlusive conditions. The mean of the 24 and 72 hours scores were: 2.16 for erythema and 1.04 for edema (ECHA) [Kl. score = 2]. Application of 0.1 ml of sodium hypochlorite (5.25% solution) to the intact skin of rabbits for 24 hours under semi-occlusive conditions was slightly irritating but not sufficient for classification as an irritant. The 24 and 72-hour mean scores were: 1.17 for erythema and 0.13 for edema (ECHA) [Kl. score = 2]. In another study, application of sodium hypochlorite (5.25% solution) to the intact skin of rabbits and guinea pigs was slightly irritating (ECHA) [Kl. score = 2].

Instillation of 0.1 g of sodium hypochlorite into the eyes of rabbits was irritating without full recovery after 7 days (ECHA) [Kl. score = 2].

## D. Sensitization

Sodium hypochlorite was not a skin sensitizer in guinea pig maximisation tests (ECHA). [Kl. score = 2]

## E. Repeated Dose Toxicity

### Oral

Male and female F344/N rats were given in their drinking water 0, 0.025, 0.05, 0.1, 0.2 0.4% sodium hypochlorite solution for 90 days. The concentrations correspond to daily intakes of: 0, 12.5, 25, 50, 100, 200 mg/kg-day for males and 14.3, 28.6, 57.2, 114.4, 228.8 mg/kg-day for females, assuming a daily water consumption of 25 ml and mean body weights of 0.5 for males and 0.35 g for females). There were deaths during the study. Body weight gain was significantly reduced in the  $\geq 0.2\%$  males and 0.4% females. There were no treatment-related changes noted at necropsy, although several animals, particularly in the 0.4% group, appeared emaciated. Absolute weights of the lung, liver and spleen of males and the salivary gland, lung, heart and brain of females were significantly lower in the 0.4% groups compared to controls. Biochemical changes in the  $\geq 0.2\%$  groups indicated possible liver toxicity, but there were no corresponding histopathological changes in the liver; nor was there any other treatment-related histopathological changes. The NOAEL for this study is 0.1% in drinking water (50 and 57 mg/kg-day for males and females, respectively) (Hasewaga et al., 1986; ECHA). [Kl. score = 1]

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm for males and 0, 1,000, and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25, and 50 mg/kg-day for males; and 0, 57, and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 ml). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of treated females) were significantly decreased. The NOAELs are 50 and 114 mg/kg-day for males and females, respectively (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of

treated females) were significantly decreased. The NOAELs are 167 and 200 mg/kg-day for males and females (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 3.5, 7, 13.75 mg/kg/day for males and 0, 4, 8, 15.7 mg/kg/day for females assuming a body weight of 0.5 and 0.35 g and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end of the studies. There were no treatment-related lesions in rats at the 14-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NO(A)EL > 275 ppm (13.75 mg/kg/day for males and 15.7 mg/kg/day for females) (NTP, 1992).

Male and female B6C3F<sub>1</sub> mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 11.7, 23.3, 45.8 mg/kg/day for males and 0, 14, 28, 55 mg/kg/day for females assuming a body weight of 30 and 25 g and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice are aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and their respective controls. There were no treatment-related lesions in mice at the 15-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NOAEL was >275 ppm (45.8 mg/kg/day for males and 55 mg/kg/day for females) (NTP, 1992).

### Inhalation

No studies were located.

### Dermal

No studies were located.

## F. Genotoxicity

### In Vitro Studies

The *in vitro* genotoxicity studies conducted on sodium hypochlorite are summarised in Table 2.

**Table 2: *In vitro* Genotoxicity Studies on Sodium Hypochlorite**

Test System	Results <sup>a</sup>		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> TA98, TA100)	-	+ (TA100 only)	2	ECHA
Bacterial reverse mutation ( <i>S. typhimurium</i> TA98, TA100, TA102)	-	NC	1	ECHA
Bacterial reverse mutation ( <i>S. typhimurium</i> TA98, TA100, TA1535, TA1537)	-	+ (TA 100 only)	1	ECHA
Chromosomal aberration (Chinese Hamster Lung cells)	<sup>b</sup>	+	2	ECHA
Chromosomal aberration (human HE2144 fibroblasts)	Ambiguous	NC	2	ECHA
<i>E. coli</i> PQ37 – SOS Chromotest [DNA repair]	-	-	2	ECHA
<i>S. cerevisiae</i> gene mutation assay	+	-	2	ECHA
Comet assay (human lymphocytes)	+	NC	2	ECHA

<sup>a</sup>+, positive; -, negative; NC, not conducted.

<sup>b</sup>No results since all concentrations were cytotoxic.

### In Vivo Studies

The *in vivo* studies conducted on sodium hypochlorite are presented below in Table 3. Sodium hypochlorite was not mutagenic or genotoxic.

**Table 3: *In Vivo* Genotoxicity Studies on Sodium Hypochlorite**

Test System	Results*	Klimisch Score	Reference
Mouse bone marrow micronucleus (intraperitoneal, 1 or 4 consecutive days)	-	1	ECHA
Mouse bone marrow micronucleus (oral gavage, 1 or 5 consecutive days)	-	2	ECHA
Mouse bone marrow chromosomal aberration (oral gavage, 1 or 5 consecutive days)	-	2	ECHA
Rat liver and kidney 8-hydroguanosine [DNA adduct] levels (oral, single dose)	-	2	ECHA
Mouse sperm head morphology	Ambiguous	2	ECHA

\*+, positive; -, negative



## G. Carcinogenicity

### Oral

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm for males and 0, 1,000, and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25, and 50 mg/kg-day for males; and 0, 57, and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 ml). Survival was similar across all groups. Water consumption was comparable across all groups. There was no evidence of carcinogenicity in the treated animals (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. There was no evidence of carcinogenicity in the treated mice (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 3.5, 7, 13.75 mg/kg/day for males and 0, 4, 8, 15.7 mg/kg/day for females assuming a body weight of 500 and 350 g and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end of the studies. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in F344/N rats receiving 70, 140, or 275 ppm (NTP, 1992).

Male and female B6C3F<sub>1</sub> mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 11.7, 23.3, 45.8 mg/kg/day for males and 0, 14, 28, 55 mg/kg-day for females assuming a body weight of 30 and 25 g and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice are aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and their respective controls. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Sporadically renal neoplasms occurred in the low and high-dose males. This is an unusual finding in mice. Therefore, additional step sections of the kidney were prepared which revealed further incidences of

renal hyperplasia in all groups including control and a carcinoma in the low dose group. Nearly all the additional neoplasms seen in the step sections were small (microscopic) adenomas believed to be the probable precursor of renal tubule carcinoma. Since no additional renal neoplasms were found in the mid and high-dose groups and since focal hyperplasia, a potential pre-neoplastic lesion, was found at similar incidences in the control and dosed groups, the small number of renal tubule cell neoplasms in male mice were not considered related to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in male or female B6C3F<sub>1</sub> mice receiving 70, 140, or 275 ppm (NTP, 1992).

## **H. Reproductive Toxicity**

In a one-generation reproductive toxicity study, male and female Long-Evans rats were given in their drinking water 0, 1, 2, or 5 mg/kg-day sodium hypochlorite. Males were dosed 56 days prior to and during mating. Females were dosed 14 days prior to mating, during mating, gestation, and until lactation day 21. There were no adverse effects on reproduction or development, including histopathology of the reproductive organs in males and females, sperm parameters in males, and histopathologic effects in the non-reproductive organs in females. The NOAEL for reproductive and developmental toxicity is 5 mg/kg-day (Carlton et al., 1986; ECHA). [Kl. score = 2]

## **I. Developmental Toxicity**

Female SD rats were given in their drinking water 0, 1, 10, or 100 mg/L sodium hypochlorite for 2.5 months prior to mating and throughout gestation. Maternal toxicity was not examined. There were no treatment-related effects on viability, fetal weights, and external appearances of the fetuses in all dose groups. The fetuses of the  $\geq 10$  mg/L groups had a non-statistically significantly higher percentage of skeletal defects compared to controls. The 100 mg/L group also had a non-statistically significantly higher rate of soft-tissue defects. These defects consisted of three cases of adrenal agenesis, one right-sided heart, one case of improper orientation of the apex of the heart, and one atrio-ventricular valve enlargement. The 100 mg/L group had a statistically significantly higher number of total defects; whereas the 1 mg/L dose had a lower percentage of defects compared to controls. In the absence of a clear dose-response and a relatively higher incidence of defects in the control animals, these findings were not considered to be of toxicological relevance. The NOAEL for developmental toxicity in this study was considered to be 100 mg/L, corresponding to 50 mg/kg-day (Abdel-Rahmen et al., 1982; ECHA). [Kl. score = 2]

## **V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES**

### **A. Non-Cancer**

An oral toxicological reference value was not derived for sodium hypochlorite.

The Australian drinking water guideline values for chlorine are 5 mg/L (health) and 0.6 mg/L (aesthetics).

### **B. Cancer**

Sodium hypochlorite was not carcinogenic to rats or mice in chronic drinking water studies; thus, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium hypochlorite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.

### B. Aquatic Toxicity

A number of studies that have been conducted on the toxicity of sodium hypochlorite (or calcium hypochlorite) of aquatic organisms. A comprehensive summary of these studies is beyond the scope of this dossier.

In developing a water quality guideline for chlorine, ANZECC reviewed the literature on the effects of the following chemicals: chlorine gas ( $\text{Cl}_2$ ) bubbled in water, sodium hypochlorite or hypochlorous acid; and ammonium sulfate or chloride and  $\text{NaOCl}$  at various combinations (molar ratios, pH values) to form monochloramine or dichloramine (ANZECC 2000). The summary of the data measured as total residual chlorine ( $\mu\text{g Cl/L}$ ) for freshwater fish and invertebrates is as follows:

#### Freshwater fish

The 24-96 hour  $\text{LC}_{50}$  values for seven species were 70- 840  $\mu\text{g/L}$ . Two of the values for *O. mykiss* were 14 and 29  $\mu\text{g/L}$  (Basch et al., 1971).

#### Freshwater crustaceans

The 24-48  $\text{LC}_{50}$  values for three species of cladocerans were 12-16  $\mu\text{g/L}$ . Two of the 48-hour  $\text{LC}_{50}$  values were 5 and 6  $\mu\text{g/L}$ , measured under a continuous flow of test solution (Taylor, 1993).

The chronic NOEC from a 10-day *C. dubia* immobilisation study was 48  $\mu\text{g/L}$ . In another chronic test, the NOEC of a 10-day *C. dubia* reproductive impairment test was 48  $\mu\text{g/L}$  (Manning et al., 1996).

#### Freshwater Mollusc

The 24-48 hour  $\text{LC}_{50}$  values in one *Nitocris* species was 7,700 to 15,600  $\mu\text{g/L}$ . The chronic 168-hour  $\text{LC}_{50}$  value for a periphyton was 32  $\mu\text{g/L}$ .

#### Other species

The 24-48  $\text{LC}_{50}$  values for the freshwater annelid *Aelosoma headleyi* were 1,680 to 3,200  $\mu\text{g/L}$ . The 24-48 hour  $\text{LC}_{50}$  values for three species of insects were 710 to 1,350  $\mu\text{g/L}$ . The 48-hour  $\text{LC}_{50}$  values for the freshwater rotifer *Philodina acuticornis* was 50 to 100  $\mu\text{g/L}$ .

## C. Terrestrial Toxicity

The acute oral LD<sub>50</sub> value of sodium hypochlorite (12.5% solution) to bobwhite quail is >2,510 mg/kg (ECHA). [Kl. score = 2]

The 8-day oral LC<sub>50</sub> value of sodium hypochlorite (12.5% solution) to bobwhite quail and mallard duck is >5,620 ppm (ECHA). [Kl. score = 2]

## D. Calculation of PNEC

### PNEC water

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of a trigger value for chlorine. The guideline for freshwater is: “A freshwater moderate trigger value of 3 µg Cl/L measured as total residual chlorine was derived using the statistical distribution method with 95% protection. This figure was obtained from the application of the default ACR of 10 instead of the empirical ACR of 2.7 from the geometric mean of 8 figures. The smaller ACR would have resulted in a value not protective of some species under continuous exposure to chlorine for at least 48 hours”.

### PNEC sediment

No experimental toxicity data on sediment organisms are available. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of sodium hypochlorite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of sodium hypochlorite is dominated by its water solubility. Sorption of sodium hypochlorite should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K<sub>oc</sub> and K<sub>ow</sub> parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning methods cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, sodium hypochlorite is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Sodium hypochlorite is an inorganic salt that dissociates completely in water to sodium (Na<sup>+</sup>) and hypochlorite (ClO<sup>-</sup>) ions. Biodegradation is not applicable to these inorganic ions; For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

As an inorganic salt, neither sodium hypochlorite nor its dissociated ions are expected to accumulate. Thus, sodium hypochlorite does not meet the criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies is <0.1 mg/L in invertebrates. Thus, sodium hypochlorite meets the criteria for toxicity.

The overall conclusion is that sodium hypochlorite is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

For sodium hypochlorite solutions that are <20%:

- Corrosive to Metals Category 1
- Skin Corrosion Category 1B
- Eye Damage Category 1
- Acute Aquatic Category 1
- Chronic Aquatic Category 2

In addition to the hazard statements corresponding to the GHS classifications, the following non-GHS hazard statement is to be added to the SDS: AUH031: Contact with acids liberates toxic gas.

The aquatic toxicity classification is not required for Australia GHS.

### B. Labelling

Dangerous

### C. Pictogram



## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

#### Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention immediately.

#### Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if the victim is not breathing. Get medical attention immediately.

### Ingestion

Do not induce vomiting. Rinse mouth and lips with plenty of water if a person is conscious. Do not use mouth-to-mouth method if the victim had ingested the substance. Get medical attention immediately.

### Notes to Physician

Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Use dry chemical, carbon dioxide, water spray or fog, or foam.

### Specific Exposure Hazards

Containers may explode when heated. Emits toxic fumes under fire conditions. Contact with metals may evolve flammable hydrogen gas. Depending on conditions, decomposition products may include the following: metal oxide/oxides, chlorine, hydrogen chloride, oxygen.

### Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if it can be done without risk.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Ventilate enclosed areas. Do not walk through spilt material. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breathe mist, vapours, or spray. Do not get in eyes, on skin, or on clothing.

### Environmental Precautions

Prevent entry into waterways, sewers, basements or confined areas.

### Steps to be Taken if Material is Released or Spilt

As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorised personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

Stop leak if it can be done without risk. Absorb or cover with dry earth, sand, or other non-combustible material and transfer to containers. Dike to collect large liquid spills.

## **D. STORAGE AND HANDLING**

### General Handling

Handle and open container with care. Use only with adequate ventilation. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent the release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breathe mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

### Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep from direct sunlight. Aqueous solutions of sodium hypochlorite will slowly evolve oxygen. Store in vented containers. Store only in non-metallic containers. Keep away from acids. Do not store above 55°C.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium hypochlorite.

### Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

### Personal Protection Equipment

*Respiratory Protection:* If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much is based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

*Hand Protection:* Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

*Eye Protection:* Wear chemical splash goggles and face shield.

*Other Precautions:* Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.



## **F. TRANSPORT INFORMATION**

### Australian Dangerous Goods

UN1791, Hypochlorite Solution (Sodium Hypochlorite)

Class 8

Packing Group: III

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

Abdel-Rahmen, M.S., Beradi, M.R., and Bull, R.J. (1982). Effect of chlorine and monochloramine in drinking water on the developing rat fetus. *J. App. Toxicol.* 2: 156-159.

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

ANZECC & ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

Basch, R.E., Newton, M.E., Truchan, J.C., and Fetterolf, C.M. (1971). Chlorinated municipal waste toxicities to rainbow trout and fathead minnows. EPA 18050-GZZ-10/71, Water Pollution Control Research Series, U.S. EPA (US NTIS PB-209890); cited in ANZECC (2000).

Carlton, B.D., Barlett, P., Basaran, A., Colling, K., Osis, I., and Smith, M.K. (1986). Reproductive effects of alternative disinfectants. *Environ. Health Perspect.* 69: 237-241.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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



- Hasegawa, R., Takahasi, M., Kokubo, T., Furukawa, F., Toyoda, K., Sato, H., Kurokawa, Y., and Hayashi, Y. (1986). Carcinogenicity study of sodium hypochlorite in F344 rats. Food Chem. Toxicol. 24: 1295-1302.
- 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.
- Kurokawa, Y., Takayama, S., Konishi, Y., Hiasa, Y., Asahina, S., Takahashi, M., Maekawa, A., and Hayashi, Y. (1986). Long-term in vivo carcinogenicity tests of potassium bromate, sodium hypochlorite, and sodium chlorite conducted in Japan. Environ. Health Perspect. 69: 221-235.
- Manning, T.M., Wilson, S.P., and Chapman, J.C. (1996). Toxicity of chlorine and other chlorinated compounds to some Australian aquatic organisms. Bull. Environ. Contam. Toxicol. 56: 971-976; cited in ANZECC (2000).
- National Toxicology Program [NTP] (1992). Toxicology and Carcinogenesis Studies of Chlorinated Water (CAS Nos. 7782-50-5 and 7681-52-9) and chlorinated water (CAS No. 10599-90-3) (Deionized and Charcoal-Filtered) in F344/N rats and B6C3F<sub>1</sub> Mice (Drinking Water Studies). National Toxicology Program Technical Report Series No. 392, U.S. Department of Health and Human Services, Public Health Services, National Institutes of Health.
- OxyChem (2014). Oxychem Sodium Hypochlorite Handbook. Available at: <http://www.oxy.com/OurBusinesses/Chemicals/Products/Documents/sodiumhypochlorite/bleach.pdf>
- Taylor, P.A. (1993). An evaluation of the toxicity of various forms of chlorine to *Ceriodaphnia dubia*. Environ. Toxicol. Chem. 12: 925-930; cited in ANZECC (2000).

#### XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre

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MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## SODIUM METABISULFITE

This dossier on sodium metabisulfite does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium metabisulfite in water treatment systems. The information presented in this dossier was obtained mainly 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).

### I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Disodium disulphite

CAS RN: 7681-57-4

Molecular formula:  $\text{Na}_2\text{S}_2\text{O}_5$

Molecular weight: 190.1

Synonyms: Sodium metabisulfite, sodium pyrosulfite; sodium disulfite; disodium disulphite; sodium metabisulphite;

SMILES: [O-]S(=O)S(=O)(=O)[O-].[Na+].[Na+]

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Sodium Metabisulfite**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline, solid	2	ECHA
Melting Point	>150°C	2	ECHA
Boiling Point	-	-	-
Density	2.6 g/cm <sup>3</sup>	2	ECHA
Vapor Pressure	Not applicable	-	-
Partition Coefficient (log P <sub>ow</sub> )	Not applicable	-	-
Water Solubility	Very soluble	2	ECHA
Flammability	-	-	-
Explosive	Not explosive	1	ECHA

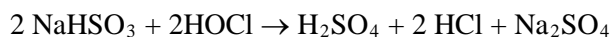
### III. ENVIRONMENTAL FATE PROPERTIES

Sodium metabisulfite dissociates in water to form sodium ( $\text{Na}^+$ ) ions, disulfite ( $\text{S}_2\text{O}_5^{2-}$ ) ions, and sulfur dioxide ( $\text{SO}_2$ ). The disulfite ions can form bisulfite ( $\text{HSO}_3^-$ ) and sulfite ions ( $\text{SO}_3^{2-}$ ) in varying proportions dependent on the pH of the solution (OECD, 2001).

Sodium metabisulfite is commonly used for removal of free chlorine. When dissolved in water, sodium bisulfite is formed from sodium metabisulfite:



Then reduces hypochlorous acid according to:



Biodegradation is not applicable to sodium metabisulfite. As an inorganic compound that dissociates in aqueous solutions, sodium metabisulfite is not expected to bioaccumulate.

#### IV. HUMAN HEALTH HAZARD ASSESSMENT

##### A. Summary

Sodium metabisulfite exhibits low-to-moderate acute toxicity by the oral route. It is not irritating to the skin, but severely irritating to the eyes. Sodium metabisulfite is not a skin sensitizer. No systemic toxicity was seen in rats when given sodium metabisulfite in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localised irritation from the ingestion of sodium metabisulfite. Genetic toxicity studies were equivocal *in vitro* but were negative *in vivo*. Lifetime oral feeding studies in rats and mice showed no evidence of carcinogenicity. No reproductive or developmental toxicity was observed in any of the animal studies.

##### B. Acute Toxicity

The oral LD<sub>50</sub> values in rats are 1,420 mg/kg (males), 1,630 mg/kg (females), and 1,540 mg/kg (combined sexes) (ECHA). [Kl. score = 2].

No acute inhalation or dermal toxicity studies were located for sodium metabisulfite.

##### C. Irritation

Application of 0.5 mL of sodium metabisulfite to the skin of rabbits for 4 hours under semi-occlusive conditions was non-irritating (ECHA). [Kl. score = 2]

Instillation of 0.1 mL of sodium metabisulfite into the eyes of rabbits produced severe irritation. The mean of the 24, 48, and 72 hours scores are as follows: 2.0 for conjunctival redness; 2.1 for conjunctival chemosis; 0.6 for corneal lesions; and 0.2 for iridial lesions. At day 8, corneal lesions conjunctival redness, and chemosis persisted in 2/3 animals (ECHA). [Kl. score = 2]

##### D. Sensitisation

Sodium metabisulfite was not considered a skin sensitizer in a mouse LLNA (ECHA). [K. score = 1]

##### E. Repeated Dose Toxicity

###### Oral

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of the sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14, 12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. The addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The general condition of the rats was good

during the first 72 weeks of the F<sub>0</sub> generation, as well as the other two generations. After 72 weeks, there was a rapid increase in mortality in all groups. Survival in the treated groups was higher than the controls, except for the 2% F<sub>1</sub> males; no deaths occurred in the 2% F<sub>2</sub> females. A marginal reduction in body weight gain was observed in the 2% dose group (both sexes) in the F<sub>1</sub> and F<sub>2</sub> generations. Feed consumption was similar between treated and groups. There were no changes in haematology and clinical chemistry parameters and urinalysis that were considered toxicologically significant. The  $\geq 1\%$  dietary groups had occult blood in their feces. Relative kidney weights were increased in the 2% F<sub>2</sub> females, but there were no pathological changes noted in the kidneys from this group. Hyperplastic changes in the fore- and glandular stomachs were noted in the  $\geq 1\%$  groups in all three generations. Some slight alterations were also noted in stomachs of the 0.5% F<sub>2</sub> rats. The NOAEL for systemic toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg-day based on a rat body weight of 400 g and a daily feed intake of 20 g. The histopathologic effects on the stomach and the occult blood in feces are considered to be the result of localised irritation (a site-of-contact effect) from the ingestion of sodium metabisulfite (Til et al., 1972; ECHA). [Kl. score = 2]

### Inhalation

No studies on sodium metabisulfite were located.

### Dermal

No studies on sodium metabisulfite were located.

## **F. Genotoxicity**

### In Vitro Studies

Sodium metabisulfite was not mutagenic in two bacterial reverse mutation assays with or without metabolic activation using both standard plate and preincubation methods (OECD, 2001). It also did not induce chromosomal aberrations in Chinese hamster fibroblast cells (Ishidate et al., 1984).

Positive findings, however, have been reported in other *in vitro* bacterial assays (Pagano and Zeiger, 1987; Pagano et al., 1990; De Giovanni-Donnelly, 1985). Bacterial strains that carry cytosines in the appropriate context in the putative target region of DNA are sensitive to mutation by bisulfite. It has been suggested that bisulfite causes cytosine deamination in single strand DNA. In particular, bisulfite appears to be a weak mutagen in bacteria when cytosines are found as CCC and CCCCC runs, but not in CCCC or GC runs (De Giovanni-Donnelly, 1985; Pagano and Zeiger, 1987). It has also been suggested that the SO<sub>3</sub><sup>-</sup> radical is responsible for the mutagenic activity (Pagano et al., 1990); this clearly depends on the specific test condition such as pH value. The pH range for mutagenicity is 4.4 to 5.6 (Pagano and Zeiger, 1987), although the doses were not clearly presented (OECD, 2001). If very high doses were used, the positive effects could be attributed to an impurity and no data on purity was provided. These positive *in vitro* studies referred to above could not support that the test substance is clearly genotoxic since the free radical-mediated mutagenic effects are very transient. Furthermore, such a mutagenic mechanism would not be relevant *in vivo* because autooxidation of sodium metabisulfite occurs (Renner 1983).

### In Vivo Studies

Sodium metabisulfite was not genotoxic in a bone marrow chromosomal aberration test in rats. Rats were dosed by oral gavage with 0, 30, 700, or 1,200 mg/kg sodium metabisulfite for five consecutive days (OECD, 2001; ECHA). Sodium metabisulfite did not show a mutagenic response in a rat dominant lethal assay from a single dose up to 1,200 mg/kg (OECD, 2001; ECHA).

## G. Carcinogenicity

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations (Til et al., 1972). [Kl. score = 2]

Male and female ICR/JCL mice were given in their drinking water 0, 1, or 2% potassium metabisulfite for two years. There was no increased incidence of tumours in the treated groups compared to the control (Tanaka et al., 1979). [Kl. score = 2]

No inhalation or dermal carcinogenicity studies were located.

## H. Reproductive Toxicity

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of the sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14, 12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. The addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The effects other than reproductive and developmental toxicity are discussed above in the Repeated Dose Toxicity section. There were no treatment-related effects on female fertility, the number of young per litter, or birth weight or mortality of the offspring. The number of F<sub>2a</sub> pups was significantly reduced in the ≥0.5% groups during the first breeding cycle, but there was no dose-response, and the reduction did not occur during the second breeding cycle. Slight growth retardation was observed in the F<sub>1</sub> and F<sub>2</sub> generation rats both before and after weaning. The NOAEL for reproductive toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg-day based on a rat body weight of 400 g and a daily feed intake of 20 g (Til et al., 1972; ECHA). [Kl. score = 2]

Male and female rats were given sodium metabisulfite in their drinking water for up to 2.5 years and three successive generations. The doses were 375 and 750 ppm as sulfur dioxide (SO<sub>2</sub>). There was no evidence of systemic toxicity in either dose group. The number of offspring of either the F<sub>1</sub> and F<sub>2</sub> generation and the proportion surviving to the end of lactation were similar between treated and control groups. The NOAEL for reproductive toxicity is 750 ppm (as SO<sub>2</sub>) in drinking water. Assuming an average rat body weight of 400 g and a daily water intake of 28 mL, 750 ppm (as SO<sub>2</sub>) corresponds to 53 mg/kg-day sodium metabisulfite (Lockett and Natoff, 1960; ECHA). [Kl. score = 2]

## I. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage up to 155 mg/kg-day potassium metabisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 155 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female Wistar rats were dosed by oral gavage up to 110 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 110 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage up to 125 mg/kg-day potassium metabisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 125 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female Wistar rats were fed in the diet 0, 0.32, 0.63, 1.25, 2.5, or 5% sodium sulfite (Na<sub>2</sub>SO<sub>3</sub> • 7H<sub>2</sub>O) during GD 8 to 20. Maternal body weight gain and feed consumption were reduced

in the 5% dose group. There was some evidence of reduced body weight gain in all treated groups, but there was no dose-response relationship, and these effects were not observed in the live birth component of the study. The live birth component showed no treatment-related changes in the pups at three weeks after birth. There was no evidence of teratogenicity. The NOAELs for maternal and developmental toxicity are 2.5% and 5% in the diet, respectively. The calculated daily doses are approximately 850 and 1,450 mg/kg-day, respectively (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage up to 150 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 150 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female Dutch-belted were dosed by oral gavage up to 100 mg/kg-day sodium bisulfite during GD 6-18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 100 mg/kg-day (ECHA). [Kl. score = 2]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium metabisulfite 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).

### A. Non-Cancer

#### Oral

There was no evidence of systemic toxicity in a two-year rat dietary study (Til et al., 1972), the highest dose being 2% sodium metabisulfite in the feed (estimated to be 955 mg/kg-day). The NOAEL of 955 mg/kg-day from this study will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

#### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 1

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 955 / (10 \times 10 \times 1 \times 1 \times 1) = 955 / 100 = \underline{10 \text{ mg/kg-day}}$$

#### 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 =  $(10 \times 70 \times 0.1)/2 = \underline{35 \text{ mg/L}}$

The Australian drinking water guidance value for sodium is 180 mg/L based on aesthetics (ADWG, 2011).

## B. Cancer

No carcinogenic effects were reported for sodium metabisulfite in rat and mouse chronic studies. Thus, a cancer reference value was not derived.

## VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium metabisulfite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## VII. ENVIRONMENTAL HAZARD ASSESSMENT

### A. Summary

No aquatic toxicity studies have been conducted on sodium metabisulfite. Other inorganic sulfite compounds show low-to-moderate toxicity concern to aquatic organisms.

### B. Aquatic Toxicity

#### Acute Studies

No acute aquatic studies are available on sodium metabisulfite; however, studies are available on other inorganic sulfite compounds. The studies on these inorganic sulfite compounds can be used to read-across to sodium metabisulfite since sulfite and bisulfite ions are formed in water upon dissociation of sodium metabisulfite. Table 2 lists the results of acute aquatic toxicity studies conducted on other inorganic sulfite compounds.

**Table 2: Acute Aquatic Toxicity Studies on Inorganic Sulfite Compounds**

Test Substance	Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Potassium sulfite	<i>Leuciscus idus</i>	96-hr LC <sub>50</sub>	316	2	ECHA
Sodium pyrosulfite	<i>Salmo gairdneri</i>	96-hr LC <sub>50</sub>	147-215 (177.8*)	2	ECHA
Potassium metabisulfite	<i>Brachydanio rerio</i>	96-hr LC <sub>50</sub>	464-1,000 (681.2*)	1	ECHA
Sodium disulfite	<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	88.8	2	ECHA
Sodium disulfite	<i>S. subspicatus</i>	96-hr EC <sub>50</sub> 72-hr EC <sub>10</sub>	43.9 33.3	2	ECHA



\*Geometric mean.

### Chronic Studies

No chronic studies are available on sodium metabisulfite; however, studies are available on sodium sulfite. The studies on sodium sulfite can be used to read-across to sodium metabisulfite since sulfite and bisulfite ions are formed in water upon dissociation of sodium metabisulfite. Table 3 lists the results of chronic aquatic toxicity studies conducted on sodium sulfite.

**Table 3: Chronic Aquatic Toxicity Studies on Sodium Sulfite (CAS No. 7757-83-7)**

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Danio rerio</i>	34-d NOEC	>316	1	ECHA
<i>Daphnia magna</i>	21-d NOEC	>10	2	ECHA

### **C. Terrestrial Toxicity**

No studies were located.

### **D. Calculation of PNEC**

The PNEC calculations for sodium metabisulfite follow the methodology discussed in DEWHA (2009).

#### PNEC water

No studies have been conducted on sodium metabisulfite; however, the results from studies conducted on other inorganic sulphite compounds can be used to read-across to sodium metabisulfite. Hence, experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (177.8 mg/L), *Daphnia* (88.8 mg/L), and algae (43.9 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC or EC<sub>10</sub> being 10 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 10 mg/L for invertebrates. The PNEC<sub>water</sub> is 1.0 mg/L.

#### PNEC sediment

No experimental toxicity data on sediment organisms are available. Sodium metabisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as sodium metabisulfite. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of sodium metabisulfite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

#### PNEC soil

No experimental toxicity data on soil organisms are available. Sodium metabisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as sodium metabisulfite. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, no adsorption of sodium metabisulfite to the soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Sodium metabisulfite is an inorganic compound that dissociates completely to sodium ions, bisulfite and sulfite ions, and sulfur dioxide in aqueous solutions. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to sodium metabisulfite or its dissociated compounds.

Sodium metabisulfite is an inorganic compound that dissociates completely in water to ionic compounds and gas. Thus, it is not expected to bioaccumulate.

There are no chronic aquatic toxicity data on sodium metabisulfite. Sodium metabisulfite forms both bisulfite and sulfite ions upon dissociation in water. The NOECs from chronic aquatic toxicity studies on sodium sulfite are >0.1 mg/L. Thus, sodium metabisulfite is not expected to meet the criteria for toxicity.

The overall conclusion is that sodium metabisulfite is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Acute Toxicity Category 4 [oral]  
Eye Damage Category 1

### B. Labelling

Danger

### C. Pictogram



## X. SAFETY AND HANDLING

### A. FIRST AID

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

Wash thoroughly with soap and water.

### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

When contacted by water, sodium metabisulfite releases sulfur dioxide (SO<sub>2</sub>), a poisonous gas. In the case of fire, the following may be liberated: Sulfur oxides and sulfur dioxide.

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas. When contacted by water, sodium metabisulfite releases sulfur dioxide (SO<sub>2</sub>), a poisonous gas.

### Steps to be Taken if Material is Released or Spilled

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

When sodium metabisulfite gets wet or moist, it liberates sulfur dioxide (SO<sub>2</sub>), a poisonous gas. Use proper protective equipment and exposure controls to prevent exposure to this toxic gas.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidising agents.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

The workplace exposure standard for sodium metabisulfite in Australia is 5 mg/m<sup>3</sup> as an 8-hr TWA.

### Engineering Controls

None

### Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Sodium metabisulfite is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

- de Giovanni-Donnelly, R. (1985). The mutagenicity of sodium bisulfite on based-substitution strains of *S. typhimurium*. *Teratogen. Carcinogen. Mutagen.* 5: 195-203.
- enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.
- European Chemicals Agency [ECHA] (2008). Guidance on Information Requirements and Chemical Safety Assessment, Chapter R11: PBT Assessment, European Chemicals Agency, Helsinki, Finland.
- Ishidate, M., Sofumi, T., Yoshikawa, K., Hayashi, M., Nohmi, T., Sawada, M., and Mastuoka, A. (1984). Primary mutagenicity screening of food additives currently used in Japan. *Fd. Chem. Toxicol.* 22: 623-636.
- 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.
- Lockett, M.F., and Natoff, I.L. (1960). A study of the toxicity of sulfite. 1. *J. Pharm. Pharmacol.* 12: 488-496.
- OECD (2001). OECD SIDS: Disodium disulphite (CAS No. 7657-4). UNEP Publications. Available at: <http://www.inchem.org/documents/sids/sids/DISODIUM.pdf>
- Pagano, D.A., and Zeiger, E. (1987). Condition affecting the mutagenicity of sodium bisulfite in *S. typhimurium*. *Mutat. Res.* 179: 159-166.
- Pagano, D.A., Zeiger, E., and Stack, A. (1990). Autooxidation and mutagenicity of sodium bisulfite. *Mutat. Res.* 228: 89-96.
- Renner, H.W., and Wever, J. (1983). Attempts to induce cytogenetic effects with sulphite in sulphite oxidase-deficient Chinese hamsters and mice. *Fd. Chem. Toxicol.* 21: 123-127.
- Tanaka, T., Fujii, M., Mori, H., and Hirono, I. (1979) Carcinogenicity test of potassium metabisulfite in mice. *Ecotoxicol. Environ. Safety* 3: 451-453.
- Til, H.P., Feron, V.P., de Groot, A.P. (1972). The toxicity of sulphite. I. Long-term feeding and multigeneration studies in rats. *Fd. Cosmet. Toxicol.* 10: 291-310.

#### **XIV. ACRONYMS AND GLOSSARY**

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals

HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
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OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

## PROPRIETARY MIXTURE A2

This dossier on Proprietary Mixture A2 does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Proprietary Mixture A2 in its use in water treatment. The majority of information presented in this dossier was obtained 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).

### I. SUBSTANCE IDENTIFICATION

**Chemical Name (IUPAC):** Proprietary Mixture A2

**CAS RN:** MixtureA2-CASRn

**Molecular formula:**

**Molecular weight:** 119.07

**Synonyms:** Proprietary Mixture A2

**SMILES:**

### II. PHYSICO-CHEMICAL PROPERTIES

**Table 1: Overview of the Physico-chemical Properties of Proprietary Mixture A2**

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Amorphous white solid	1	ECHA
Melting Point	243°C	1	ECHA
Boiling Point	Partial at 272°C with decomposition	1	ECHA
Density (relative)	2.08 @ 22°C	1	ECHA
Vapor Pressure	$5.8 \times 10^{-15}$ Pa @ 25°C	1	ECHA
Partition Coefficient (log $P_{ow}$ )	-3.84	1	ECHA
Water Solubility	Very soluble	1	ECHA
Auto flammability	Not below 400°C	1	ECHA

### III. ENVIRONMENTAL FATE PROPERTIES

Proprietary Mixture A2 will dissociate completely in water to sodium ( $\text{Na}^+$ ) and sulfamate ( $\text{O}_3\text{SNH}_2^-$ ) ions. Biodegradation is not applicable to Proprietary Mixture A2. As an inorganic salt, Proprietary Mixture A2 is not expected to bioaccumulate. The  $K_{oc}$  of Proprietary Mixture A2 was experimentally determined to be <17.8 (log  $K_{oc}$  is <1.25) (ECHA) [Kl. score = 1].

## **IV. HUMAN HEALTH HAZARD ASSESSMENT**

### **A. Summary**

Proprietary Mixture A2 exhibits low acute toxicity by the oral and dermal route. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day Proprietary Mixture A2 in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Proprietary Mixture A2 was inactive when evaluated in *in vitro* genotoxicity tests.

### **B. Acute Toxicity**

The oral LD<sub>50</sub> in female rats was >2,000 mg/kg; there were no deaths at this limit dose (ECHA). [Kl. score = 1]

The dermal LD<sub>50</sub> in rats was >2,000 mg/kg; there were no deaths at this limit dose (ECHA). [Kl. score = 1]

### **C. Irritation**

Application of 0.1 ml of 0.5 g of Proprietary Mixture A2 to the skin of rabbits for 4 hours under semi-occlusive conditions was mildly irritating; the primary irritation index was 0.8. Proprietary Mixture A2 was not considered an irritant according to the GHS classification. (ECHA). [Kl. score = 1]

Instillation of 0.1 ml of test substance (10% w/w aqueous solution of Proprietary Mixture A2, pH 8.1 – 8.5) into the eyes of rabbits was mildly irritating and was considered not irritating according to the GHS classification. There was moderate conjunctival redness which returned to normal at the 72-hour post-observation time point. The maximum group mean score was 10 (ECHA). [Kl. score = 1]

### **D. Sensitisation**

Proprietary Mixture A2 was not a skin sensitiser in a Magnusson and Kligman guinea pig sensitisation test (ECHA). [Kl. score = 1]

### **E. Repeated Dose Toxicity**

#### Oral

Proprietary Mixture A2 has been tested in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 100, 300, or 1,000 mg/kg-day Proprietary Mixture A2. There were no treatment-related effects. The NOAEL for systemic toxicity in this study is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

#### Inhalation

No studies were located.

#### Dermal

No studies were located.



## F. Genotoxicity

### In Vitro Studies

The *in vitro* genotoxicity studies conducted on Proprietary Mixture A2 are listed in Table 2.

**Table 2: *In vitro* Genotoxicity Studies on Proprietary Mixture A2**

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation ( <i>S. typhimurium</i> and <i>E. coli</i> strains)	-	-	1	ECHA
HPRT mammalian cell gene mutation (CHO cells)	-	-	1	ECHA
Chromosomal aberration (human lymphocytes)	-	-	1	ECHA

\*+, positive; -, negative

### In Vivo Studies

No studies were located.

## G. Carcinogenicity

No studies were located.

## H. Reproductive Developmental Toxicity

Proprietary Mixture A2 has been tested in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 100, 300, or 1,000 mg/kg-day Proprietary Mixture A2. There were no treatment-related reproductive or developmental effects. The NOAEL for reproductive and developmental toxicity in this study is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score =1]

## V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for Proprietary Mixture A2 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).

### A. Non-Cancer

#### Oral

Proprietary Mixture A2 was tested in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study using rats. The NOAEL for systemic, reproductive, and developmental toxicity in this study is 1,000 mg/kg-day, the highest dose tested. The NOAEL of 1,000 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

### Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

$\text{UF}_A$  (interspecies variability) = 10

$\text{UF}_H$  (intraspecies variability) = 10

$\text{UF}_L$  (LOAEL to NOAEL) = 1

$\text{UF}_{\text{Sub}}$  (subchronic to chronic) = 10

$\text{UF}_D$  (database uncertainty) = 1

$$\text{Oral RfD} = 1,000 / (10 \times 10 \times 1 \times 10 \times 1) = 1,000 / 1,000 = \underline{1.0 \text{ mg/kg-day}}$$

### Drinking water guidance value

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

### Using the oral RfD,

$$\text{Drinking water guidance value} = (\text{oral RfD}) \times (\text{human weight}) \times (\text{proportion of water consumed}) / (\text{volume of water consumed})$$

Where:

Human weight = 70 kg (ADWG, 2011)

Proportion of water consumed = 10% (ADWG, 2011)

Volume of water consumed = 2L (ADWG, 2011)

$$\text{Drinking water guidance value} = (1 \times 70 \times 0.1) / 2 = \underline{3.5 \text{ mg/L}}$$

The Australian drinking water guidance value for sodium is 180 mg/L based on aesthetics (ADWG, 2011).

## **B. Cancer**

No carcinogenicity studies on Proprietary Mixture A2 were located; thus, a cancer reference value was not derived.

## **VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES**

Proprietary Mixture A2 does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

## **VII. ENVIRONMENTAL HAZARD ASSESSMENT**

### **A. Summary**

Proprietary Mixture A2 exhibits low acute toxicity to fish and invertebrates, but moderate toxicity concern to aquatic plants.

## B. Aquatic Toxicity

### Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on Proprietary Mixture A2.

**Table 3: Acute Aquatic Toxicity Studies on Proprietary Mixture A2**

Test Species	Endpoint	Results (mg/L)	Klimsich score	Reference
<i>Oncorhynchus mykiss</i>	96-hr LC <sub>50</sub>	>100	1	ECHA
<i>Daphnia magna</i>	48-hr EC <sub>50</sub>	>100	1	ECHA
<i>Pseudokirchneriella subcapitata</i>	72-hr EC <sub>50</sub>	86 (growth rate) 6.1 (cell number)	1	ECHA

### Chronic Studies

No studies were located.

## C. Terrestrial Toxicity

No studies were located.

## D. Calculation of PNEC

The PNEC calculations for Proprietary Mixture A2 follow the methodology discussed in DEWHA (2009).

### PNEC water

Experimental results are available for three trophic levels. Acute E(L)C<sub>50</sub> values are available for fish (>100 mg/L), *Daphnia* (>100 mg/L), and algae (6.1 mg/L). On the basis that the data consists of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest reported acute E(L)C<sub>50</sub> value of 6.1 mg/L from algae. The PNEC<sub>water</sub> is 0.006 mg/L.

### PNEC sediment

No experimental toxicity data on sediment organisms are available. Proprietary Mixture A2 dissociates completely in water, and its environmental distribution is dominated by its high water solubility. K<sub>ow</sub> and K<sub>oc</sub> parameters do not readily apply to inorganics, such as Proprietary Mixture A2. Thus, the equilibrium partitioning method cannot be used to calculate the PNEC<sub>sed</sub>. Based on its properties, no adsorption of Proprietary Mixture A2 to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

### PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of Proprietary Mixture A2 is dominated by its water solubility. Sorption of Proprietary Mixture A2 should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K<sub>oc</sub> and K<sub>ow</sub> parameters do not readily apply to inorganics, such as Proprietary Mixture A2. Thus, the equilibrium partitioning methods cannot be used to calculate the PNEC<sub>soil</sub>. Based on its properties, Proprietary Mixture A2 is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

## VIII. PBT ASSESSMENT

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).

Proprietary Mixture A2 is an inorganic salt that dissociates completely to sodium and sulfamate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

As an inorganic salt, neither Proprietary Mixture A2 nor its dissociated ions are expected to accumulate.

There are no chronic aquatic toxicity studies on Proprietary Mixture A2. The acute E(L)C<sub>50</sub>s are >0.1 mg/L in fish, invertebrates and algae. Thus, Proprietary Mixture A2 does not meet the screening criteria for toxicity.

The overall conclusion is that Proprietary Mixture A2 is not a PBT substance.

## IX. CLASSIFICATION AND LABELLING (AUSTRALIA GHS)

### A. Classification

Not classified.

### B. Labelling

No signal word.

### C. Pictogram

None.

## X. SAFETY AND HANDLING

### A. FIRST AID

#### Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

#### Skin Contact

Wash thoroughly with soap and water.

#### Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

#### Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

## **B. FIRE FIGHTING INFORMATION**

### Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

### Specific Exposure Hazards

Carbon oxides, nitrogen oxides

### Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

## **C. ACCIDENTAL RELEASE MEASURES**

### Personal Precautions

Use appropriate protective equipment.

### Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

### Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

## **D. STORAGE AND HANDLING**

### General Handling

No special measures necessarily provided product is used correctly.

### Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidising agents.

### Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

## **E. EXPOSURE CONTROLS / PERSONAL PROTECTION**

### Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Proprietary Mixture A2.

### Engineering Controls

None

## Personal Protection Equipment

*Respiratory Protection:* Respiratory protection is not required.

*Hand Protection:* Chemical resistant protective gloves.

*Skin Protection:* Body protection must be chosen depending on activity and possible exposure.

*Eye protection:* Safety glasses with side-shields.

*Other Precautions:* Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

## **F. TRANSPORT INFORMATION**

Proprietary Mixture A2 is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

## **XI. DISPOSAL**

Disposal should be in accordance with all local, state, and federal regulations.

## **XII. REGULATORY INFORMATION**

Australian AICS Inventory: Listed.

## **XIII. REFERENCES**

ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council.

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: <http://echa.europa.eu/information-on-chemicals/registered-substances>

enHealth Human Risk Assessment [HHRA] (2012). Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards. Office of Health Protection of the Australian Government Department of Health.

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.

## **XIV. ACRONYMS AND GLOSSARY**

°C                      degrees Celsius

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ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m <sup>3</sup>	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

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## APPENDIX E GEOGENIC DATA



Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID		Drinking Water Guideline Values (mg/L)	Stock Watering (mg/L)	Aquatic Ecosystems (µg/L)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Sample Date					21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014
Lab Parameters	Unit										
Ionic Balance					-	-	-	-	-	-	-
Total Anions					-	-	-	-	-	-	-
Total Cations					-	-	-	-	-	-	-
pH	pH units	6.5 - 8.5 <sup>a</sup>	<sup>d</sup>	6.5 - 7.5 <sup>f</sup>	9.4	11.6	11.3	9.0	8.6	11.6	11.70
Electrical conductivity (EC)	µS/cm	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	75100	65100	20600	44000	32400	6470	16600
Total Dissolved Solids	mg/L	500 aesthetic <sup>a</sup>	2,000 - 10000 <sup>f</sup>	<sup>h</sup>	52100	44100	18200	31700	21900	3370	9160
Suspended Solids (SS)	mg/L				1100	5 U	101000	89700	66500	36500	20800
Calcium	mg/L	<sup>b</sup>	1,000 <sup>f</sup>	116000 <sup>j</sup>	1330	592	840	1040	1110	35	59
Magnesium	mg/L	<sup>b</sup>	10 <sup>g</sup>	1900 <sup>f</sup>	0.1 U	0.1 U	0.1 U	26.6	0.1 U	0.1 U	0.1 U
Sodium	mg/L	180 (aesthetic); 250 (aesthetic) <sup>a</sup>	2,000 as sodium <sup>g</sup>	680000 <sup>j</sup>	1700	596	2580	3290	1050	1330	2290
Potassium	mg/L	<sup>b</sup>	<sup>d</sup>	53000 <sup>j</sup>	12700	17300	4280	14800	7360	216	1770
Chloride	mg/L	250 (aesthetic) <sup>a</sup>	<sup>d</sup>	230000 as chloride <sup>i</sup>	18200	17800	8640	15100	9910	1470	5050
Sulfate (as SO4)	mg/L				185	58	19	142	27	60	69
Hydroxide Alkalinity as CaCO3		<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	1 U	327	1 U	1 U	1640	1 U	58
Carbonate Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	34	77	3680	274	105	1180	354
Bicarbonate Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	236	1 U	3440	1940	5	1140	1 U
Total Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	270	404	7120	2210	1750	2320	412
Total Hardness as CaCO3	mg/L	200 (aesthetic) <sup>a</sup>			3320	1480	2100	2710	2770	87	146
Dissolved Organic Carbon	mg/L				-	-	-	-	-	-	-
Total Organic Carbon	mg/L				-	-	-	-	-	-	-
Sodium Adsorption Ratio		<sup>b</sup>	<sup>d</sup>		12.8	6.7	24.5	27.5	8.7	62.0	82.3
Mercury - T	mg/L	0.001 (health) <sup>a</sup>	0.002 <sup>f</sup>	0.6 <sup>f</sup>	0.0001 U	0.001 U	0.001 U	0.0012	0.001 U	0.001 U	0.0001 U
Mercury - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Fluoride	mg/L	1.5 <sup>a</sup>			0.3	0.4	1.0 U	0.4	0.1 U	4.0 U	0.8
Ammonia as N	mg/L	0.5 (aesthetic) <sup>a</sup>			9.56	5.50	7.12	5.64	7.50	0.97	1.43
Nitrite as N	mg/L	3 <sup>a</sup>			0.01 U	0.02	0.02	0.02	0.02	0.02	0.02
Nitrate as N	mg/L	50 <sup>a</sup>			0.02	0.01	0.01 U	0.01 U	0.01	0.03	0.01 U
Nitrite + Nitrate as N	mg/L				0.02	0.03	0.02	0.01 U	0.03	0.05	0.02
Total Kjeldahl Nitrogen as N	mg/L				14.3	36.4	40.2	28.8	64.8	19.1	11.3
Total Nitrogen as N (TKN + NOx)	mg/L				14.3	36.4	40.2	28.8	64.8	19.2	11.3
Total Phosphorus as P	mg/L				1.69	9.38	18.40	14.50	19.60	10.60	4.62
Total Metals		mg/L									
Aluminium - T	mg/L	0.2 <sup>a</sup>	5 <sup>f</sup>	55 <sup>f</sup>	1.57	610	800	1030	189	328	105
Aluminium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Antimony - T	mg/L	0.003 <sup>a</sup>			0.021 U	0.052 U	0.052 U	0.052 U	0.021 U	0.052 U	0.011
Antimony - D	mg/L				-	-	-	-	-	-	-
Arsenic - T	mg/L	0.007 as arsenic, not specified (health) <sup>a</sup>	0.5 - 5 as arsenic, not specified <sup>f</sup>	24 <sup>f</sup>	0.021 U	0.37	0.394	0.382	0.289	0.157	0.135
Arsenic - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Barium - T	mg/L	2 (health) <sup>a</sup>	4 <sup>d</sup>	4 <sup>j</sup>	12.4	25.7	45.7	45.4	17.6	8.2	7.6
Barium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Beryllium - T	mg/L	0.6 <sup>a</sup>			0.021 U	0.052 U	0.069	0.074	0.039	0.052 U	0.01
Beryllium - D	mg/L				-	-	-	-	-	-	-
Boron - T	mg/L	4 (health) <sup>a</sup>	5 <sup>f</sup>	370 <sup>f</sup>	0.105 U	0.262 U	0.64	1.69	0.105 U	0.262 U	0.478
Boron - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Cadmium - T	mg/L	0.002 (health) <sup>a</sup>	1 <sup>f</sup>	0.2 <sup>f</sup>	0.0021 U	0.0174	0.0194	0.0193	0.0124	0.0077	0.0036
Cadmium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Chromium - T	mg/L	0.05 as chromium VI (health); 0.1 as total chromium (health) <sup>a,k</sup>	1 as chromium, not specified <sup>f</sup>	1 as chromium VI <sup>f</sup>	0.023	0.825	1.300	0.996	0.79	0.599	0.374
Chromium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Cobalt - T	mg/L	0.0006 <sup>n</sup>			0.021 U	0.916	1.110	1.240	0.546	0.330	0.182
Cobalt - D	mg/L				-	-	-	-	-	-	-
Copper - T	mg/L	2 (health); 1 (aesthetic) <sup>a,a</sup>	0.4 - 5 <sup>f</sup>	1.4 <sup>f</sup>	0.10	7.67	5.12	4.77	2.77	2.94	1.25
Copper - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Iron - T	mg/L	0.3 (aesthetic) <sup>a</sup>	10 <sup>g</sup>		2.95	1300	1870	2010	842	722	329
Iron - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Lead - T	mg/L	0.01 (health) <sup>a</sup>	0.1 <sup>f</sup>	3.4 <sup>f</sup>	0.021 U	1.090	1.55	1.41	0.813	0.748	0.31
Lead - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Lithium - T	mg/L	0.004 <sup>n</sup>			0.027	0.708	0.956	1.050	0.491	0.405	0.266
Lithium - D	mg/L				-	-	-	-	-	-	-
Manganese - T	mg/L	0.5 (health); 0.1 (aesthetic) <sup>a,a</sup>	10 <sup>g</sup>	1400 <sup>f</sup>	0.060	34.6	46.3	43.4	23.4	13.2	7.42
Manganese - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Molybdenum - T	mg/L	0.01 <sup>n</sup>			0.339	0.119	0.089	0.077	0.263	0.052 U	0.078
Molybdenum - D	mg/L				-	-	-	-	-	-	-
Nickel - T	mg/L	0.02 (health) <sup>a</sup>	1 <sup>f</sup>	11 <sup>f</sup>	0.021 U	0.891	1.18	1.11	0.613	0.416	0.253
Nickel - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Selenium - T	mg/L	0.01 (health) <sup>a</sup>	0.02 <sup>f</sup>	11 <sup>f</sup>	0.021 U	0.052 U	0.052 U	0.072	0.028	0.052 U	0.009
Selenium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	-	-	-	-
Silver - T	mg/L	0.1 (health) <sup>a</sup>	<sup>d</sup>	0.05 <sup>f</sup>	0.021 U	0.052 U	0.052 U	0.052 U	0.021 U	0.052 U	0.005 U

Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID		Drinking Water Guideline Values (mg/L)	Stock Watering (mg/L)	Aquatic Ecosystems (µg/L)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Sample Date					21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014
Silver - D	mg/L	b	d	i	-	-	-	-	-	-	-
Thorium - T	mg/L				0.021 U	0.197	0.185	0.265	0.141	0.074	0.052
Thorium - D	mg/L				-	-	-	-	-	-	-
Tin - T	mg/L				0.021 U	0.052 U	0.052 U	0.052 U	0.021 U	0.052 U	0.005 U
Tin - D	mg/L				-	-	-	-	-	-	-
Uranium - T	mg/L				0.021 U	0.052 U	0.052 U	0.052 U	0.022	0.052 U	0.007
Uranium - D	mg/L				-	-	-	-	-	-	-
Vanadium - T	mg/L	0.0086 n RSL			0.041	1.48	1.77	2.65	0.945	0.711	0.429
Vanadium - D	mg/L				-	-	-	-	-	-	-
Zinc - T	mg/L	3 (aesthetic) a	20	8 f	0.024	6.61	7.9	8.9	4.93	3.97	1.64
Zinc - D	mg/L	0.6 n RSL	d	i	-	-	-	-	-	-	-
Glycols											
2-Ethoxyethyl acetate	mg/L	0.012 n RSL			2 U	2 U	2 U	2 U	2 U	2 U	2 U
2-Butoxyethanol	mg/L				2 U	2 U	2 U	2 U	2 U	2 U	2 U
Propylene glycol	mg/L	40 n RSL			2 U	2 U	2 U	2 U	2 U	2 U	2 U
Ethylene glycol	mg/L	4 n RSL			2 U	2 U	2 U	2 U	2 U	2 U	2 U
Diethylene glycol monobutyl ether	mg/L	0.06 n RSL			2 U	2 U	2 U	2 U	2 U	2 U	2 U
Diethylene glycol	mg/L				2 U	2 U	2 U	2 U	2 U	2 U	2 U
Triethylene glycol	mg/L	4 n RSL			2 U	2 U	2 U	2 U	2 U	2 U	2 U
Total Petroleum Hydrocarbons - Silica Gel Clean Up											
C10 - C14 Fraction	mg/L				0.05 U	0.05 U	0.67	1.21	2.28	0.25 U	0.5 U
C15 - C28 Fraction	mg/L				0.12	0.59	12.3	23	27.4	5.82	4.20
C15 - C28 Fraction	µg/L				-	-	-	-	-	-	-
C29 - C36 Fraction	mg/L				0.07	0.71	10.3	13.2	29.5	5.65	4.33
C10 - C36 Fraction (sum)	mg/L				0.19	1.3	23.3	37.4	59.2	11.5	8.53
Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup											
>C10 - C16 Fraction	mg/L				0.10 U	0.1 U	0.95	5	3.44	0.3 U	0.6 U
>C16 - C34 Fraction	mg/L				0.18	1.1	20.2	29.9	47.4	10.3	7.76
>C34 - C40 Fraction	mg/L				0.10 U	0.47	4.65	5.59	27.7	2.64	1.97
>C10 - C40 Fraction (sum)	mg/L				0.18	1.57	25.8	40.5	78.5	12.9	9.73
>C10 - C16 Fraction minus Naphthalene (F2)	mg/L				0.10 U	0.1 U	0.95	5	3.44	0.3 U	0.6 U
BTEXN											
Benzene	mg/L	0.001 (health) a	14.3 - 74.3 e	950 f	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Toluene	mg/L	0.8 (health) and 0.025 (aesthetics) a	89.5 - 464 e	2 j	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.005	0.002 U
Ethylbenzene	mg/L	0.3 (health); 0.003 (aesthetic) a	11.7 - 60.6 e	90 j	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
meta- & para-Xylene	mg/L	0.6 (health); 0.02 (aesthetic) a			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.003	0.002 U
para		b	d	200 f							
meta		b	d	1.8 j							
ortho-Xylene	mg/L	0.6 (health); 0.02 (aesthetic) a	d	350 f	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.004	0.002 U
Total Xylenes	mg/L	0.6 (health); 0.02 (aesthetic) a	71.7 - 371 e	13 j	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.007	0.002 U
Sum of BTEX	mg/L				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.012	0.001 U
Naphthalene	mg/L	0.00017 c** RSL			0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Total Petroleum Hydrocarbons											
C6 - C9 Fraction	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.03	0.02 U
C10 - C14 Fraction	mg/L				0.32	0.32	2.12	2.28	3.56	1.13	0.37
C15 - C28 Fraction	mg/L				0.54	1.62	18	30.4	35.60	11.4	6.23
C29 - C36Fraction	mg/L				0.3	1.6	13.3	15.5	34.0	9.1	5.4
C10 - C36 Fraction (sum)	mg/L				1.16	3.49	33.4	48.2	73.2	21.6	12
Total Recoverable Hydrocarbons - NEPM 2013 Fractions											
C6 - C10 Fraction	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.04	0.02 U
C6 - C10 Fraction minus BTEX (F1)	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.03	0.02 U
>C10 - C16 Fraction	mg/L				0.33	0.36	2.59	6.82	5.32	1.27	0.41
>C16 - C34 Fraction	mg/L				0.74	2.69	27.7	38.1	58.2	18.3	10.4
>C34 - C40 Fraction	mg/L				0.12	1	6.39	6.82	30.3	4.36	2.76
>C10 - C40 Fraction (sum)	mg/L				1.19	4.05	36.7	51.7	93.8	23.9	13.6
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L				330	0.36	2.59	6.82	5.32	1.27	0.41

Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID		Drinking Water Guideline Values (mg/L)		Stock Watering (mg/L)		Aquatic Ecosystems (µg/L)		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	
Sample Date								21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014	
Polynuclear Aromatic Hydrocarbons															
3-Methylcholanthrene	mg/L	0.0000011	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
2-Methylnaphthalene	mg/L	0.0036	n	RSL				0.0001 U	0.0001	0.0051	0.014	0.0004	0.0002	0.0014	
7.12-Dimethylbenz(a)anthracene	mg/L	0.0000001	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
Acenaphthene	mg/L	0.05	n	RSL				0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
Acenaphthylene	mg/L							0.0001 U	0.0001 U	0.0001 U	0.001	0.0001 U	0.0001 U	0.0001 U	
Anthracene	mg/L	0.18	n	RSL				0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
Benz(a)anthracene	mg/L	0.000012	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
Benzo(a)pyrene	mg/L	0.00001		a	0.402 - 2.08 as HMW PAH	e	0.015	j	0.0001 U	0.0001 U	0.0003	0.0013	0.00005 U	0.00005 U	0.00005 U
Benzo(b+j)fluoranthene	mg/L	0.000034	c	RSL					0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	
Benzo(e)pyrene	mg/L								0.0001 U	0.0001 U	0.0003	0.0013	0.0001 U	0.0001 U	0.0001 U
Benzo(g,h,i)perylene	mg/L								0.0001 U	0.0001 U	0.0003	0.0006	0.0001 U	0.0001 U	0.0003
Benzo(k)fluoranthene	mg/L	0.00034	c	RSL					0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Chrysene	mg/L	0.0034	c	RSL					0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Coronene	mg/L								0.0001 U	0.0001 U	0.0001 U	0.0001	0.0001 U	0.0001 U	0.0003
Dibenz(a,h)anthracene	mg/L	0.0000034	c	RSL					0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Fluoranthene	mg/L	0.08	n	RSL					0.0001 U	0.0001 U	0.0005	0.0009	0.0001 U	0.0001 U	0.0002
Fluorene	mg/L	0.029	n	RSL					0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Indeno(1.2.3.cd)pyrene	mg/L	0.000034	c	RSL					0.0001 U	0.0001 U	0.0001	0.0002	0.0001 U	0.0001 U	0.0001
N-2-Fluorenyl Acetamide	mg/L								0.0001 U	0.0001 U	0.0004	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Naphthalene	mg/L	0.00017	c**	RSL	2.01 - 10.4 as LMW PAH	e	16	f	0.0001 U	0.0002	0.0035	0.0121	0.0005	0.0006	0.001
Perylene	mg/L								0.0001 U	0.0001 U	0.0008	0.003	0.0001 U	0.0001 U	0.0003
Phenanthrene	mg/L			b	2.01 - 10.4 as LMW PAH	e	0.4	j	0.0001 U	0.0001 U	0.0012	0.0025	0.0001	0.0001 U	0.0004
Pyrene	mg/L	0.012	n	RSL					0.0001 U	0.0001 U	0.0005	0.0017	0.0001 U	0.0001 U	0.0002
Sum of PAHs	mg/L								0.0001 U	0.0002	0.0064	0.0203	0.0006	0.0006	0.0022
Benzo(a)pyrene TEQ (zero)	mg/L								0.0001 U	0.0001 U	0.0003	0.0013	0.00005 U	0.00005 U	0.00005 U
Phenol	mg/L	0.58	n	RSL					-	-	0.0278	0.0050 U	0.0057 U	0.0515	0.046
2-Chlorophenol	mg/L	0.0091	n	RSL					-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
2-Methylphenol	mg/L								-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
3- & 4-Methylphenol	mg/L								-	-	0.010 U	0.010 U	0.01 U	0.005 U	0.01 U
2-Nitrophenol	mg/L								-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
2,4-Dimethylphenol	mg/L	0.036	n	RSL					-	-	0.0059	0.0069	0.005 U	0.0025 U	0.005 U
2,4-Dichlorophenol	mg/L	0.0046	n	RSL					-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
2,6-Dichlorophenol	mg/L								-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
4-Chloro-3-methylphenol	mg/L								-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
2,4,6-Trichlorophenol	mg/L	0.0012	n	RSL					-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
2,4,5-Trichlorophenol	mg/L	0.12	n	RSL					-	-	0.005 U	0.005 U	0.005 U	0.0025 U	0.005 U
Pentachlorophenol	mg/L	0.000041	c*	RSL					-	-	0.010 U	0.010 U	0.01 U	0.005 U	0.01 U

NOTES:

XXX EXCEEDS DRINKING WATER GUIDELINE VALUES  
XXX EXCEEDS STOCK WATERING LEVELS  
XXX EXCEEDS AQUATIC ECOSYSTEMS LEVELS

Notes for Criteria for DERM:

<sup>a</sup> Australia Drinking Water Guidelines  
Natural Resource Management Ministerial Council. Australian Drinking Water Guidelines 6, Volume 1. National Water Quality Management Strategy. January 2011.

<sup>b</sup> No existing guideline based on Drinking Water hierarchy

<sup>c</sup> May contain bromate from naturally occurring sodium bromide (WHO Guidelines for Drinking-water Quality, pp. 187-188). Australian drinking water guideline for bromate is 0.02 mg/L.  
World Health Organization. Guidelines for Drinknig-water Quality, Fourth Edition. WHO Press, Geneva, Switzerland. ISBN 978 92 4 154815 1. pp 189. 2011. Available online at: <http://www.who.int>

<sup>d</sup> No existing guideline based on Stock Watering hierarchy

<sup>e</sup> API Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons ( cattle/calves, sheep, goat, horse)  
American Petroleum Institute. Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons. Regulatory Analysis and Scientific Affairs. Publication Number 4733. July 2004.

<sup>f</sup> Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.

<sup>g</sup> Other (Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering.)  
Department of Water Affairs and Forestry. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering. Republic of South Africa. 1993. ISBN 0-7988-5343-3.

<sup>h</sup> No existing guideline based on Aquatic Ecosystem hierarchy

<sup>i</sup> EPA Ambient Water Quality Criteria  
  
USEPA. National Recommended Water Quality Criteria for Priority Pollutants. Office of Water, Office of Science and Technology (4304T). 2009. Available online at: <http://water.epa.gov/scitech/swguidance/standards/current/>

<sup>j</sup> Other (EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks)  
USEPA. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks. 2011. Available online at: <http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm>

<sup>k</sup> U.S. EPA Maximum Contaminant Levels (MCLs)  
  
USEPA. National Primary Drinking Water Regulations. EPA 816-F-09-0004. 2009. Available online at: <http://water.epa.gov/drink/contaminants/index.cfm#List>

<sup>l</sup> Section 8.3.5.15 Incorporating effects of water hardness of ANZECC & ARMCANZ (2000) notes to compare total to guideline, if exceeds, then compare dissolved  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.

<sup>RSL</sup> USEPA. Regional Screening Levels (RSLs)- Residential Soil THQ = 0.1. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016>  
RSL Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;

Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID Sample Date		Drinking Water Guideline Values (mg/L)	Stock Watering (mg/L)	Aquatic Ecosystems (µg/L)	Sample 8 29/10/2014	Sample 9 41681	Sample 10 41740	Sample 11 42249.41667	Sample 12 42249.42708	Sample 13 42249.4375
Lab Parameters	Unit									
Ionic Balance					-	-	-	9	8	6
Total Anions					-	-	-	322	701	1380
Total Cations					-	-	-	384	600	1220
pH	pH units	6.5 - 8.5 <sup>a</sup>		6.5 - 7.5 <sup>f</sup>	11.80	12.00	11.70	8.64	8.74	8.98
Electrical conductivity (EC)	µS/cm	<sup>b</sup>		<sup>d</sup>	67000	67000	18100	33900	70300	120000
Total Dissolved Solids	mg/L	500 aesthetic <sup>a</sup>	2,000 - 10000 <sup>f</sup>	<sup>h</sup>	43600	39800	10400	21300	47700	93100
Suspended Solids (SS)	mg/L				238	154000	24000	-	-	-
Calcium	mg/L	<sup>b</sup>	1,000 <sup>f</sup>	116000 <sup>j</sup>	1620	1490	235	74	105	100
Magnesium	mg/L	<sup>b</sup>	10 <sup>g</sup>	1900 <sup>f</sup>	0.1 U	-	0.1 U	15	16	18
Sodium	mg/L	180 (aesthetic); 250 (aesthetic) <sup>a</sup>	2,000 as sodium <sup>g</sup>	680000 <sup>j</sup>	2310	2830	2260	2840	3710	10800
Potassium	mg/L	<sup>b</sup>	53000 <sup>d</sup>	53000 <sup>j</sup>	13400	15000	2560	10000	16900	29300
Chloride	mg/L	250 (aesthetic) <sup>a</sup>	<sup>d</sup>	230000 as chloride <sup>i</sup>	20700	16100	6010	10800	23700	46000
Sulfate (as SO4)	mg/L				184	101	69	264	636	2550
Hydroxide Alkalinity as CaCO3		<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	169	662	1 U	510	804	893
Carbonate Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	580	466	2240	104	151	402
Bicarbonate Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	1 U	1 U	1590	1 U	1 U	1 U
Total Alkalinity as CaCO3	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>h</sup>	750	1130	3840	614	955	1300
Total Hardness as CaCO3	mg/L	200 (aesthetic) <sup>a</sup>			4040	-	587	-	-	-
Dissolved Organic Carbon	mg/L				-	-	-	41	132	286
Total Organic Carbon	mg/L				-	-	-	51	149	299
Sodium Adsorption Ratio		<sup>b</sup>	<sup>d</sup>		15.8	-	40.6	78.7	89.1	261
Mercury - T	mg/L	0.001 (health) <sup>a</sup>	0.002 <sup>f</sup>	0.6 <sup>f</sup>	0.0001 U	0.001 U	0.0005 U	0.0001 U	0.0001 U	0.0001 U
Mercury - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.0001 U	0.0001 U	0.0001 U
Fluoride	mg/L	1.5 <sup>a</sup>			0.4	0.4	2 U	-	-	-
Ammonia as N	mg/L	0.5 (aesthetic) <sup>a</sup>			8.93	9.62	3.08	-	-	-
Nitrite as N	mg/L	3 <sup>a</sup>			0.01 U	0.01 U	0.01	0.01 U	0.01 U	0.01 U
Nitrate as N	mg/L	50 <sup>a</sup>			0.01	0.01	0.02	0.08	0.08	0.05
Nitrite + Nitrate as N	mg/L				0.01	0.01	0.03	0.08	0.08	0.05
Total Kjeldahl Nitrogen as N	mg/L				10.7	91.6	15.5	2.9	4.6	15.5
Total Nitrogen as N (TKN + NOx)	mg/L				10.7	91.6	15.5	3	4.7	15.6
Total Phosphorus as P	mg/L				0.11	18.2	9.26	1.78	2.81	14.10
Total Metals										
Aluminium - T	mg/L	0.2 <sup>a</sup>	5 <sup>f</sup>	55 <sup>f</sup>	1.79	566	45.2	0.24	0.01 U	0.01 U
Aluminium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.15	0.01 U	0.01 U
Antimony - T	mg/L	0.003 <sup>a</sup>			0.005 U	0.021 U	0.006	0.001 U	0.001 U	0.001 U
Antimony - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Arsenic - T	mg/L	0.007 as arsenic, not specified (health) <sup>a</sup>	0.5 - 5 as arsenic, not specified <sup>f</sup>	24 <sup>f</sup>	0.005 U	0.451	0.025	0.001 U	0.010	0.027
Arsenic - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.006	0.009	0.024
Barium - T	mg/L	2 (health) <sup>a</sup>	4 <sup>d</sup>	4 <sup>j</sup>	8.0	23.5	2.8	1.8	1.6	1.4
Barium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	1.78	1.48	1.28
Beryllium - T	mg/L	0.6 <sup>a</sup>			0.005 U	0.049	0.005 U	0.001 U	0.001 U	0.001 U
Beryllium - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Boron - T	mg/L	4 (health) <sup>a</sup>	5 <sup>f</sup>	370 <sup>f</sup>	0.026 U	0.105 U	0.284	0.610	0.920	3.4
Boron - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.9	1.06	3.85
Cadmium - T	mg/L	0.002 (health) <sup>a</sup>	1 <sup>f</sup>	0.2 <sup>f</sup>	0.0005 U	0.0172	0.0009	0.0001 U	0.0001 U	0.0001 U
Cadmium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.0001 U	0.0001 U	0.0001 U
Chromium - T	mg/L	0.05 as chromium VI (health); 0.1 as total chromium (health) <sup>a,j,k</sup>	1 as chromium, not specified <sup>f</sup>	1 as chromium VI <sup>f</sup>	0.02	0.722	0.081	0.001 U	0.001 U	0.001 U
Chromium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.001 U	0.001 U	0.001 U
Cobalt - T	mg/L	0.0006 <sup>n</sup>			0.005 U	0.695	0.037	0.001 U	0.001 U	0.001 U
Cobalt - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Copper - T	mg/L	2 (health); 1 (aesthetic) <sup>a,j</sup>	0.4 - 5 <sup>f</sup>	1.4 <sup>f</sup>	0.04	2.91	0.25	0.001 U	0.001 U	0.001 U
Copper - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.001 U	0.001 U	0.001 U
Iron - T	mg/L	0.3 (aesthetic) <sup>a</sup>	10 <sup>g</sup>		3.17	1190	68.8	0.90	0.05 U	0.05 U
Iron - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.23	0.05 U	0.05 U
Lead - T	mg/L	0.01 (health) <sup>a</sup>	0.1 <sup>f</sup>	3.4 <sup>f</sup>	0.005 U	1.19	0.069	0.001 U	0.001 U	0.001 U
Lead - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.001 U	0.001 U	0.001 U
Lithium - T	mg/L	0.004 <sup>n</sup>			0.06	0.67	0.088	0.37	0.201	1.86
Lithium - D	mg/L				-	-	-	0.508	0.224	2.16
Manganese - T	mg/L	0.5 (health); 0.1 (aesthetic) <sup>a,j</sup>	10 <sup>g</sup>	1400 <sup>f</sup>	0.098	29.2	1.6	0.062	0.091	0.027
Manganese - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.03	0.082	0.017
Molybdenum - T	mg/L	0.01 <sup>n</sup>			0.351	0.169	0.157	0.038	0.029	0.225
Molybdenum - D	mg/L				-	-	-	0.047	0.023	0.192
Nickel - T	mg/L	0.02 (health) <sup>a</sup>	1 <sup>f</sup>	11 <sup>f</sup>	0.009	0.748	0.048	0.007	0.006	0.012
Nickel - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.006	0.007	0.012
Selenium - T	mg/L	0.01 (health) <sup>a</sup>	0.02 <sup>f</sup>	11 <sup>f</sup>	0.005 U	0.134	0.005 U	0.01 U	0.01 U	0.01 U
Selenium - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.01 U	0.01 U	0.01 U
Silver - T	mg/L	0.1 (health) <sup>a</sup>	<sup>d</sup>	0.05 <sup>f</sup>	0.005 U	0.021 U	0.005 U	0.001 U	0.001 U	0.001 U

Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID Sample Date		Drinking Water Guideline Values (mg/L)	Stock Watering (mg/L)	Aquatic Ecosystems (µg/L)	Sample 8 29/10/2014	Sample 9 41681	Sample 10 41740	Sample 11 42249.41667	Sample 12 42249.42708	Sample 13 42249.4375
Silver - D	mg/L	<sup>b</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.001 U	0.001 U	0.001 U
Thorium - T	mg/L				0.005 U	0.221	0.013	0.001 U	0.001 U	0.001 U
Thorium - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Tin - T	mg/L				0.005 U	0.021 U	0.005 U	0.001 U	0.001 U	0.001 U
Tin - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Uranium - T	mg/L				0.005 U	0.032	0.005 U	0.001 U	0.001 U	0.001 U
Uranium - D	mg/L				-	-	-	0.001 U	0.001 U	0.001 U
Vanadium - T	mg/L	0.0086 <sup>n</sup> <sup>RSL</sup>			0.014	1.54	0.096	0.01 U	0.01 U	0.01 U
Vanadium - D	mg/L				-	-	-	0.01 U	0.01 U	0.01 U
Zinc - T	mg/L	3 (aesthetic) <sup>a</sup>	20 <sup>f</sup>	8 <sup>f</sup>	0.034	5.88	0.268	0.005 U	0.005 U	0.005 U
Zinc - D	mg/L	0.6 <sup>n</sup> <sup>RSL</sup>	<sup>d</sup>	<sup>i</sup>	-	-	-	0.005 U	0.005 U	0.005 U
Glycols										
2-Ethoxyethyl acetate	mg/L	0.012 <sup>n</sup> <sup>RSL</sup>			2 U	2 U	2 U	-	-	-
2-Butoxyethanol	mg/L				2 U	2 U	2 U	-	-	-
Propylene glycol	mg/L	40 <sup>n</sup> <sup>RSL</sup>			2 U	2 U	2 U	-	-	-
Ethylene glycol	mg/L	4 <sup>n</sup> <sup>RSL</sup>			2 U	2 U	2 U	-	-	-
Diethylene glycol monobutyl ether	mg/L	0.06 <sup>n</sup> <sup>RSL</sup>			2 U	2 U	2 U	-	-	-
Diethylene glycol	mg/L				2 U	2 U	2 U	-	-	-
Triethylene glycol	mg/L	4 <sup>n</sup> <sup>RSL</sup>			2 U	2 U	2 U	-	-	-
Total Petroleum Hydrocarbons - Silica Gel Clean Up										
C10 - C14 Fraction	mg/L				0.05 U	0.62 U	0.2	0.05 U	0.05 U	0.05 U
C15 - C28 Fraction	mg/L				0.22	16.2	3.71	0.1 U	0.1 U	0.1 U
C15 - C28 Fraction	µg/L				-	-	-	0.05 U	0.05 U	0.05 U
C29 - C36 Fraction	mg/L				0.07	14.7	3.3	-	-	-
C10 - C36 Fraction (sum)	mg/L				0.29	30.9	7.21	0.05 U	0.05 U	0.05 U
Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup										
>C10 - C16 Fraction	mg/L				0.1 U	0.75 U	0.28	2.04	0.34	0.24
>C16 - C34 Fraction	mg/L				0.27	28.4	6.29	1.25	0.9	0.93
>C34 - C40 Fraction	mg/L				0.1 U	4.89	1.74	0.21	0.13	0.19
>C10 - C40 Fraction (sum)	mg/L				0.27	33.3	8.31	3.5	1.37	1.36
>C10 - C16 Fraction minus Naphthalene (F2)	mg/L				0.1 U	0.75 U	0.28	-	-	-
BTEXN										
Benzene	mg/L	0.001 (health) <sup>a</sup>	14.3 - 74.3 <sup>e</sup>	950 <sup>f</sup>	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Toluene	mg/L	0.8 (health) and 0.025 (aesthetics) <sup>a</sup>	89.5 - 464 <sup>e</sup>	2 <sup>j</sup>	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Ethylbenzene	mg/L	0.3 (health); 0.003 (aesthetic) <sup>a</sup>	11.7 - 60.6 <sup>e</sup>	90 <sup>j</sup>	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
meta- & para-Xylene	mg/L	0.6 (health); 0.02 (aesthetic) <sup>a</sup>			0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
para		<sup>b</sup>	<sup>d</sup>	200 <sup>f</sup>				0.002 U	0.002 U	0.002 U
meta		<sup>b</sup>	<sup>d</sup>	1.8 <sup>j</sup>				0.002 U	0.002 U	0.002 U
ortho-Xylene	mg/L	0.6 (health); 0.02 (aesthetic) <sup>a</sup>	<sup>d</sup>	350 <sup>f</sup>	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Total Xylenes	mg/L	0.6 (health); 0.02 (aesthetic) <sup>a</sup>	71.7 - 371 <sup>e</sup>	13 <sup>j</sup>	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Sum of BTEX	mg/L				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Naphthalene	mg/L	0.00017 <sup>c**</sup> <sup>RSL</sup>			0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Total Petroleum Hydrocarbons										
C6 - C9 Fraction	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
C10 - C14 Fraction	mg/L				0.07	0.75	0.95	1.97	0.21	0.18
C15 - C28 Fraction	mg/L				0.41	22.7	6.13	1.16	0.95	0.78
C29 - C36Fraction	mg/L				0.1	17.9	4.2	0.31	0.12	0.28
C10 - C36 Fraction (sum)	mg/L				0.6	41.4	11.3	3.44	1.28	1.24
Total Recoverable Hydrocarbons - NEPM 2013 Fractions										
C6 - C10 Fraction	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
C6 - C10 Fraction minus BTEX (F1)	mg/L				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
>C10 - C16 Fraction	mg/L				0.1 U	0.87	1.1	0.1 U	0.1 U	0.1 U
>C16 - C34 Fraction	mg/L				0.5	37.5	9.28	0.1 U	0.1 U	0.1 U
>C34 - C40 Fraction	mg/L				0.1 U	6.32	2.23	0.1 U	0.1 U	0.1 U
>C10 - C40 Fraction (sum)	mg/L				0.5	44.7	12.6	0.1 U	0.1 U	0.1 U
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L				0.1 U	0.87	1.1	2.04	0.34	0.24

Table E-1  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid

Sample ID Sample Date		Drinking Water Guideline Values (mg/L)		Stock Watering (mg/L)		Aquatic Ecosystems (µg/L)		Sample 8 29/10/2014	Sample 9 41681	Sample 10 41740	Sample 11 42249.41667	Sample 12 42249.42708	Sample 13 42249.4375
Polynuclear Aromatic Hydrocarbons													
3-Methylcholanthrene	mg/L	0.0000011	c	RSL				0.0001 U	0.0001 U	0.0001 U	-	-	-
2-Methylnaphthalene	mg/L	0.0036	n	RSL				0.0001	0.0007	0.0008	-	-	-
7,12-Dimethylbenz(a)anthracene	mg/L	0.0000001	c	RSL				0.0001 U	0.0001 U	0.0001 U	-	-	-
Acenaphthene	mg/L	0.05	n	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Acenaphthylene	mg/L							0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Anthracene	mg/L	0.18	n	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Benz(a)anthracene	mg/L	0.000012	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Benzo(a)pyrene	mg/L	0.00001		a	0.402 - 2.08	as HMW PAH	e	0.015		j	0.00005 U	0.00005 U	0.00005 U
Benzo(b+j)fluoranthene	mg/L	0.000034	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Benzo(e)pyrene	mg/L							0.0001 U	0.0001 U	0.0001 U	1	1	1
Benzo(g,h,i)perylene	mg/L							0.0001 U	0.0001	0.0001 U	0.001 U	0.001 U	0.001 U
Benzo(k)fluoranthene	mg/L	0.00034	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Chrysene	mg/L	0.0034	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Coronene	mg/L							0.0001 U	0.0001 U	0.0001 U	-	-	-
Dibenz(a,h)anthracene	mg/L	0.0000034	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Fluoranthene	mg/L	0.08	n	RSL				0.0001 U	0.0002	0.0001 U	0.001 U	0.001 U	0.001 U
Fluorene	mg/L	0.029	n	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
Indeno(1,2,3.cd)pyrene	mg/L	0.000034	c	RSL				0.0001 U	0.0001 U	0.0001 U	0.001 U	0.001 U	0.001 U
N-2-Fluorenyl Acetamide	mg/L							0.0001 U	0.0001 U	0.0001 U	-	-	-
Naphthalene	mg/L	0.00017	c**	RSL	2.01 - 10.4	as LMW PAH	e	16		f	0.0001	0.0004	0.0016
Perylene	mg/L							0.0001 U	0.0004	0.0001 U	-	-	-
Phenanthrene	mg/L			b	2.01 - 10.4	as LMW PAH	e	0.4		j	0.0001 U	0.0004	0.0002
Pyrene	mg/L	0.012	n	RSL				0.0001 U	0.0002	0.0001 U	0.001 U	0.001 U	0.001 U
Sum of PAHs	mg/L							0.0001	0.0013	0.0018	0.0005 U	0.0005 U	0.0005 U
Benzo(a)pyrene TEQ (zero)	mg/L							0.00005 U	0.00005 U	0.00005 U	0.0005 U	0.0005 U	0.0005 U
Phenol	mg/L	0.58	n	RSL				0.001 U	0.0073	0.0178	-	-	-
2-Chlorophenol	mg/L	0.0091	n	RSL				0.001 U	0.0062 U	0.001 U	-	-	-
2-Methylphenol	mg/L							0.001 U	0.0062 U	0.001 U	-	-	-
3- & 4-Methylphenol	mg/L							0.002 U	0.0125 U	0.002 U	-	-	-
2-Nitrophenol	mg/L							0.001 U	0.0062 U	0.001 U	-	-	-
2,4-Dimethylphenol	mg/L	0.036	n	RSL				0.001 U	0.0062 U	0.0012	-	-	-
2,4-Dichlorophenol	mg/L	0.0046	n	RSL				0.001 U	0.0062 U	0.001 U	-	-	-
2,6-Dichlorophenol	mg/L							0.001 U	0.0062 U	0.001 U	-	-	-
4-Chloro-3-methylphenol	mg/L							0.001 U	0.0062 U	0.001 U	-	-	-
2,4,6-Trichlorophenol	mg/L	0.0012	n	RSL				0.001 U	0.0062 U	0.001 U	-	-	-
2,4,5-Trichlorophenol	mg/L	0.12	n	RSL				0.001 U	0.0062 U	0.001 U	-	-	-
Pentachlorophenol	mg/L	0.000041	c*	RSL				0.002 U	0.0125 U	0.003 U	-	-	-

NOTES:  
XXX EXCEEDS DRINKING WATER GUIDELINE VALUES  
XXX EXCEEDS STOCK WATERING LEVELS  
XXX EXCEEDS AQUATIC ECOSYSTEMS LEVELS

Notes for Criteria for DERM:

<sup>a</sup> Australia Drinking Water Guidelines  
Natural Resource Management Ministerial Council. Australian Drinking Water Guidelines 6, Volume 1. National Water Quality Management Strategy. January 2011.

<sup>b</sup> No existing guideline based on Drinking Water hierarchy

<sup>c</sup> May contain bromate from naturally occurring sodium bromide (WHO Guidelines for Drinking-water Quality, pp. 187-188). Australian drinking water guideline for bromate is 0.02 mg/L.  
World Health Organization. Guidelines for Drinknig-water Quality, Fourth Edition. WHO Press, Geneva, Switzerland. ISBN 978 92 4 154815 1. pp 189. 2011. Available online at: <http://www.who.int>

<sup>d</sup> No existing guideline based on Stock Watering hierarchy

<sup>e</sup> API Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons ( cattle/calves, sheep, goat, horse)  
American Petroleum Institute. Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons. Regulatory Analysis and Scientific Affairs. Publication Number 4733. July 2004.

<sup>f</sup> Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.

<sup>g</sup> Other (Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering.)  
Department of Water Affairs and Forestry. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering. Republic of South Africa. 1993. ISBN 0-7988-5343-3.

<sup>h</sup> No existing guideline based on Aquatic Ecosystem hierarchy

<sup>i</sup> EPA Ambient Water Quality Criteria  
  
USEPA. National Recommended Water Quality Criteria for Priority Pollutants. Office of Water, Office of Science and Technology (4304T). 2009. Available online at: <http://water.epa.gov/scitech/swguidance/standards/current/>

<sup>j</sup> Other (EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks)  
USEPA. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks. 2011. Available online at: <http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwstd/screenbench.htm>

<sup>k</sup> U.S. EPA Maximum Contaminant Levels (MCLs)  
USEPA. National Primary Drinking Water Regulations. EPA 816-F-09-0004. 2009. Available online at: <http://water.epa.gov/drink/contaminants/index.cfm#List>

<sup>l</sup> Section 8.3.5.15 Incorporating effects of water hardness of ANZECC & ARMCANZ (2000) notes to compare total to guideline, if exceeds, then compare dissolved  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.

<sup>RSL</sup> USEPA. Regional Screening Levels (RSLs)- Residential Soil THQ = 0.1. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016>  
RSL Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;



Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	
Sample Date	A Residential	C Recreational	A Residential			C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014		
Lab Parameters		Unit																	
Ionic Balance												-	-	-	-	-	-	-	
Total Anions												-	-	-	-	-	-	-	
Total Cations												-	-	-	-	-	-	-	
pH	pH units/kg											9.4	11.6	11.3	9.02	8.56	11.6	11.7	
Electrical conductivity (EC)	µS/kg											75,100	65,100	20,600	44,000	32,400	6,470	16,600	
Total Dissolved Solids	mg/kg											31,260	26,460	10,920	19,020	13,140	2,022	5,496	
Suspended Solids (SS)	mg/kg											660	3 U	60,600	53,820	39,900	21,900	12,480	
Calcium	mg/kg											798	355	504	624	666	20.88	35.16	
Magnesium	mg/kg											0.06 U	0.06 U	0.06 U	15.96	0.06 U	0.06 U	0.06 U	
Sodium	mg/kg											1,020	358	1,548	1,974	630	798	1,374	
Potassium	mg/kg											7,620	10,380	2,568	8,880	4,416	129.6	1,062	
Chloride	mg/kg											10,920	10,680	5,184	9,060	5,946	882	3,030	
Sulfate (as SO4)	mg/kg											111	34.8	11.4	85.2	16.2	36	41.4	
Hydroxide Alkalinity as CaCO3												0.6 U	196	0.6 U	0.6 U	984	0.6 U	34.8	
Carbonate Alkalinity as CaCO3	mg/kg											20.4	46.2	2,208	164.4	63	708	212	
Bicarbonate Alkalinity as CaCO3	mg/kg											141.6	0.6 U	2,064	1,164	3	684	0.6 U	
Total Alkalinity as CaCO3	mg/kg											162	242	4,272	1,326	1,050	1,392	247	
Total Hardness as CaCO3	mg/kg											1,992	888	1,260	1,626	1,662	52.2	87.6	
Dissolved Organic Carbon	mg/kg											-	-	-	-	-	-	-	
Total Organic Carbon	mg/kg											-	-	-	-	-	-	-	
Sodium Adsorption Ratio												7.68	4.044	14.7	16.5	5.202	37.2	49.38	
Mercury - T	mg/kg	40	80									0.00006 U	0.0006 U	0.0006 U	0.00072	0.0006 U	0.0006 U	0.00006 U	
Fluoride	mg/kg			310	n							0.18	0.24	0.6 U	0.24	0.06 U	2.4 U	0.48	
Ammonia as N	mg/kg											5.736	3.3	4.272	3.384	4.5	0.582	0.858	
Nitrite as N	mg/kg			780	n							0.006 U	0.012	0.012	0.012	0.012	0.012	0.012	
Nitrate as N	mg/kg			13000	n							0.012	0.006	0.006 U	0.006 U	0.006	0.018	0.006 U	
Nitrite + Nitrate as N	mg/kg											0.012	0.018	0.012	0.006 U	0.018	0.03	0.012	
Total Kjeldahl Nitrogen as N	mg/kg											8.58	21.84	24.12	17.28	38.88	11.46	6.78	
Total Nitrogen as N (TKN + NOx)	mg/kg											8.58	21.84	24.12	17.28	38.88	11.52	6.78	
Total Phosphorus as P	mg/kg											1.014	5.628	11.04	8.7	11.76	6.36	2.772	
Total Metals																			
Aluminium - T	mg/kg			7700	n							0.942	366	480	618	113.4	197	63	
Antimony - T	mg/kg											0.0126 U	0.0312 U	0.0312 U	0.0312 U	0.0126 U	0.0312 U	0.0066	
Arsenic - T	mg/kg	100	300				40	100		200		0.0126 U	0.222	0.2364	0.2292	0.1734	0.0942	0.081	
Barium - T	mg/kg			1500	n							7.44	15.42	27.42	27.24	10.56	4.89	4.572	
Beryllium - T	mg/kg	60	90									0.0126 U	0.0312 U	0.0414	0.0444	0.0234	0.0312 U	0.006	
Boron - T	mg/kg	4500	20000							100		0.063 U	0.1572 U	0.384	1.014	0.063 U	0.1572 U	0.2868	
Cadmium - T	mg/kg	20	90							3		0.00126 U	0.01044	0.01164	0.01158	0.00744	0.00462	0.00216	
Chromium - T	mg/kg	100	300							400		0.0138	0.495	0.78	0.5976	0.474	0.3594	0.2244	
Cobalt - T	mg/kg	100	300									0.0126 U	0.5496	0.666	0.744	0.3276	0.198	0.1092	
Copper - T	mg/kg	6000	17000							100		0.06	4.602	3.072	2.862	1.662	1.764	0.75	
Iron - T	mg/kg			5500	n							1.77	780	1,122	1,206	505	433	197	
Lead - T	mg/kg	300	600				470	1100		600		0.0126 U	0.654	0.93	0.846	0.4878	0.4488	0.186	
Lithium - T	mg/kg			16	n							0.0162	0.4248	0.5736	0.63	0.2946	0.243	0.1596	
Manganese - T	mg/kg	3800	19000									0.036	20.76	27.78	26.04	14.04	7.92	4.452	
Molybdenum - T	mg/kg			39	n							0.2034	0.0714	0.0534	0.0462	0.1578	0.0312 U	0.0468	
Nickel - T	mg/kg	400	1200									0.0126 U	0.5346	0.708	0.666	0.3678	0.2496	0.1518	
Selenium - T	mg/kg	200	700		n					5		0.0126 U	0.0312 U	0.0312 U	0.0432	0.0168	0.0312 U	0.0054	
Silver - T	mg/kg			39	n							0.0126 U	0.0312 U	0.0312 U	0.0312 U	0.0126 U	0.0312 U	0.003 U	
Thorium - T	mg/kg											0.0126 U	0.1182	0.111	0.159	0.0846	0.0444	0.0312	
Tin - T	mg/kg			4700	n							0.0126 U	0.0312 U	0.0312 U	0.0312 U	0.0126 U	0.0312 U	0.003 U	
Uranium - T	mg/kg											0.0126 U	0.0312 U	0.0312 U	0.0312 U	0.0132	0.0312 U	0.0042	
Vanadium - T	mg/kg			39	n							0.0246	0.888	1.062	1.59	0.567	0.4266	0.2574	
Zinc - T	mg/kg	7400	30000									0.0144	3.966	4.74	5.34	2.958	2.382	0.984	
Glycols																			
2-Ethoxyethyl acetate	mg/kg			260	n							1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
2-Butoxyethanol	mg/kg											1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
Propylene glycol	mg/kg			130000	nm							1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
Ethylene glycol	mg/kg			13000	n							1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
Diethylene glycol monobutyl ether	mg/kg			190	n							1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
Diethylene glycol	mg/kg											1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	
Triethylene glycol	mg/kg			13000	n							1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	

Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Sample Date		A Residential	C Recreational			A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014
Total Petroleum Hydrocarbons - Silica Gel Clean Up																		
C10 - C14 Fraction	mg/kg											0.03 U	0.03 U	0.402	0.726	1.368	0.15 U	0.3 U
C15 - C28 Fraction	mg/kg											0.072	0.354	7.38	13.8	16.44	3.492	2.52
C15 - C28 Fraction	µg/kg											-	-	-	-	-	-	-
C29 - C36 Fraction	mg/kg											0.042	0.426	6.18	7.92	17.7	3.39	2.598
C10 - C36 Fraction (sum)	mg/kg											0.114	0.78	13.98	22.44	35.52	6.9	5.118
Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup																		
>C10 - C16 Fraction	mg/kg					3,300	3,800				150	0.06 U	0.06 U	0.57	3	2.064	0.18 U	0.36 U
>C16 - C34 Fraction	mg/kg					4,500	5,300				1,300	0.108	0.66	12.12	17.94	28.44	6.18	4.656
>C34 - C40 Fraction	mg/kg					6,300	7,400				5,600	0.06 U	0.282	2.79	3.354	16.62	1.584	1.182
>C10 - C40 Fraction (sum)	mg/kg											0.108	0.942	15.48	24.3	47.1	7.74	5.838
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg											0.06 U	0.06 U	0.57	3	2.064	0.18 U	0.36 U
BTEXN																		
Benzene	mg/kg			1.2	c**	100	120	10	50	756	1	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
Toluene	mg/kg			490	n	14,000	18,000	65	105	4,719		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.003	0.0012 U
Ethylbenzene	mg/kg			5.8	c*	4,500	5300	40	125	617		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
meta- & para-Xylene	mg/kg			55	n							0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0018	0.0012 U
ortho-Xylene	mg/kg			65	n							0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0024	0.0012 U
Total Xylenes	mg/kg			58	n	12000	15000	1.6	45	3782		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0042	0.0012 U
Sum of BTEX	mg/kg											0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0072	0.0006 U
Naphthalene	mg/kg			3.8	c**	1400	1900					0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Total Petroleum Hydrocarbons																		
C6 - C9 Fraction	mg/kg											0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.018	0.012 U
C10 - C14 Fraction	mg/kg											0.192	0.192	1.272	1.368	2.136	0.678	0.222
C15 - C28 Fraction	mg/kg											0.324	0.972	10.8	18.24	21.36	6.84	3.738
C29 - C36Fraction	mg/kg											0.18	0.93	7.98	9.3	20.4	5.43	3.216
C10 - C36 Fraction (sum)	mg/kg											0.696	2.094	20.04	28.92	43.92	12.96	7.2
Total Recoverable Hydrocarbons - NEPM 2013 Fractions																		
C6 - C10 Fraction	mg/kg					4,400	5,100				170	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.024	0.012 U
C6 - C10 Fraction minus BTEX (F1)	mg/kg							125	180			0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.018	0.012 U
>C10 - C16 Fraction	mg/kg					3,300	3,800				150	0.198	0.216	1.554	4.092	3.192	0.762	0.246
>C16 - C34 Fraction	mg/kg					4,500	5,300				1,300	0.444	1.614	16.62	22.86	34.92	10.98	6.24
>C34 - C40 Fraction	mg/kg					6,300	7,400				5,600	0.072	0.6	3.834	4.092	18.18	2.616	1.656
>C10 - C40 Fraction (sum)	mg/kg											0.714	2.43	22.02	31.02	56.28	14.34	8.16
>C10 - C16 Fraction minus Naphthalene (F2)	µg/kg							25	120			198	0.216	1.554	4.092	3.192	0.762	0.246
Polynuclear Aromatic Hydrocarbons																		
3-Methylcholanthrene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
2-Methylnaphthalene	mg/kg			24	n							0.00006 U	0.00006	0.00306	0.0084	0.00024	0.00012	0.00084
7.12-Dimethylbenz(a)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Acenaphthene	mg/kg			360	n							0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Acenaphthylene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006	0.00006 U	0.00006 U	0.00006 U
Anthracene	mg/kg			1800	n							0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Benz(a)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Benzo(a)pyrene	mg/kg	3	3					0.7	0.7			0.00003 U	0.00003 U	0.000174	0.000756	0.00003 U	0.00003 U	0.00003 U
Benzo(b+j)fluoranthene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Benzo(e)pyrene	mg/kg											0.00006 U	0.00006 U	0.00018	0.00078	0.00006 U	0.00006 U	0.00006 U
Benzo(g,h,i)perylene	mg/kg											0.00006 U	0.00006 U	0.00018	0.00036	0.00006 U	0.00006 U	0.00018
Benzo(k)fluoranthene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Chrysene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Coronene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006	0.00006 U	0.00006 U	0.00018
Dibenz(a,h)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Fluoranthene	mg/kg			240	n							0.00006 U	0.00006 U	0.0003	0.00054	0.00006 U	0.00006 U	0.00012
Fluorene	mg/kg			240	n							0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Indeno(1.2.3.cd)pyrene	mg/kg											0.00006 U	0.00006 U	0.00006	0.00012	0.00006 U	0.00006 U	0.00006



Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Sample Date		A Residential	C Recreational			A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	21/10/2014	22/10/2014	23/10/2014	26/10/2014	27/10/2014	28/10/2014	30/10/2014
N-2-Fluorenyl Acetamide	mg/kg											0.00006 U	0.00006 U	0.00024	0.00006 U	0.00006 U	0.00006 U	0.00006 U
Naphthalene	mg/kg					1400	1900					0.00006 U	0.00012	0.0021	0.00726	0.0003	0.00036	0.0006
Perylene	mg/kg											0.00006 U	0.00006 U	0.00048	0.0018	0.00006 U	0.00006 U	0.00018
Phenanthrene	mg/kg											0.00006 U	0.00006 U	0.00072	0.0015	0.00006	0.00006 U	0.00024
Pyrene	mg/kg			180	n							0.00006 U	0.00006 U	0.0003	0.00102	0.00006 U	0.00006 U	0.00012
Sum of PAHs	mg/kg	300	300								20	0.00003 U	0.00012	0.00384	0.01218	0.00036	0.00036	0.00132
Benzo(a)pyrene TEQ (zero)	mg/kg											0.00003 U	0.00003 U	0.00018	0.00078	0.00003 U	0.00003 U	0.00003 U
Phenol	mg/kg	3000	40000									-	-	0.01668	0.003 U	0.00342 U	0.0309	0.0276
2-Chlorophenol	mg/kg			39	n							-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
2-Methylphenol	mg/kg											-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
3- & 4-Methylphenol	mg/kg											-	-	0.006 U	0.006 U	0.006 U	0.003 U	0.006 U
2-Nitrophenol	mg/kg											-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
2,4-Dimethylphenol	mg/kg			130	n							-	-	0.00354	0.00414	0.003 U	0.0015 U	0.003 U
2,4-Dichlorophenol	mg/kg			19	n							-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
2,6-Dichlorophenol	mg/kg											-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
4-Chloro-3-methylphenol	mg/kg											-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
2,4,6-Trichlorophenol	mg/kg			6.3	n							-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
2,4,5-Trichlorophenol	mg/kg			630	n							-	-	0.003 U	0.003 U	0.003 U	0.0015 U	0.003 U
Pentachlorophenol	mg/kg	100	120									-	-	0.006 U	0.006 U	0.006 U	0.003 U	0.006 U

Notes:  
**XXX** EXCEEDS RESIDENTIAL HILS OR RSLs  
**XXX** EXCEEDS RESIDENTIAL HSLs  
**XXX** EXCEEDS ECOLOGICAL

Resident Soil Notes:  
Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;

Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13
Sample Date		A Residential	C Recreational			A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	29/10/2014	41681	41740	42249.41667	42249.42708	42249.4375
Lab Parameters		Unit															
Ionic Balance												-	-	-	29.399706	25.533078	19.133142
Total Anions												-	-	-	1,073	2,337	4,600
Total Cations												-	-	-	1,280	2,000	4,067
pH	pH units/kg											11.8	12	11.7	8.64	8.74	8.98
Electrical conductivity (EC)	µS/kg											67,000	67,000	18,100	33,900	70,300	120,000
Total Dissolved Solids	mg/kg											26,160	23,880	6,240	12,780	28,620	55,860
Suspended Solids (SS)	mg/kg											142.8	92,400	14,400	-	-	-
Calcium	mg/kg											972	894	141	44.4	63	60
Magnesium	mg/kg											0.06 U	-	0.06 U	9	9.6	10.8
Sodium	mg/kg											1,386	1,698	1,356	1,704	2,226	6,480
Potassium	mg/kg											8,040	9,000	1,536	6,000	10,140	17,580
Chloride	mg/kg											12,420	9,660	3,606	6,480	14,220	27,600
Sulfate (as SO4)	mg/kg											110.4	60.6	41.4	158.4	382	1,530
Hydroxide Alkalinity as CaCO3												101.4	397	0.6 U	306	482	536
Carbonate Alkalinity as CaCO3	mg/kg											348	280	1,344	62.4	90.6	241
Bicarbonate Alkalinity as CaCO3	mg/kg											0.6 U	0.6 U	954	0.6 U	0.6 U	0.6 U
Total Alkalinity as CaCO3	mg/kg											450	678	2,304	368	573	780
Total Hardness as CaCO3	mg/kg											2,424	-	352	-	-	-
Dissolved Organic Carbon	mg/kg											-	-	-	24.6	79.2	171.6
Total Organic Carbon	mg/kg											-	-	-	30.6	89.4	179.4
Sodium Adsorption Ratio												9.48	-	24.36	47.22	53.46	156.6
Mercury - T	mg/kg	40	80									0.00006 U	0.0006 U	0.0003 U	0.00006 U	0.00006 U	0.00006 U
Fluoride	mg/kg			310	n							0.24	0.24	1.2 U	-	-	-
Ammonia as N	mg/kg											5.358	5.772	1.848	-	-	-
Nitrite as N	mg/kg			780	n							0.006 U	0.006 U	0.006	0.006 U	0.006 U	0.006 U
Nitrate as N	mg/kg			13000	n							0.006	0.006	0.012	0.048	0.048	0.03
Nitrite + Nitrate as N	mg/kg											0.006	0.006	0.018	0.048	0.048	0.03
Total Kjeldahl Nitrogen as N	mg/kg											6.42	54.96	9.3	1.74	2.76	9.3
Total Nitrogen as N (TKN + NOx)	mg/kg											6.42	54.96	9.3	1.8	2.82	9.36
Total Phosphorus as P	mg/kg											0.066	10.92	5.556	1.068	1.686	8.46
Total Metals																	
Aluminium - T	mg/kg			7700	n							1.074	340	27.12	0.144	0.006 U	0.006 U
Antimony - T	mg/kg											0.003 U	0.0126 U	0.0036	0.0006 U	0.0006 U	0.0006 U
Arsenic - T	mg/kg	100	300					40	100		200	0.003 U	0.2706	0.015	0.0006 U	0.006	0.0162
Barium - T	mg/kg			1500	n							4.818	14.1	1.668	1.056	0.93	0.816
Beryllium - T	mg/kg	60	90									0.003 U	0.0294	0.003 U	0.0006 U	0.0006 U	0.0006 U
Boron - T	mg/kg	4500	20000								100	0.0156 U	0.063 U	0.1704	0.366	0.552	2.04
Cadmium - T	mg/kg	20	90								3	0.0003 U	0.01032	0.00054	0.00006 U	0.00006 U	0.00006 U
Chromium - T	mg/kg	100	300								400	0.012	0.4332	0.0486	0.0006 U	0.0006 U	0.0006 U
Cobalt - T	mg/kg	100	300									0.003 U	0.417	0.0222	0.0006 U	0.0006 U	0.0006 U
Copper - T	mg/kg	6000	17000								100	0.021	1.746	0.1494	0.0006 U	0.0006 U	0.0006 U
Iron - T	mg/kg			5500	n							1.902	714	41.28	0.54	0.03 U	0.03 U
Lead - T	mg/kg	300	600					470	1100		600	0.003 U	0.714	0.0414	0.0006 U	0.0006 U	0.0006 U
Lithium - T	mg/kg			16	n							0.036	0.402	0.0528	0.222	0.1206	1.116
Manganese - T	mg/kg	3800	19000									0.0588	17.52	0.96	0.0372	0.0546	0.0162
Molybdenum - T	mg/kg			39	n							0.2106	0.1014	0.0942	0.0228	0.0174	0.135
Nickel - T	mg/kg	400	1200									0.0054	0.4488	0.0288	0.0042	0.0036	0.0072
Selenium - T	mg/kg	200	700		n						5	0.003 U	0.0804	0.003 U	0.006 U	0.006 U	0.006 U
Silver - T	mg/kg			39	n							0.003 U	0.0126 U	0.003 U	0.0006 U	0.0006 U	0.0006 U
Thorium - T	mg/kg											0.003 U	0.1326	0.0078	0.0006 U	0.0006 U	0.0006 U
Tin - T	mg/kg			4700	n							0.003 U	0.0126 U	0.003 U	0.0006 U	0.0006 U	0.0006 U
Uranium - T	mg/kg											0.003 U	0.0192	0.003 U	0.0006 U	0.0006 U	0.0006 U
Vanadium - T	mg/kg			39	n							0.0084	0.924	0.0576	0.006 U	0.006 U	0.006 U
Zinc - T	mg/kg	7400	30000									0.0204	3.528	0.1608	0.003 U	0.003 U	0.003 U
Glycols																	
2-Ethoxyethyl acetate	mg/kg			260	n							1.2 U	1.2 U	1.2 U	-	-	-
2-Butoxyethanol	mg/kg											1.2 U	1.2 U	1.2 U	-	-	-
Propylene glycol	mg/kg			130000	nm							1.2 U	1.2 U	1.2 U	-	-	-
Ethylene glycol	mg/kg			13000	n							1.2 U	1.2 U	1.2 U	-	-	-
Diethylene glycol monobutyl ether	mg/kg			190	n							1.2 U	1.2 U	1.2 U	-	-	-
Diethylene glycol	mg/kg											1.2 U	1.2 U	1.2 U	-	-	-
Triethylene glycol	mg/kg			13000	n							1.2 U	1.2 U	1.2 U	-	-	-

Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13
Sample Date		A Residential	C Recreational			A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	29/10/2014	41681	41740	42249.41667	42249.42708	42249.4375
Total Petroleum Hydrocarbons - Silica Gel Clean Up																	
C10 - C14 Fraction	mg/kg											0.03 U	0.372 U	0.12	0.03 U	0.03 U	0.03 U
C15 - C28 Fraction	mg/kg											0.132	9.72	2.226	0.06 U	0.06 U	0.06 U
C15 - C28 Fraction	µg/kg											-	-	-	0.03 U	0.03 U	0.03 U
C29 - C36 Fraction	mg/kg											0.042	8.82	1.98	-	-	-
C10 - C36 Fraction (sum)	mg/kg											0.174	18.54	4.326	0.03 U	0.03 U	0.03 U
Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup																	
>C10 - C16 Fraction	mg/kg					3,300	3,800				150	0.06 U	0.45 U	0.168	1.224	0.204	0.144
>C16 - C34 Fraction	mg/kg					4,500	5,300				1,300	0.162	17.04	3.774	0.75	0.54	0.558
>C34 - C40 Fraction	mg/kg					6,300	7,400				5,600	0.06 U	2.934	1.044	0.126	0.078	0.114
>C10 - C40 Fraction (sum)	mg/kg											0.162	19.98	4.986	2.1	0.822	0.816
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg											0.06 U	0.45 U	0.168	-	-	-
BTEXN																	
Benzene	mg/kg			1.2	c**	100	120	10	50	756	1	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
Toluene	mg/kg			490	n	14,000	18,000	65	105	4,719		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
Ethylbenzene	mg/kg			5.8	c*	4,500	5300	40	125	617		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
meta- & para-Xylene	mg/kg			55	n							0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
ortho-Xylene	mg/kg			65	n							0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
Total Xylenes	mg/kg			58	n	12000	15000	1.6	45	3782		0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U	0.0012 U
Sum of BTEX	mg/kg											0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U	0.0006 U
Naphthalene	mg/kg			3.8	c**	1400	1900					0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Total Petroleum Hydrocarbons																	
C6 - C9 Fraction	mg/kg											0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
C10 - C14 Fraction	mg/kg											0.042	0.45	0.57	1.182	0.126	0.108
C15 - C28 Fraction	mg/kg											0.246	13.62	3.678	0.696	0.57	0.468
C29 - C36Fraction	mg/kg											0.072	10.74	2.544	0.186	0.072	0.168
C10 - C36 Fraction (sum)	mg/kg											0.36	24.84	6.78	2.064	0.768	0.744
Total Recoverable Hydrocarbons - NEPM 2013 Fractions																	
C6 - C10 Fraction	mg/kg					4,400	5,100				170	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
C6 - C10 Fraction minus BTEX (F1)	mg/kg							125	180			0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U
>C10 - C16 Fraction	mg/kg					3,300	3,800				150	0.06 U	0.522	0.66	0.06 U	0.06 U	0.06 U
>C16 - C34 Fraction	mg/kg					4,500	5,300				1,300	0.3	22.5	5.568	0.06 U	0.06 U	0.06 U
>C34 - C40 Fraction	mg/kg					6,300	7,400				5,600	0.06 U	3.792	1.338	0.06 U	0.06 U	0.06 U
>C10 - C40 Fraction (sum)	mg/kg											0.3	26.82	7.56	0.06 U	0.06 U	0.06 U
>C10 - C16 Fraction minus Naphthalene (F2)	µg/kg							25	120			0.06 U	0.522	0.66	1.224	0.204	0.144
Polynuclear Aromatic Hydrocarbons																	
3-Methylcholanthrene	mg/kg											0.00006 U	0.00006 U	0.00006 U	-	-	-
2-Methylnaphthalene	mg/kg			24	n							0.00006	0.00042	0.00048	-	-	-
7.12-Dimethylbenz(a)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	-	-	-
Acenaphthene	mg/kg			360	n							0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Acenaphthylene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Anthracene	mg/kg			1800	n							0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Benz(a)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Benzo(a)pyrene	mg/kg	3	3					0.7	0.7			0.00003 U	0.00003 U	0.00003 U	0.0003 U	0.0003 U	0.0003 U
Benzo(b+j)fluoranthene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Benzo(e)pyrene	mg/kg											0.00006 U	0.00006 U	0.00006 U	-	-	-
Benzo(g,h,i)perylene	mg/kg											0.00006 U	0.00006	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Benzo(k)fluoranthene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Chrysene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Coronene	mg/kg											0.00006 U	0.00006 U	0.00006 U	-	-	-
Dibenz(a,h)anthracene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Fluoranthene	mg/kg			240	n							0.00006 U	0.00012	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Fluorene	mg/kg			240	n							0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Indeno(1.2.3.cd)pyrene	mg/kg											0.00006 U	0.00006 U	0.00006 U	0.0006 U	0.0006 U	0.0006 U

Table E-2  
Summary of Empirical Data for Geogenic Chemicals in Drilling Fluid Solids

Sample ID		Health Investigation Levels (HILs)		USEPA RSL Resident Soil (mg/kg)		Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 8	Sample 9	Sample 10	Sample 11	Sample 12	Sample 13
Sample Date		A Residential	C Recreational			A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	29/10/2014	41681	41740	42249.41667	42249.42708	42249.4375
N-2-Fluorenyl Acetamide	mg/kg											0.00006 U	0.00006 U	0.00006 U	-	-	-
Naphthalene	mg/kg					1400	1900					0.00006	0.00024	0.00096	0.0006 U	0.0006 U	0.0006 U
Perylene	mg/kg											0.00006 U	0.00024	0.00006 U	-	-	-
Phenanthrene	mg/kg											0.00006 U	0.00024	0.00012	0.0006 U	0.0006 U	0.0006 U
Pyrene	mg/kg			180	n							0.00006 U	0.00012	0.00006 U	0.0006 U	0.0006 U	0.0006 U
Sum of PAHs	mg/kg	300	300								20	0.00006	0.00078	0.00108	0.0003 U	0.0003 U	0.0003 U
Benzo(a)pyrene TEQ (zero)	mg/kg											0.00003 U	0.00003 U	0.00003 U	0.0003 U	0.0003 U	0.0003 U
Phenol	mg/kg	3000	40000									0.0006 U	0.00438	0.01068	-	-	-
2-Chlorophenol	mg/kg			39	n							0.0006 U	0.00372 U	0.0006 U	-	-	-
2-Methylphenol	mg/kg											0.0006 U	0.00372 U	0.0006 U	-	-	-
3- & 4-Methylphenol	mg/kg											0.0012 U	0.0075 U	0.0012 U	-	-	-
2-Nitrophenol	mg/kg											0.0006 U	0.00372 U	0.0006 U	-	-	-
2,4-Dimethylphenol	mg/kg			130	n							0.0006 U	0.00372 U	0.00072	-	-	-
2,4-Dichlorophenol	mg/kg			19	n							0.0006 U	0.00372 U	0.0006 U	-	-	-
2,6-Dichlorophenol	mg/kg											0.0006 U	0.00372 U	0.0006 U	-	-	-
4-Chloro-3-methylphenol	mg/kg											0.0006 U	0.00372 U	0.0006 U	-	-	-
2,4,6-Trichlorophenol	mg/kg			6.3	n							0.0006 U	0.00372 U	0.0006 U	-	-	-
2,4,5-Trichlorophenol	mg/kg			630	n							0.0006 U	0.00372 U	0.0006 U	-	-	-
Pentachlorophenol	mg/kg	100	120									0.0012 U	0.0075 U	0.0018 U	-	-	-

Notes:

XXX EXCEEDS RESIDENTIAL HILS OR RSLs  
XXX EXCEEDS RESIDENTIAL HSLs  
XXX EXCEEDS ECOLOGICAL

Resident Soil Notes:

Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;

Table E-3  
Summary of Empirical Data for Geogenic Chemicals in Drill Cuttings

Sample ID				Health Investigation Levels (HILs)		Resident Soil (mg/kg)	Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24	Sample 25	Sample 26	
Sample Date				A Residential	C Recreational		A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015		
Lab Parameters	FRACTION	UNIT	LIMIT OF RESULT																							
Bicarbonate Alkalinity as CaCO3	N	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Carbonate Alkalinity as CaCO3	N	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Hydroxide Alkalinity as CaCO3	N	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Total Alkalinity as CaCO3	N	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Bicarbonate Alkalinity as CaCO3	N	mg/kg	1									237	324	166	136	244	204	288	1 U	202	153	1040	661	446		
Carbonate Alkalinity as CaCO3	N	mg/kg	1									91	53	89	16	1 U	1 U	1 U	277	50	16	1 U	1 U	1 U		
Total Alkalinity as CaCO3	N	mg/kg	1									328	376	256	152	244	204	288	2260	252	169	1040	661	446		
Electrical Conductivity @ 25°C	N	µS/cm	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Electrical Conductivity @ 25°C	N	µS/cm	1									3,670	8,140	4,150	15,800	12,400	10,300	18,400	11,500	11,700	13,700	14,000	12,500	7,160		
Total Dissolved Solids @180°C	T	mg/L	10									-	-	-	-	-	-	-	-	-	-	-	-	-		
Mercury	T	mg/kg	0.1	40	80							0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U		
Calcium	D	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Magnesium	D	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Potassium	D	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Sodium	D	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Calcium	D	mg/kg	10									40	80	40	1130	710	410	1650	800	400	440	910	1230	280		
Magnesium	D	mg/kg	10									20	40	10 U	10 U	20	30	40	10 U	110	130	120	120	50		
Potassium	D	mg/kg	10									4,620	10,500	4,780	20,100	16,100	12,800	22,500	14,200	13,600	16,000	14,300	10,600	7,840		
Sodium	D	mg/kg	10									520	1390	790	3290	2640	2390	4280	3340	3360	3750	5040	5820	2000		
Sodium Adsorption Ratio	N	-	0.01									-	-	-	-	-	-	-	-	-	-	-	-	-		
Chloride	N	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Chloride	N	mg/kg	10									5,690	13,900	6,150	30,000	23,000	18,500	35,800	21,900	22,000	25,100	24,900	23,600	11,900		
pH - Lab	N	pH Unit	0.01									-	-	-	-	-	-	-	-	-	-	-	-	-		
pH - Lab	N	pH Unit	0.1									9	9.2	9.4	9.1	8.9	8.8	8.5	11.9	9	8.9	8.2	8.3	8.6		
Nitrate as N (Sol.)	N	mg/kg	0.1									0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U		
Nitrate as N (Sol.)	N	mg/kg	0.1									0.1 U	0.1	0.1 U	0.4	0.1	0.1 U	0.1	0.1 U	0.2	0.2	0.4	0.1	0.1		
Total Kjeldahl Nitrogen as N	N	mg/kg	20									100	470	210	340	430	420	320	350	640	1290	400	280	200		
Total Nitrogen as N	N	mg/kg	20									100	470	210	340	430	420	320	350	640	1290	400	280	200		
Nitrite + Nitrate as N (Sol.)	N	mg/kg	0.1									0.1 U	0.1	0.1 U	0.4	0.1	0.1 U	0.1	0.1 U	0.2	0.2	0.4	0.1	0.1		
Total Phosphorus as P	N	mg/kg	2									116	169	166	272	195	216	252	220	292	251	269	235	186		
Sulfate as SO4 2-	D	mg/L	1									-	-	-	-	-	-	-	-	-	-	-	-	-		
Algae - Field	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Clarity - Field	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Colour - Field	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Dominant Horizon	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Hydrocarbon - Field	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Moisture	N	No Unit	0.001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Mottled	N	No Unit	0.05									-	-	-	-	-	-	-	-	-	-	-	-	-		
Odour - Field	N	No Unit	0.05									-	-	-	-	-	-	-	-	-	-	-	-	-		
Texture	N	No Unit	0.0001									-	-	-	-	-	-	-	-	-	-	-	-	-		
Moisture Content (dried @ 103°C)	N	%	1									10.5	10	6.8	11.4	10.9	9.8	9.3	21.7	9.1	7.8	6.2	7	9.9		
Sulfate as SO4 2-	D	mg/kg	10									130	190	90	490	360	250	500	250	140	150	220	140	120		
Total Organic Carbon	N	%	0.02									0.59	2.77	2.51	4.4	3.68	3.53	1.63	1.74	5.42	5.25	1.26	0.74	0.65		
Total Soluble Salts	N	mg/kg	5									11,900	26,400	13,500	51,200	40,300	33,400	59,900	37,400	38,000	44,600	45,500	40,700	23,300		
Sodium Adsorption Ratio	N	-	0.01									17.8	30.3	30.5	25.3	26.1	31.9	30.1	21	35.5	40.4	41.4	43	27.3		
Aluminium	T	mg/kg	50			7700	n					6,400	6,820	4,170	9,330	9,390	9,620	9,310	13,800	8,750	9,520	9,270	9,270	7,860		
Antimony	T	mg/kg	5									5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U		
Arsenic	T	mg/kg	5	100	300				40	100	200	5 U	5 U	5 U	5 U	5 U	5 U	5	9	5	5 U	5 U	5 U	5 U		
Barium	T																									

Table E-3  
Summary of Empirical Data for Geogenic Chemicals in Drill Cuttings

Sample ID				Health Investigation Levels (HILs)		Resident Soil (mg/kg)	Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 14	Sample 15	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20	Sample 21	Sample 22	Sample 23	Sample 24	Sample 25	Sample 26	
Sample Date				A Residential	C Recreational		A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015		
Lab Parameters		FRACTION	UNIT	LIMIT OF RESULT																						
>C10 - C40 Fraction (sum)		N	mg/kg	50									50 U	50 U	50 U	210	50 U	250	50 U	50 U	160	160	120	50 U	50 U	
>C16 - C34 Fraction		N	mg/kg	100				4,500	5,300			1,300	100 U	100 U	100 U	210	100 U	250	100 U	100 U	160	160	120	100 U	100 U	
>C34 - C40 Fraction		N	mg/kg	100				6,300	7,400			5,600	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	
C10 - C14 Fraction		N	mg/kg	50									50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	
C10 - C36 Fraction (sum)		N	mg/kg	50									50 U	50 U	50 U	150	50 U	290	50 U	50 U	110	120	50 U	50 U	50 U	
C15 - C28 Fraction		N	mg/kg	100									100 U	100 U	100 U	150	100 U	180	100 U	100 U	110	120	100 U	100 U	100 U	
C29 - C36 Fraction		N	mg/kg	100									100 U	100 U	100 U	100 U	100 U	110	100 U	100 U	100 U	100 U	100 U	100 U	100 U	
Benzene		N	mg/kg	0.2			1.2 c**	100	120	10	50	756	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
C6 - C10 Fraction		N	mg/kg	10				4,400	5,100				170	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	
C6 - C10 Fraction minus BTEX (F1)		N	mg/kg	10						125	180			10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	
C6 - C9 Fraction		N	mg/kg	10										10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	
Ethylbenzene		N	mg/kg	0.5			5.8 c*	4,500	5300	40	125	617		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
meta- & para-Xylene		N	mg/kg	0.5			55 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.8	0.5 U	
Naphthalene		N	mg/kg	1				1400	1900					1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	
ortho-Xylene		N	mg/kg	0.5			65 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Sum of BTEX		N	mg/kg	0.2										0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	1.5	0.2 U	
Toluene		N	mg/kg	0.5			490 n	4,500	5300	40	125	617		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.7	0.5 U	
Total Xylenes		N	mg/kg	0.5			58 n	12000	15000	1.6	45	3782		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.8	0.5 U	
Acenaphthene		N	mg/kg	0.5			360 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Acenaphthylene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Anthracene		N	mg/kg	0.5			1800 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benz(a)anthracene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benzo(a)pyrene		N	mg/kg	0.5	3	3				0.7	0.7			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benzo(a)pyrene TEQ (Half LOR)		N	mg/kg	0.5										0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Benzo(a)pyrene TEQ (LOR)		N	mg/kg	0.5										1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	
Benzo(a)pyrene TEQ (zero)		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benzo(b+j)fluoranthene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benzo(g,h,i)perylene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Benzo(k)fluoranthene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Chrysene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Dibenz(a,h)anthracene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Fluoranthene		N	mg/kg	0.5			240 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Fluorene		N	mg/kg	0.5			240 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Indeno(1.2.3.cd)pyrene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Naphthalene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6	0.5 U	0.5 U	
Phenanthrene		N	mg/kg	0.5										0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Pyrene		N	mg/kg	0.5			180 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
Sum of polycyclic aromatic hydrocarbons (PAHs)		N	mg/kg	0.5	300	300						20		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.6	0.5 U	0.5 U	

Notes	
BLANK CELL	Information
FRACTION	T - Total
	D - Dissolved
	N - Null
SAMPLE TYPE	N - Normal
	TB - Trip
	NST - No
WORKORDER (Empty)	FD - Field
	Field

Resident Soil Notes:  
Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X  
= APPENDIX PPRTV SCREEN (See FAQ #27); H =  
HEAST; F = See FAQ; J = New Jersey; O = EPA  
Office of Water; E = see user guide Section 2.3.5;

XXX EXCEEDS RESIDENTIAL HILS or RSLs  
XXX EXCEEDS RESIDENTIAL HSLs  
XXX EXCEEDS ECOLOGICAL

**Table E-3**  
**Summary of Empirical Data for Geogenic Chemicals in Drill Cuttings**

Sample ID				Health Investigation Levels (HILs)		Resident Soil (mg/kg)	Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 27	Sample 28	Sample 29	Sample 30	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36	Sample 37	Sample 38	Sample 39
Sample Date				A Residential	C Recreational		A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	
Lab Parameters		FRACTION	UNIT	LIMIT OF RESULT																					
Bicarbonate Alkalinity as CaCO3		N	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	2140	
Carbonate Alkalinity as CaCO3		N	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	1 U	
Hydroxide Alkalinity as CaCO3		N	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	1 U	
Total Alkalinity as CaCO3		N	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	2140	
Bicarbonate Alkalinity as CaCO3		N	mg/kg	1								653	454	870	222	236	161	200	887	460	618	510	702		
Carbonate Alkalinity as CaCO3		N	mg/kg	1								16	25	1 U	1 U	1 U	30	19	8	193	1 U	1 U	137		
Total Alkalinity as CaCO3		N	mg/kg	1								670	479	870	222	236	191	219	895	653	618	510	839		
Electrical Conductivity @ 25°C		N	µS/cm	1								-	-	-	-	-	-	-	-	-	-	-	-	150000	
Electrical Conductivity @ 25°C		N	µS/cm	1								5,660	4,510	27,600	14,000	11,800	6,380	5,980	5,050	5,380	5,450	9,840	4,270	-	
Total Dissolved Solids @180°C		T	mg/L	10								-	-	-	-	-	-	-	-	-	-	-	-	110000	
Mercury		T	mg/kg	0.1	40	80						0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U		
Calcium		D	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	459	
Magnesium		D	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	78	
Potassium		D	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	49500	
Sodium		D	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	4960	
Calcium		D	mg/kg	10								150	80	1420	620	490	150	130	300	50	170	180	60	-	
Magnesium		D	mg/kg	10								40	10 U	250	40	20	10 U	10 U	10	10 U	10 U	40	10 U	-	
Potassium		D	mg/kg	10								7,770	5,240	37,000	16,700	14,400	8,580	7,210	9,460	7,760	9,060	16,000	5,920	-	
Sodium		D	mg/kg	10								1040	1570	11400	2620	1790	1150	1250	1600	1330	1580	3240	930	-	
Sodium Adsorption Ratio		N	-	0.01								-	-	-	-	-	-	-	-	-	-	-	-	56.2	
Chloride		N	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	48600	
Chloride		N	mg/kg	10								8,990	7,470	52,200	24,000	19,500	11,100	9,620	11,800	9,530	10,800	23,000	6,870	-	
pH - Lab		N	pH Unit	0.01								-	-	-	-	-	-	-	-	-	-	-	-	7.48	
pH - Lab		N	pH Unit	0.1								8.8	9	8.3	8.5	8.6	9	9	8.4	9.3	8.6	8.6	9.2	-	
Nitrate as N (Sol.)		N	mg/kg	0.1								0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.3	0.1 U	-	
Nitrate as N (Sol.)		N	mg/kg	0.1								0.3	0.1 U	0.4	0.4	0.3	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	-	
Total Kjeldahl Nitrogen as N		N	mg/kg	20								150	280	390	450	540	430	550	740	490	700	730	410	-	
Total Nitrogen as N		N	mg/kg	20								150	280	390	450	540	430	550	740	490	700	730	410	-	
Nitrite + Nitrate as N (Sol.)		N	mg/kg	0.1								0.3	0.1 U	0.4	0.4	0.3	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.3	0.1 U	-	
Total Phosphorus as P		N	mg/kg	2								170	243	227	284	240	290	223	371	322	316	284	328	-	
Sulfate as SO4 2-		D	mg/L	1								-	-	-	-	-	-	-	-	-	-	-	-	628	
Algae - Field		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Clarity - Field		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Colour - Field		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Dominant Horizon		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Hydrocarbon - Field		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Moisture		N	No Unit	0.001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Mottled		N	No Unit	0.05								-	-	-	-	-	-	-	-	-	-	-	-	-	
Odour - Field		N	No Unit	0.05								-	-	-	-	-	-	-	-	-	-	-	-	-	
Texture		N	No Unit	0.0001								-	-	-	-	-	-	-	-	-	-	-	-	-	
Moisture Content (dried @ 103°C)		N	%	1								15.9	16.1	4.2	3.3	2.2	13.1	7.6	39.6	19.8	30.4	28.6	19.8	-	
Sulfate as SO4 2-		D	mg/kg	10								120	120	250	90	120	150	130	950	390	1260	930	760	-	
Total Organic Carbon		N	%	0.02								0.76	2.33	1.34	2.05	2.17	2.35	1.8	2.11	1.21	2.67	3.03	1.81	-	
Total Soluble Salts		N	mg/kg	5								18,400	14,600	89,600	45,400	38,500	20,700	19,400	16,400	17,500	17,700	32,000	13,900	-	
Sodium Adsorption Ratio		N	-	0.01								16	41.5	53.2	26.1	18.7	23.5	27.2	27.7	43	27.8	50.5	27	-	
Aluminium		T	mg/kg	50		7700	n					7,310	9,570	9,130	9,920	9,670	9,820	9,930	9,510	9,350	11,400	10,300	10,600	-	
Antimony		T	mg/kg	5								5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	-	
Arsenic		T	mg/kg	5	100	300			40	100	200	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5	5 U	7	5 U	6	-	
Barium		T	mg/kg	10		1500	n					50	70	160	1240	1500	1100	500	480	70	260	150	60	-	
Beryllium		T	mg/kg	1	60	90						1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	-	
Boron		T	mg/kg	50	4500	20000					100	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	-	
Cadmium		T	mg/kg	1	20	90					3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	-	
Chromium		T	mg/kg	2	100	300					400	10	10	12	9	10	10	9	39	11	103	49	12	-	
Cobalt		T	mg/kg	2	100	300						9	12	12	13	12	12	12	14	11	15	12	11	-	
Copper		T	mg/kg	5	6000	17000					100	109	21	59	30	31	29	34	68	26	78	52	22	-	
Iron		T	mg/kg	50		5500	n					17,400	18,000	19,400	17,200	16,800	23,800	20,100	28,300	16,700	36,200	27,600	19,600	-	
Lead		T	mg/kg	5	300	600			470	1100	600	7	10	13	10	11	14	11	22	18	22	15	18	-	
Manganese		T	mg/kg	5	3800	19000						397	564	455	382	401	592	456	380	293	558	442	349	-	
Molybdenum		T	mg/kg	2		39	n					2 U	2 U	2 U	2 U	2 U	2 U	2 U	7	2 U	5	3	2 U	-	
Nickel		T	mg/kg	2	400	1200						11	12	11	11	12	12	12	24	11	25	18	12	-	
Selenium		T	mg/kg	5	200	700					5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	-	
Silver		T	mg/kg	2		39	n					2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	-	
Tin		T	mg/kg	5		4700	n					5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	-	
Vanadium		T	mg/kg	5		39	n					21	32	26	27	25	28	28	25	24	30	26	29	-	
Zinc		T	mg/kg	5	7400	30000						60	66	86	75	68	80	78	100	82	114	97	82	-	
Lithium		T	mg/kg	0.1		16	n					7.1	7.4	10	8.3	8.7	8.3	8.6	7.5	7.5	11.1	9.4	10.4	-	
Thorium		T	mg/kg	0.1								3.2	3.5	4	3.4	3.8	3.6	3.8	2.8	3	3.8	3.1	3.4	-	
Uranium		T	mg/kg	0.1								0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.3	0.3	0.4	0.3	0.3	-	
>C10 - C16 Fraction		N	mg/kg	50				3,300	3,800		150	50 U	50 U	50 U	50 U	50 U	50 U	50 U	90	50 U	50 U	50 U	80	-	
>C10 - C16 Fraction minus Naphthalene (F2)		N	mg/kg	50						25	120	50 U	50 U	50 U	50 U	50 U	50 U	50 U	90	50 U	50 U	50 U	80	-	



Table E-3  
Summary of Empirical Data for Geogenic Chemicals in Drill Cuttings

Sample ID				Health Investigation Levels (HILs)		Resident Soil (mg/kg)	Health Screening Levels (HSLs)*		Ecological Screen Levels		API	Model EA	Sample 27	Sample 28	Sample 29	Sample 30	Sample 31	Sample 32	Sample 33	Sample 34	Sample 35	Sample 36	Sample 37	Sample 38	Sample 39
Sample Date				A Residential	C Recreational		A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space	(Livestock)	Conditions	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	12/1/2015	
Lab Parameters		FRACTION	UNIT	LIMIT OF RESULT																					
>C10 - C40 Fraction (sum)		N	mg/kg	50									50 U	50 U	50 U	50 U	50 U	50 U	50 U	410	50 U	240	50 U	360	
>C16 - C34 Fraction		N	mg/kg	100				4,500	5,300			1,300	100 U	100 U	100 U	100 U	100 U	100 U	100 U	320	100 U	240	100 U	280	
>C34 - C40 Fraction		N	mg/kg	100				6,300	7,400			5,600	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	100 U	-
C10 - C14 Fraction		N	mg/kg	50									50 U	50 U	50 U	50 U	50 U	50 U	50 U	50	50 U	50 U	50 U	50 U	-
C10 - C36 Fraction (sum)		N	mg/kg	50									50 U	50 U	50 U	50 U	50 U	50 U	50 U	430	50 U	260	50 U	260	-
C15 - C28 Fraction		N	mg/kg	100									100 U	100 U	100 U	100 U	100 U	100 U	100 U	270	100 U	150	100 U	260	-
C29 - C36 Fraction		N	mg/kg	100									100 U	100 U	100 U	100 U	100 U	100 U	100 U	110	100 U	110	100 U	100 U	-
Benzene		N	mg/kg	0.2		1.2 c**	100	120	10	50	756	1	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	-
C6 - C10 Fraction		N	mg/kg	10			4,400	5,100				170	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	-
C6 - C10 Fraction minus BTEX (F1)		N	mg/kg	10					125	180			10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	-
C6 - C9 Fraction		N	mg/kg	10									10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	-
Ethylbenzene		N	mg/kg	0.5		5.8 c*	4,500	5300	40	125	617		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
meta- & para-Xylene		N	mg/kg	0.5		55 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Naphthalene		N	mg/kg	1			1400	1900					1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	-
ortho-Xylene		N	mg/kg	0.5		65 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Sum of BTEX		N	mg/kg	0.2									0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	-
Toluene		N	mg/kg	0.5		490 n	4,500	5300	40	125	617		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Total Xylenes		N	mg/kg	0.5		58 n	12000	15000	1.6	45	3782		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Acenaphthene		N	mg/kg	0.5		360 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Acenaphthylene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Anthracene		N	mg/kg	0.5		1800 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benz(a)anthracene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benzo(a)pyrene		N	mg/kg	0.5	3	3			0.7	0.7			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benzo(a)pyrene TEQ (Half LOR)		N	mg/kg	0.5									0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	-
Benzo(a)pyrene TEQ (LOR)		N	mg/kg	0.5									1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	-
Benzo(a)pyrene TEQ (zero)		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benzo(b+j)fluoranthene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benzo(g,h,i)perylene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Benzo(k)fluoranthene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Chrysene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Dibenz(a,h)anthracene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Fluoranthene		N	mg/kg	0.5		240 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Fluorene		N	mg/kg	0.5		240 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Indeno(1.2.3.cd)pyrene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Naphthalene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Phenanthrene		N	mg/kg	0.5									0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Pyrene		N	mg/kg	0.5		180 n							0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-
Sum of polycyclic aromatic hydrocarbons (PAHs)		N	mg/kg	0.5	300	300						20	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	-

Notes		XXX	EXCEEDS RESIDENTIAL HILS or RSLs
BLANK CELL	Information	XXX	EXCEEDS RESIDENTIAL HSLs
FRACTION	T - Total	XXX	EXCEEDS ECOLOGICAL
	D - Dissolved		
	N - Null		
SAMPLE TYPE	N - Normal		
	TB - Trip		
	NST - No		
WORKORDER (Empty)	FD - Field		
	Field		

Resident Soil Notes:  
Key: I = IRIS; P = PPRTV; A = ATSDR; C = Cal EPA; X  
= APPENDIX PPRTV SCREEN (See FAQ #27); H =  
HEAST; F = See FAQ; J = New Jersey; O = EPA  
Office of Water; E = see user guide Section 2.3.5;



**Table E-4**  
**Summary of Geogenic Chemicals in Aqueous Drilling Fluids Descriptive Statistics**

Chemical	Units	Minimum	Maximum	Average	Frequency	Frequency Detection Exceeds Criteria			Aquatic Ecosystems Criteria
						Detection Limit Range	Drinking Water	Stock Water	
Ionic Balance		5.74	8.82	7.41	3 / 3	NA	0 / 3	0 / 3	0 / 3
Total Anions		322	1380	801	3 / 3	NA	0 / 3	0 / 3	0 / 3
Total Cations		384	1220	735	3 / 3	NA	0 / 3	0 / 3	0 / 3
pH	pH units	8.56	12	10.4	13 / 13	NA	13 / 13	0 / 13	13 / 13
Electrical conductivity (EC)	µS/cm	6470	120000	48967	13 / 13	NA	0 / 13	0 / 13	0 / 13
Total Dissolved Solids	mg/L	3370	93100	33572	13 / 13	NA	13 / 13	0 / 13	13 / 13
Suspended Solids (SS)	mg/L	238	154000	54871	9 / 10	5	0 / 9	0 / 9	0 / 9
Calcium	mg/L	34.8	1620	663.8	13 / 13	NA	0 / 13	5 / 13	0 / 13
Magnesium	mg/L	15	26.6	18.9	4 / 12	0.1	0 / 4	4 / 4	0 / 4
Sodium	mg/L	596	10800	2891	13 / 13	NA	13 / 13	9 / 13	0 / 13
Potassium	mg/L	216	29300	11199	13 / 13	NA	0 / 13	0 / 13	0 / 13
Chloride	mg/L	1470	46000	15345	13 / 13	NA	13 / 13	0 / 13	0 / 13
Sulfate (as SO <sub>4</sub> )	mg/L	19	2550	336	13 / 13	NA	0 / 13	0 / 13	0 / 13
Hydroxide Alkalinity as CaCO <sub>3</sub>		58	1640	632.875	8 / 13	1	0 / 8	0 / 8	0 / 8
Carbonate Alkalinity as CaCO <sub>3</sub>	mg/L	34	3680	742	13 / 13	NA	0 / 13	0 / 13	0 / 13
Bicarbonate Alkalinity as CaCO <sub>3</sub>	mg/L	5	3440	1392	6 / 13	1	0 / 6	0 / 6	0 / 6
Total Alkalinity as CaCO <sub>3</sub>	mg/L	270	7120	1775	13 / 13	NA	0 / 13	0 / 13	0 / 13
Total Hardness as CaCO <sub>3</sub>	mg/L	87	4040	1916	9 / 9	NA	7 / 9	0 / 9	0 / 9
Dissolved Organic Carbon	mg/L	41	286	153	3 / 3	NA	0 / 3	0 / 3	0 / 3
Total Organic Carbon	mg/L	51	299	166	3 / 3	NA	0 / 3	0 / 3	0 / 3
Sodium Adsorption Ratio		6.74	261	59.1	12 / 12	NA	0 / 12	0 / 12	0 / 12
Mercury - T	mg/L	0.0012	0.0012	0.0012	1 / 13	0.0001-0.001	1 / 1	0 / 1	0 / 1
Mercury - D	mg/L	ND	ND	ND	0 / 3	0.0001	0 / 0	0 / 0	0 / 0
Fluoride	mg/L	0.3	0.8	0.45	6 / 10	0.1-4	0 / 6	0 / 6	0 / 6
Ammonia as N	mg/L	0.97	9.62	5.935	10 / 10	NA	10 / 10	0 / 10	0 / 10
Nitrite as N	mg/L	0.01	0.02	0.0186	7 / 13	0.01	0 / 7	0 / 7	0 / 7
Nitrate as N	mg/L	0.01	0.08	0.03	11 / 13	0.01	0 / 11	0 / 11	0 / 11
Nitrite + Nitrate as N	mg/L	0.01	0.08	0.0358	12 / 13	0.01	0 / 12	0 / 12	0 / 12
Total Kjeldahl Nitrogen as N	mg/L	2.9	91.6	27.4	13 / 13	NA	0 / 13	0 / 13	0 / 13
Total Nitrogen as N (TKN + NO <sub>x</sub> )	mg/L	3	91.6	27.4	13 / 13	NA	0 / 13	0 / 13	0 / 13
Total Phosphorus as P	mg/L	0.11	19.6	9.62	13 / 13	NA	0 / 13	0 / 13	0 / 13
Aluminium - T	mg/L	0.24	1030	334	11 / 13	0.01	11 / 11	8 / 11	7 / 11
Aluminium - D	mg/L	0.15	0.15	0.15	1 / 3	0.01	0 / 1	0 / 1	0 / 1
Antimony - T	mg/L	0.006	0.011	0.0085	2 / 13	0.001-0.052	0 / 2	0 / 2	0 / 2
Antimony - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Arsenic - T	mg/L	0.01	0.451	0.224	10 / 13	0.001-0.021	10 / 10	0 / 10	0 / 10
Arsenic - D	mg/L	0.006	0.024	0.013	3 / 3	NA	0 / 3	0 / 3	0 / 3
Barium - T	mg/L	1.36	45.7	15.5	13 / 13	NA	10 / 13	0 / 13	9 / 13
Barium - D	mg/L	1.28	1.78	1.51	3 / 3	NA	0 / 3	0 / 3	0 / 3
Beryllium - T	mg/L	0.01	0.074	0.0482	5 / 13	0.001-0.052	0 / 5	0 / 5	0 / 5
Beryllium - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Boron - T	mg/L	0.284	3.4	1.146	7 / 13	0.026-0.262	0 / 7	0 / 7	0 / 7
Boron - D	mg/L	0.9	3.85	1.94	3 / 3	NA	0 / 3	0 / 3	0 / 3
Cadmium - T	mg/L	0.0009	0.0194	0.0122	8 / 13	0.0001-0.0021	7 / 8	0 / 8	0 / 8
Cadmium - D	mg/L	ND	ND	ND	0 / 3	0.0001	0 / 0	0 / 0	0 / 0
Chromium - T	mg/L	0.02	1.3	0.573	10 / 13	0.001	8 / 10	1 / 10	1 / 10
Chromium - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Cobalt - T	mg/L	0.037	1.24	0.632	8 / 13	0.001-0.021	8 / 8	0 / 8	0 / 8
Cobalt - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Copper - T	mg/L	0.035	7.67	2.78	10 / 13	0.001	6 / 10	7 / 10	6 / 10
Copper - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Iron - T	mg/L	0.9	2010	758	11 / 13	0.05	11 / 11	8 / 11	0 / 11
Iron - D	mg/L	0.23	0.23	0.23	1 / 3	0.05	0 / 1	0 / 1	0 / 1
Lead - T	mg/L	0.069	1.55	0.898	8 / 13	0.001-0.021	8 / 8	7 / 8	0 / 8
Lead - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Lithium - T	mg/L	0.027	1.86	0.550	13 / 13	NA	13 / 13	0 / 13	0 / 13
Lithium - D	mg/L	0.224	2.16	0.964	3 / 3	NA	0 / 3	0 / 3	0 / 3
Manganese - T	mg/L	0.027	46.3	15.3	13 / 13	NA	8 / 13	6 / 13	0 / 13
Manganese - D	mg/L	0.017	0.082	0.043	3 / 3	NA	0 / 3	0 / 3	0 / 3
Molybdenum - T	mg/L	0.029	0.351	0.161	12 / 13	0.052	12 / 12	0 / 12	0 / 12
Molybdenum - D	mg/L	0.023	0.192	0.0873	3 / 3	NA	0 / 3	0 / 3	0 / 3
Nickel - T	mg/L	0.006	1.18	0.441	12 / 12	NA	8 / 12	2 / 12	0 / 12
Nickel - D	mg/L	0.006	0.012	0.00833	3 / 3	NA	0 / 3	0 / 3	0 / 3
Selenium - T	mg/L	0.009	0.134	0.0608	4 / 13	0.005-0.052	3 / 4	3 / 4	0 / 4
Selenium - D	mg/L	ND	ND	ND	0 / 3	0.01	0 / 0	0 / 0	0 / 0
Silver - T	mg/L	ND	ND	ND	0 / 13	0.001-0.052	0 / 0	0 / 0	0 / 0
Silver - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Thorium - T	mg/L	0.013	0.265	0.1435	8 / 13	0.001-0.021	0 / 8	0 / 8	0 / 8
Thorium - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Tin - T	mg/L	ND	ND	ND	0 / 13	0.001-0.052	0 / 0	0 / 0	0 / 0
Tin - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Uranium - T	mg/L	0.007	0.032	0.020	3 / 13	0.001-0.052	0 / 3	0 / 3	0 / 3
Uranium - D	mg/L	ND	ND	ND	0 / 3	0.001	0 / 0	0 / 0	0 / 0
Vanadium - T	mg/L	0.014	2.65	0.968	10 / 13	0.01	10 / 10	0 / 10	0 / 10
Vanadium - D	mg/L	ND	ND	ND	0 / 3	0.01	0 / 0	0 / 0	0 / 0
Zinc - T	mg/L	0.024	8.9	4.02	10 / 13	0.005	6 / 10	0 / 10	1 / 10

**Table E-4**  
**Summary of Geogenic Chemicals in Aqueous Drilling Fluids Descriptive Statistics**

Chemical	Units	Minimum	Maximum	Average	Frequency	Frequency Detection Exceeds Criteria			Aquatic Ecosystems Criteria
						Detection Limit Range	Drinking Water	Stock Water	
Zinc - D	mg/L	ND	ND	ND	0 / 3	0.005	0 / 0	0 / 0	0 / 0
Glycols		ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0
2-Ethoxyethyl acetate	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
2-Butoxyethanol	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
Propylene glycol	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
Ethylene glycol	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
Diethylene glycol monobutyl ether	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
Diethylene glycol	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
Triethylene glycol	mg/L	ND	ND	ND	0 / 10	2	0 / 0	0 / 0	0 / 0
C10 - C14 Fraction	mg/L	0.2	2.28	1.09	4 / 13	0.05-0.62	0 / 4	0 / 4	0 / 4
C15 - C28 Fraction	mg/L	0.12	27.4	9.36	10 / 13	0.1	0 / 10	0 / 10	0 / 10
C15 - C28 Fraction	µg/L	ND	ND	ND	0 / 3	0.05	0 / 0	0 / 0	0 / 0
C29 - C36 Fraction	mg/L	0.07	29.5	8.18	10 / 10	NA	0 / 10	0 / 10	0 / 10
C10 - C36 Fraction (sum)	mg/L	0.19	59.2	18.0	10 / 13	0.05	0 / 10	0 / 10	0 / 10
>C10 - C16 Fraction	mg/L	0.24	5	1.76	7 / 13	0.1-0.75	0 / 7	0 / 7	0 / 7
>C16 - C34 Fraction	mg/L	0.18	47.4	11.91	13 / 13	NA	0 / 13	0 / 13	0 / 13
>C34 - C40 Fraction	mg/L	0.13	27.7	4.56	11 / 13	0.1	0 / 11	0 / 11	0 / 11
>C10 - C40 Fraction (sum)	mg/L	0.18	78.5	16.71	13 / 13	NA	0 / 13	0 / 13	0 / 13
>C10 - C16 Fraction minus Naphthalene (F2)	mg/L	0.95	5	3.13	3 / 9	0.1-0.75	0 / 3	0 / 3	0 / 3
Benzene	mg/L	ND	ND	ND	0 / 13	0.001	0 / 0	0 / 0	0 / 0
Toluene	mg/L	0.005	0.005	0.005	1 / 13	0.002	0 / 1	0 / 1	0 / 1
Ethylbenzene	mg/L	ND	ND	ND	0 / 13	0.002	0 / 0	0 / 0	0 / 0
meta- & para-Xylene	mg/L	0.003	0.003	0.003	1 / 13	0.002	0 / 1	0 / 1	0 / 1
ortho-Xylene	mg/L	0.004	0.004	0.004	1 / 13	0.002	0 / 1	0 / 1	0 / 1
Total Xylenes	mg/L	0.007	0.007	0.007	1 / 13	0.002	0 / 1	0 / 1	0 / 1
Sum of BTEX	mg/L	0.012	0.012	0.012	1 / 13	0.001	0 / 1	0 / 1	0 / 1
Naphthalene	mg/L	ND	ND	ND	0 / 13	0.005	0 / 0	0 / 0	0 / 0
C6 - C9 Fraction	mg/L	0.03	0.03	0.03	1 / 13	0.02	0 / 1	0 / 1	0 / 1
C10 - C14 Fraction	mg/L	0.07	3.56	1.09	13 / 13	NA	0 / 13	0 / 13	0 / 13
C15 - C28 Fraction	mg/L	0.41	35.6	10.46	13 / 13	NA	0 / 13	0 / 13	0 / 13
C29 - C36 Fraction	mg/L	0.12	34	7.85	13 / 13	NA	0 / 13	0 / 13	0 / 13
C10 - C36 Fraction (sum)	mg/L	0.6	73.2	19.41	13 / 13	NA	0 / 13	0 / 13	0 / 13
C6 - C10 Fraction	mg/L	0.04	0.04	0.04	1 / 13	0.02	0 / 1	0 / 1	0 / 1
C6 - C10 Fraction minus BTEX (F1)	mg/L	0.03	0.03	0.03	1 / 13	0.02	0 / 1	0 / 1	0 / 1
>C10 - C16 Fraction	mg/L	0.33	6.82	2.12	9 / 13	0.1	0 / 9	0 / 9	0 / 9
>C16 - C34 Fraction	mg/L	0.5	58.2	20.341	10 / 13	0.1	0 / 10	0 / 10	0 / 10
>C34 - C40 Fraction	mg/L	0.12	30.3	6.7	9 / 13	0.1	0 / 9	0 / 9	0 / 9
>C10 - C40 Fraction (sum)	mg/L	0.5	93.8	28.274	10 / 13	0.1	0 / 10	0 / 10	0 / 10
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	0.24	330	29.28	12 / 13	0.1	0 / 12	0 / 12	0 / 12
3-Methylcholanthrene	mg/L	ND	ND	ND	0 / 10	0.0001	0 / 0	0 / 0	0 / 0
2-Methylnaphthalene	mg/L	0.0001	0.014	0.00253	9 / 10	0.0001	2 / 9	0 / 9	0 / 9
7,12-Dimethylbenz(a)anthracene	mg/L	ND	ND	ND	0 / 10	0.0001	0 / 0	0 / 0	0 / 0
Acenaphthene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Acenaphthylene	mg/L	0.001	0.001	0.001	1 / 13	0.0001-0.001	0 / 1	0 / 1	0 / 1
Anthracene	mg/L	ND	ND	ND	0 / 10	0.0001-0.001	0 / 0	0 / 0	0 / 0
Benz(a)anthracene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Benzo(a)pyrene	mg/L	0.00029	0.00126	0.000775	2 / 13	0.00005-0.0005	2 / 2	0 / 2	0 / 2
Benzo(b+j)fluoranthene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Benzo(e)pyrene	mg/L	0.0003	0.0013	0.0008	2 / 10	0.0001	0 / 2	0 / 2	0 / 2
Benzo(g,h,i)perylene	mg/L	0.0001	0.0006	0.000325	4 / 13	0.0001-0.001	0 / 4	0 / 4	0 / 4
Benzo(k)fluoranthene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Chrysene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Coronene	mg/L	0.0001	0.0003	0.0002	2 / 10	0.0001	0 / 2	0 / 2	0 / 2
Dibenz(a,h)anthracene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Fluoranthene	mg/L	0.0002	0.0009	0.00045	4 / 13	0.0001-0.001	0 / 4	0 / 4	0 / 4
Fluorene	mg/L	ND	ND	ND	0 / 13	0.0001-0.001	0 / 0	0 / 0	0 / 0
Indeno(1,2,3-cd)pyrene	mg/L	0.0001	0.0002	0.000133	3 / 13	0.0001-0.001	3 / 3	0 / 3	0 / 3
N-2-Fluorenyl Acetamide	mg/L	0.0004	0.0004	0.0004	1 / 10	0.0001	0 / 1	0 / 1	0 / 1
Naphthalene	mg/L	0.0001	0.0121	0.00222	9 / 13	0.0001-0.001	8 / 9	0 / 9	0 / 9
Perylene	mg/L	0.0003	0.003	0.001125	4 / 10	0.0001	0 / 4	0 / 4	0 / 4
Phenanthrene	mg/L	0.0001	0.0025	0.0008	6 / 13	0.0001-0.001	0 / 6	0 / 6	0 / 6
Pyrene	mg/L	0.0002	0.0017	0.00065	4 / 13	0.0001-0.001	0 / 4	0 / 4	0 / 4
Sum of PAHs	mg/L	0.0001	0.0203	0.00372	9 / 13	0.00005-0.0005	0 / 9	0 / 9	0 / 9
Benzo(a)pyrene TEQ (zero)	mg/L	0.0003	0.0013	0.0008	2 / 13	0.00005-0.0005	0 / 2	0 / 2	0 / 2
Phenol	mg/L	0.0073	0.0515	0.0301	5 / 8	0.001-0.0057	0 / 5	0 / 5	0 / 5
2-Chlorophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
2-Methylphenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
3- & 4-Methylphenol	mg/L	ND	ND	ND	0 / 8	0.002-0.0125	0 / 0	0 / 0	0 / 0
2-Nitrophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
2,4-Dimethylphenol	mg/L	0.0012	0.0069	0.00467	3 / 8	0.001-0.0062	0 / 3	0 / 3	0 / 3
2,4-Dichlorophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
2,6-Dichlorophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
4-Chloro-3-methylphenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
2,4,6-Trichlorophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
2,4,5-Trichlorophenol	mg/L	ND	ND	ND	0 / 8	0.001-0.0062	0 / 0	0 / 0	0 / 0
Pentachlorophenol	mg/L	ND	ND	ND	0 / 8	0.002-0.0125	0 / 0	0 / 0	0 / 0

**Table E-5**  
**Summary of Geogenic Chemicals in Drilling Fluid Solids Descriptive Statistics**

Chemical	Units	Minimum	Maximum	Average	Frequency	Detection Limit Range	Frequency Detection Exceeds Criteria							API	EA Conditions
							HILs		HSLs		EPA	Areas of Ecological Significance	Areas of Urban Residential and Open Public		
							Residential	Recreational	Residential	Recreational	Residential Soil				
Ionic Balance		5.74	8.82	7.41	3 / 3	NA	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Total Anions		322	1380	801	3 / 3	NA	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Total Cations		384	1220	735	3 / 3	NA	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
pH	pH units	8.56	12	10.4	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Electrical conductivity (EC)	µS/cm	6470	120000	48967	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Total Dissolved Solids	mg/L	11233.221	310330.23	20143	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Suspended Solids (SS)	mg/L	793.3254	513328.2	32923	9 / 10	16.6665	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
Calcium	mg/L	115.99884	5399.946	398	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Magnesium	mg/L	49.9995	88.66578	11.3	4 / 12	0.33333	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Sodium	mg/L	1986.6468	35999.64	1735	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Potassium	mg/L	719.9928	97665.69	6719	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Chloride	mg/L	4899.951	153331.8	9207	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Sulfate (as SO4)	mg/L	63.3327	8499.915	201	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Hydroxide Alkalinity as CaCO3	mg/L	193.3314	5466.612	380	8 / 13	3.3333	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
Carbonate Alkalinity as CaCO3	mg/L	113.3322	12266.544	445	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Bicarbonate Alkalinity as CaCO3	mg/L	16.6665	11466.552	835	6 / 13	3.3333	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6
Total Alkalinity as CaCO3	mg/L	899.991	23733.096	1065	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Total Hardness as CaCO3	mg/L	289.9971	13466.532	1149	9 / 9	NA	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
Dissolved Organic Carbon	mg/L	136.6653	953.3238	91.8	3 / 3	NA	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Total Organic Carbon	mg/L	169.9983	996.6567	99.8	3 / 3	NA	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Sodium Adsorption Ratio	mg/L	22.466442	869.9913	35.5	12 / 12	NA	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12
Mercury - T	mg/L	0.00399996	0.00399996	0.00072	1 / 13	0.00033333-0.0033333	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Mercury - D	mg/L	ND	ND	ND	0 / 3	0.00033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Fluoride	mg/L	0.99999	2.66664	0.27	6 / 10	0.33333-13.3332	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6
Ammonia as N	mg/L	3.233301	32.066346	3.56	10 / 10	NA	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Nitrite as N	mg/L	0.033333	0.066666	0.0111	7 / 13	0.033333	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7
Nitrate as N	mg/L	0.033333	0.266664	0.018	11 / 13	0.033333	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11
Nitrite + Nitrate as N	mg/L	0.033333	0.266664	0.0215	12 / 13	0.033333	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12
Total Kjeldahl Nitrogen as N	mg/L	9.66657	305.33028	16.4	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Total Nitrogen as N (TKN + NOx)	mg/L	9.9999	305.33028	16.4	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Total Phosphorus as P	mg/L	0.366663	65.33268	5.77	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Aluminium - T	mg/L	0.799992	3433.299	201	11 / 13	0.033333	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11
Antimony - T	mg/L	0.0199998	0.0366663	0.0051	2 / 13	0.00333333-0.1733316	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
Arsenic - T	mg/L	0.0333330	1.5033183	0.134	10 / 13	0.00333333-0.0699993	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Barium - T	mg/L	4.533288	152.33181	9.30	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Beryllium - T	mg/L	0.033333	0.2466642	0.0289	5 / 13	0.00333333-0.1733316	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5
Boron - T	mg/L	0.9466572	11.33322	0.688	7 / 13	0.0866658-0.8733246	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7
Cadmium - T	mg/L	0.00299997	0.06466602	0.00734	8 / 13	0.000333333-0.00699993	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
Chromium - T	mg/L	0.066666	4.33329	0.344	10 / 13	0.0033333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Cobalt - T	mg/L	0.1233321	4.133292	0.379	8 / 13	0.00333333-0.0699993	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
Copper - T	mg/L	0.1166655	25.566411	1.67	10 / 13	0.0033333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Iron - T	mg/L	2.99997	6699.933	455	11 / 13	0.166665	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11
Lead - T	mg/L	0.2299977	5.166615	0.5385	8 / 13	0.00333333-0.0699993	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
Lithium - T	mg/L	0.0899991	6.199938	0.330	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13

**Table E-5**  
**Summary of Geogenic Chemicals in Drilling Fluid Solids Descriptive Statistics**

Chemical	Units	Minimum	Maximum	Average	Frequency	Detection Limit Range	Frequency Detection Exceeds Criteria							API	EA Conditions
							HILs		HSLs		EPA	Areas of Ecological Significance	Areas of Urban Residential and Open Public		
							Residential	Recreational	Residential	Recreational	Residential Soil				
Manganese - T	mg/L	0.0899991	154.33179	9.21	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Molybdenum - T	mg/L	0.0966657	1.1699883	0.0967	12 / 13	0.1733316	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12
Nickel - T	mg/L	0.0199998	3.933294	0.265	12 / 12	NA	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12
Selenium - T	mg/L	0.0299997	0.4466622	0.0365	4 / 13	0.0166665-0.1733316	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Silver - T	mg/L	ND	ND	ND	0 / 13	0.0033333-0.1733316	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Thorium - T	mg/L	0.0433329	0.8833245	0.0861	8 / 13	0.0033333-0.0699993	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
Tin - T	mg/L	ND	ND	ND	0 / 13	0.0033333-0.1733316	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Uranium - T	mg/L	0.0233331	0.1066656	0.0122	3 / 13	0.0033333-0.1733316	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Vanadium - T	mg/L	0.0466662	8.833245	0.581	10 / 13	0.033333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Zinc - T	mg/L	0.0799992	29.66637	2.41	10 / 13	0.0166665	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
Glycols	mg/L	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2-Ethoxyethyl acetate	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2-Butoxyethanol	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Propylene glycol	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Ethylene glycol	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Diethylene glycol monobutyl ether	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Diethylene glycol	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Triethylene glycol	mg/L	ND	ND	ND	0 / 10	6.6666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C10 - C14 Fraction	mg/L	0.66666	7.599924	0.654	4 / 13	0.166665-2.066646	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
C15 - C28 Fraction	mg/L	0.399996	91.33242	5.61	10 / 13	0.33333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
C15 - C28 Fraction	mg/L	ND	ND	ND	0 / 3	0.166665	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C29 - C36 Fraction	mg/L	0.233331	98.33235	4.91	10 / 10	NA	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
C10 - C36 Fraction (sum)	mg/L	0.633327	197.33136	10.8	10 / 13	0.166665	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
>C10 - C16 Fraction	mg/L	0.799992	16.6665	1.05	7 / 13	0.33333-2.499975	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7
>C16 - C34 Fraction	mg/L	0.599994	157.99842	7.15	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
>C34 - C40 Fraction	mg/L	0.433329	92.33241	2.74	11 / 13	0.33333	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11	0 / 11
>C10 - C40 Fraction (sum)	mg/L	0.599994	261.66405	10.0	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
>C10 - C16 Fraction minus Naphthalene (F2)	mg/L	3.166635	16.6665	1.88	3 / 9	0.33333-2.499975	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Benzene	mg/L	ND	ND	ND	0 / 13	0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Toluene	mg/L	0.0166665	0.0166665	0.003	1 / 13	0.0066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Ethylbenzene	mg/L	ND	ND	ND	0 / 13	0.0066666	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
meta- & para-Xylene	mg/L	0.0099999	0.0099999	0.0018	1 / 13	0.0066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
ortho-Xylene	mg/L	0.0133332	0.0133332	0.0024	1 / 13	0.0066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Total Xylenes	mg/L	0.0233331	0.0233331	0.0042	1 / 13	0.0066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Sum of BTEX	mg/L	0.0399996	0.0399996	0.0072	1 / 13	0.0033333	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Naphthalene	mg/L	ND	ND	ND	0 / 13	0.0166665	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C6 - C9 Fraction	mg/L	0.099999	0.099999	0.018	1 / 13	0.066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
C10 - C14 Fraction	mg/L	0.233331	11.866548	0.656769231	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
C15 - C28 Fraction	mg/L	1.366653	118.66548	6.27	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
C29 - C36Fraction	mg/L	0.399996	113.3322	4.71	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
C10 - C36 Fraction (sum)	mg/L	1.99998	243.99756	11.6	13 / 13	NA	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
C6 - C10 Fraction	mg/L	0.133332	0.133332	0.024	1 / 13	0.066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
C6 - C10 Fraction minus BTEX (F1)	mg/L	0.099999	0.099999	0.018	1 / 13	0.066666	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
>C10 - C16 Fraction	mg/L	1.099989	22.733106	1.27	9 / 13	0.33333	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
>C16 - C34 Fraction	mg/L	1.666650	193.99806	12.2	10 / 13	0.33333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
>C34 - C40 Fraction	mg/L	0.399996	100.99899	4.02	9 / 13	0.33333	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9

**Table E-5**  
**Summary of Geogenic Chemicals in Drilling Fluid Solids Descriptive Statistics**

Chemical	Units	Minimum	Maximum	Average	Frequency	Detection Limit Range	Frequency Detection Exceeds Criteria							API	EA Condition
							HILs		HSLs		EPA Residential Soil	Areas of Ecological Significance	Areas of Urban Residential and Open Public		
							Residential	Recreational	Residential	Recreational					
>C10 - C40 Fraction (sum)	mg/L	1.66665	312.66354	17.0	10 / 13	0.33333	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10	0 / 10
>C10 - C16 Fraction minus Naphthalene (F2)	mg/L	0.799992	1100	17.6	12 / 13	0.33333	0 / 12	0 / 12	0 / 12	0 / 12	0 / 12	1 / 12	1 / 12	0 / 12	0 / 12
3-Methylcholanthrene	mg/L	ND	ND	ND	0 / 10	0.00033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2-Methylnaphthalene	mg/L	0.00033333	0.0466662	0.00152	9 / 10	0.00033333	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
7.12-Dimethylbenz(a)anthracene	mg/L	ND	ND	ND	0 / 10	0.00033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Acenaphthene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Acenaphthylene	mg/L	0.0033333	0.0033333	0.0006	1 / 13	0.00033333-0.0033333	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Anthracene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benz(a)anthracene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(a)pyrene	mg/L	0.000966657	0.004199958	0.000465	2 / 13	0.000166665-0.00166665	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
Benzo(b+j)fluoranthene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(e)pyrene	mg/L	0.00099999	0.00433329	0.00048	2 / 10	0.00033333	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
Benzo(g,h,i)perylene	mg/L	0.00033333	0.00199998	0.000195	4 / 13	0.00033333-0.0033333	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Benzo(k)fluoranthene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Chrysene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Coronene	mg/L	0.00033333	0.00099999	0.00012	2 / 10	0.00033333	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
Dibenz(a,h)anthracene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Fluoranthene	mg/L	0.00066666	0.00299997	0.00027	4 / 13	0.00033333-0.0033333	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Fluorene	mg/L	ND	ND	ND	0 / 13	0.00033333-0.0033333	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Indeno(1,2,3.cd)pyrene	mg/L	0.00033333	0.00066666	0.00008	3 / 13	0.00033333-0.0033333	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
N-2-Fluorenyl Acetamide	mg/L	0.00133332	0.00133332	0.00024	1 / 10	0.00033333	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Naphthalene	mg/L	0.00033333	0.04033293	0.00133	9 / 13	0.00033333-0.0033333	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
Perylene	mg/L	0.00099999	0.0099999	0.000675	4 / 10	0.00033333	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Phenanthrene	mg/L	0.00033333	0.00833325	0.00048	6 / 13	0.00033333-0.0033333	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6
Pyrene	mg/L	0.00066666	0.00566661	0.00039	4 / 13	0.00033333-0.0033333	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Sum of PAHs	mg/L	0.00033333	0.06766599	0.0022	9 / 13	0.000166665-0.00166665	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9	0 / 9
Benzo(a)pyrene TEQ (zero)	mg/L	0.00099999	0.00433329	0.00048	2 / 13	0.000166665-0.00166665	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
Phenol	mg/L	0.02433309	0.17166495	0.0180	5 / 8	0.0033333-0.01899981	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5	0 / 5
2-Chlorophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2-Methylphenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
3- & 4-Methylphenol	mg/L	ND	ND	ND	0 / 8	0.0066666-0.04166625	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2-Nitrophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2,4-Dimethylphenol	mg/L	0.00399996	0.02299977	0.0028	3 / 8	0.0033333-0.02066646	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
2,4-Dichlorophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2,6-Dichlorophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
4-Chloro-3-methylphenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2,4,6-Trichlorophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2,4,5-Trichlorophenol	mg/L	ND	ND	ND	0 / 8	0.0033333-0.02066646	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Pentachlorophenol	mg/L	ND	ND	ND	0 / 8	0.0066666-0.04166625	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

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Chemical	Units	Minimum	Maximum	Average	Frequency	Detection Limit Range	Frequency Detection Exceeds Criteria								
							HILs		HSLs		EPA	Areas of Ecological Significance	Areas of Urban Residential and Open Public Space	API	EA Conditions
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Bicarbonate Alkalinity as CaCO3	mg/L	2140	2140	2140	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Carbonate Alkalinity as CaCO3	mg/L	ND	ND	1	0 / 1	1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Hydroxide Alkalinity as CaCO3	mg/L	ND	ND	1	0 / 1	1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Total Alkalinity as CaCO3	mg/L	2140	2140	2140	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Bicarbonate Alkalinity as CaCO3	mg/kg	136	1040	403	24 / 25	1	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24
Carbonate Alkalinity as CaCO3	mg/kg	8	277	41.2	14 / 25	1	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14
Total Alkalinity as CaCO3	mg/kg	152	2260	523	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Electrical Conductivity @ 25°C	µS/cm	150000	150000	150000	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Electrical Conductivity @ 25°C	µS/cm	3670	27600	9974	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Total Dissolved Solids @180°C	mg/L	110000	110000	110000	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Mercury	mg/kg	ND	ND	0.1	0 / 25	0.1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Calcium	mg/L	459	459	459	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Magnesium	mg/L	78	78	78	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Potassium	mg/L	49500	49500	49500	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Sodium	mg/L	4960	4960	4960	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Calcium	mg/kg	40	1650	476.8	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Magnesium	mg/kg	10	250	46.8	16 / 25	10	0 / 16	0 / 16	0 / 16	0 / 16	0 / 16	0 / 16	0 / 16	0 / 16	0 / 16
Potassium	mg/kg	4620	37000	12522	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Sodium	mg/kg	520	11400	2724	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Sodium Adsorption Ratio	-	56.2	56.2	56.2	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Chloride	mg/L	48600	48600	48600	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Chloride	mg/kg	5690	52200	18293	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
pH - Lab	pH Unit	7.48	7.48	7.5	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
pH - Lab	pH Unit	8.2	11.9	8.92	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Nitrate as N (Sol.)	mg/kg	0.3	0.3	0.108	1 / 25	0.1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Nitrate as N (Sol.)	mg/kg	0.1	0.4	0.172	13 / 25	0.1	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13	0 / 13
Total Kjeldahl Nitrogen as N	mg/kg	100	1290	452	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Total Nitrogen as N	mg/kg	100	1290	452	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Nitrite + Nitrate as N (Sol.)	mg/kg	0.1	0.4	0.18	14 / 25	0.1	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14	0 / 14
Total Phosphorus as P	mg/kg	116	371	245	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Sulfate as SO4 2-	mg/L	628	628	628	1 / 1	NA	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Algae - Field	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Clarity - Field	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Colour - Field	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Dominant Horizon	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Hydrocarbon - Field	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Moisture	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Mottled	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Odour - Field	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Texture	No Unit	ND	ND	ND	0 / 0	NA	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Moisture Content (dried @ 103°C)	%	2.2	39.6	13.2	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Sulfate as SO4 2-	mg/kg	90	1260	332	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Total Organic Carbon	%	0.59	5.42	2.31	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Total Soluble Salts	mg/kg	11900	89600	32408	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Sodium Adsorption Ratio	-	16	53.2	31	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Aluminium	mg/kg	4170	13800	9201	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	21 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Antimony	mg/kg	ND	ND	5	0 / 25	5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Arsenic	mg/kg	5	9	5.28	6 / 25	5	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6	0 / 6
Barium	mg/kg	20	1500	270	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25

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Beryllium	mg/kg	ND	ND	1	0 / 25	1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Boron	mg/kg	ND	ND	50	0 / 25	50	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Cadmium	mg/kg	ND	ND	1	0 / 25	1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Chromium	mg/kg	9	103	17.5	25 / 25	NA	1 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Cobalt	mg/kg	6	16	11.8	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	25 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Copper	mg/kg	8	109	40.7	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	1 / 25
Iron	mg/kg	12400	36200	22000	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	25 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Lead	mg/kg	6	22	12.5	24 / 25	5	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24	0 / 24
Manganese	mg/kg	277	972	509	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	25 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Molybdenum	mg/kg	3	7	2.44	4 / 25	2	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4	0 / 4
Nickel	mg/kg	5	25	13.0	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Selenium	mg/kg	ND	ND	5	0 / 25	5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Silver	mg/kg	ND	ND	2	0 / 25	2	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Tin	mg/kg	ND	ND	5	0 / 25	5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Vanadium	mg/kg	17	33	26.3	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Zinc	mg/kg	24	114	74.1	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Lithium	mg/kg	3.6	11.1	7.87	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Thorium	mg/kg	1.9	4.7	3.53	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Uranium	mg/kg	0.2	0.7	0.4	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
>C10 - C16 Fraction	mg/kg	80	90	52.8	2 / 25	50	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2
>C10 - C16 Fraction minus Naphthalene (F2)	mg/kg	80	90	52.8	2 / 25	50	0 / 2	0 / 2	0 / 2	0 / 2	0 / 2	2 / 2	0 / 2	0 / 2	0 / 2
>C10 - C40 Fraction (sum)	mg/kg	120	410	110	8 / 25	50	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
>C16 - C34 Fraction	mg/kg	120	320	138	8 / 25	100	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8	0 / 8
>C34 - C40 Fraction	mg/kg	ND	ND	100	0 / 25	100	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C10 - C14 Fraction	mg/kg	50	50	50	1 / 25	50	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
C10 - C36 Fraction (sum)	mg/kg	110	430	101	7 / 25	50	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7
C15 - C28 Fraction	mg/kg	110	270	122	7 / 25	100	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7	0 / 7
C29 - C36 Fraction	mg/kg	110	110	101	3 / 25	100	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3	0 / 3
Benzene	mg/kg	ND	ND	0.2	0 / 25	0.2	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C6 - C10 Fraction	mg/kg	ND	ND	10	0 / 25	10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C6 - C10 Fraction minus BTEX (F1)	mg/kg	ND	ND	10	0 / 25	10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
C6 - C9 Fraction	mg/kg	ND	ND	10	0 / 25	10	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Ethylbenzene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
meta- & para-Xylene	mg/kg	0.8	0.8	0.51	1 / 25	0.5	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Naphthalene	mg/kg	ND	ND	1	0 / 25	1	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
ortho-Xylene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Sum of BTEX	mg/kg	1.5	1.5	0.252	1 / 25	0.2	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Toluene	mg/kg	0.7	0.7	0.508	1 / 25	0.5	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Total Xylenes	mg/kg	0.8	0.8	0.512	1 / 25	0.5	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Acenaphthene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Acenaphthylene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Anthracene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benz(a)anthracene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(a)pyrene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(a)pyrene TEQ (Half LOR)	mg/kg	0.6	0.6	0.6	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Benzo(a)pyrene TEQ (LOR)	mg/kg	1.2	1.2	1.2	25 / 25	NA	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25	0 / 25
Benzo(a)pyrene TEQ (zero)	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(b+j)fluoranthene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

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Benzo(g,h,i)perylene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Benzo(k)fluoranthene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Chrysene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Dibenz(a,h)anthracene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Fluoranthene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Fluorene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Indeno(1,2,3-cd)pyrene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Naphthalene	mg/kg	0.6	0.6	0.504	1 / 25	0.5	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1
Phenanthrene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Pyrene	mg/kg	ND	ND	0.5	0 / 25	0.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Sum of polycyclic aromatic hydrocarbons (PAHs)	mg/kg	0.6	0.6	0.504	1 / 25	0.5	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1	0 / 1



## **APPENDIX F PRODUCED WATER AND WATER TREATMENT CHEMICAL SUMMARIES**

Table F-1  
Summary of Exposure Point Concentrations for COPCs in Produced Water, Permeate and Brine  
Narrabri Gas Project

Chemical Name/Use	CAS Registry Number	Produced Water COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Produced Water (mg/kg)	Expected Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)	Soil Concentration after 20 years of Irrigation	Permeate COPC Concentration with Degradation (mg/l) based on residence time in System and Effluent Tanks	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l) 7
<b>Geogenic Compounds</b>									
Total Dissolved Solids (TDS)	NA	23800	NA	< 650	NA	108403	NA	650	< 16.25
pH	NA	8.57	NA	6-8.5	NA	8.88	NA	6-8.5	6-8.5
SAR	NA	> 100	NA	< 5	NA	>100	NA	5	< 5
Bicarbonate (as calcium carbonate equivalent)	NA	12400	NA	260	NA	99200	NA	260	6.5
Carbonate	NA	730	NA	2	NA	21261.43	NA	2	0.05
Total Alkalinity	NA	12600	NA	262	NA	38718.8	NA	262	6.55
Chloride(CI)	NA	2100	210	< 100	< 4.0	10277.31	21	100	< 2.5
Sodium (Na)	7646-69-7	6500	650	131	5.18	36914.75	28	131	3.275
Sulphate (SO4)	18785-72-3	18	1.8	< 5	< 0.20	42.7	1.1	5	0.125
Calcium (Ca)	7440-70-2	15	1.5	< 50	< 1.98	38.62	11	50	< 1.25
Magnesium (Mg)	7439-95-4	9.2	0.92	0.04	0.002	35.65	0.01	0.04	0.001
Potassium (K)	7440-09-7	81	8.1	< 5	< 0.20	838.78	1.05	5	< 0.125
Strontium (Sr)	7440-24-6	4.6	0.46	< 0.02	< 0.001	10.33	0.004	0.02	< 0.0005
Barium (Ba)	7440-39-3	15	1.5	< 0.1	< 0.004	36.18	0.02	0.1	< 0.0025
Fluoride (F)	7782-41-4	6.4	0.64	< 0.3	< 0.01	33.17	0.06	0.3	< 0.0075
Silica (SiO2)	NA	24	2.4	< 0.9	< 0.04	111.39	0.19	0.9	< 0.0225
Boron (B)	7440-42-2	1.3	0.13	0.7	0.03	4.2	0.15	0.7	0.0175
Iron (Fe, dissolved)	7439-89-6	0.52	0.052	< 0.1	< 0.004	4.16	0.02	0.1	< 0.0025
Cyanide	74-90-8	0.004	0.0004	< 0.001	< 0.00004	0.032	0.0002	0.001	< 0.000025
Manganese	7439-96-5	0.18	0.018	~ 0.02	~ 0.0008	1.14	0.004	0.02	0.0005
Aluminium	7429-90-5	6.1	0.61	~ 0.02	~ 0.0008	48.8	0.004	0.02	0.0005
Ammonia	NA	16	1.6	6-10	1680.24	128	8961	6-10	6-10
Nitrate as N	NA	0.1	0.01	< 0.1	< 0.004	1.17	0.02	0.1	< 0.0025
Copper Sulphate	7758-98-7	0.14	0.014	< 0.01	< 0.0004	1.12	0.002	0.01	< 0.00025
Nickel Sulphate	7786-81-4	0.013	0.0013	< 0.01	< 0.0004	0.104	0.002	0.01	< 0.00025
Arsenic	7784-42-1	0.036	0.0036	< 0.01	< 0.0004	0.288	0.002	0.01	< 0.00025
Cadmium	7440-43-9	0.036	0.0036	< 0.002	< 0.00008	0.288	0.0004	0.002	< 0.00005
Mercury	7439-97-6	0.015	0.0015	< 0.001	< 0.00004	0.12	0.0002	0.001	< 0.000025
Selenium	7782-49-2	0.054	0.0054	< 0.01	< 0.0004	0.432	0.002	0.01	< 0.00025
Zinc	7440-66-6	0.15	0.015	< 0.01	< 0.0004	1.2	0.002	0.01	< 0.00025
Chromium	7440-47-3	0.04	0.004	< 0.01	< 0.0004	0.32	0.002	0.01	< 0.00025
Hexavalent Chromium	18540-29-9	< 0.05	< 0.005	< 0.01	< 0.0004	0.4	0.002	0.01	< 0.00025
Molybdenum	7439-98-7	0.0069	0.00069	< 0.005	< 0.00020	0.0552	0.001	0.005	< 0.000125
Antimony	7440-36-0	0.0011	0.00011	< 0.001	< 0.00004	0.0088	0.0002	0.001	< 0.000025
Tin	7440-31-5	0.0027	0.00027	< 0.001	< 0.00004	0.0216	0.0002	0.001	< 0.000025
Uranium	7440-61-1	0.0007	0.00007	< 0.001	< 0.00004	0.0056	0.0002	0.001	< 0.000025
Lead	7439-92-1	0.013	0.0013	< 0.001	< 0.00004	0.104	0.0002	0.001	< 0.000025
Beryllium	7440-41-7	0.001	0.0001	< 0.001	< 0.00004	0.008	0.0002	0.001	< 0.000025
Cobalt	7440-48-4	0.0035	0.00035	< 0.001	< 0.00004	0.028	0.0002	0.001	< 0.000025
Iodide	20461-54-5	0.2	0.02	< 0.05	< 0.002	1.6	0.01	0.05	< 0.00125
Lithium	554-13-2	2.9	0.29	< 0.01	< 0.0004	23.2	0.002	0.01	< 0.00025
Thallium	7440-28-0	0.0005	0.00005	< 0.0005	< 0.00002	0.004	0.0001	0.0005	< 0.0000125
Vanadium	7440-62-2	0.016	0.0016	< 0.01	< 0.0004	0.128	0.002	0.01	< 0.00025
Phosphorus	NA	0.63	0.063	< 0.05	< 0.002	5.04	0.01	0.05	< 0.00125
Nitrite	NA	0.04	0.004	< 0.04	< 0.002	0.32	0.01	0.04	< 0.001

Table F-1  
Summary of Exposure Point Concentrations for COPCs in Produced Water, Permeate and Brine  
Narrabri Gas Project

Chemical Name/Use	CAS Registry Number	Produced Water COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Produced Water (mg/kg)	Expected Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)	Soil Concentration after 20 years of Irrigation	Permeate COPC Concentration with Degradation (mg/l) based on residence time in System and Effluent Tanks	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l) 7
<b>Chemical Additives</b>									
Proprietary Polymer A	PolymerA-CasRn	NA	NA	0.49	0.04	Will dissociate and degrade	0.21	0.06	0.0015
Proprietary Ester A	EsterA-CasRn	NA	NA	0.098	0.008	see geogenic above for brine	0.01	0.012	0.0003
Aluminium Chlorohydrate	1327-41-9	NA	NA	Dissociates to Al and Cl concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	NA	Dissociates to Na and SO4 concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	Dissociates to Na and Cl concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	Dissociates to Na and OH concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	NA
Citric Acid	77-92-9	NA	NA	Dissociated and rapidly breaks down to TOC	NA (rapidly degrades in soil)	see geogenic above for brine	NA (rapidly degrades in soil)	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	Dissociates and reacts to water and chloride concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	NA
Calcium Chloride	10043-52-4	NA	NA	47.2 - Dissociates and reacts to calcium and chloride concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate
Ethylene diamine tetraacetic acid, EDTA	64-02-8	NA	NA	0.29	0.02	18	0.12	0.29	0.007
Polydadmac	26062-79-3	NA	NA	NA <sup>4</sup>	NA	NA <sup>4</sup>	NA	NA	NA
Polyacrylamide	9003-05-8	NA	NA	NA <sup>1</sup>	NA	NA <sup>1</sup>	NA	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	NA	0.50	NA 8	NA <sup>6</sup>	NA	0.028	0.00070
2-methyl-4-isothiazolin-3-one	2682-20-4	NA	NA	0.10	NA 8	NA <sup>6</sup>	NA	0.006	0.00014
Proprietary Mixture D1	MixtureD1-CasRn	NA	NA	0.065	NA 8	NA <sup>6</sup>	NA	0.001	0.00002
Proprietary Mixture D2	MixtureD2-CasRn	NA	NA	0.065	0.005	NA <sup>6</sup>	0.03	0.065	0.002
Sodium Chloride	7647-14-5	NA	NA	Dissociates and reacts to sodium and chloride concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate
Sodium dodecyl sulfate	151-21-3	NA	NA	Dissociates and reacts to sodium and sulfate concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate
Proprietary Mixture A2	MixtureA2-CasRn	NA	NA	Dissociates and reacts to sodium and sulfate concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate

Table F-1  
Summary of Exposure Point Concentrations for COPCs in Produced Water, Permeate and Brine  
Narrabri Gas Project

Chemical Name/Use	CAS Registry Number	Produced Water COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Produced Water (mg/kg)	Expected Permeate COPC Concentration (mg/l)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Brine COPC Concentration (mg/l)	Soil Concentration after 20 years of Irrigation	Permeate COPC Concentration with Degradation (mg/l) based on residence time in System and Effluent Tanks	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l) 7
Chemical Additives									
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	Reaction product with sodium hypchlorite. Will dissociated to sulfate, chloride, and ammonia consistent with geogenic background.	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate
Magnesium Nitrate	10377-60-3	NA	NA	Dissociates to magnesium and nitrate concentration consistent with geogenic background	see geogenic above for permeate	see geogenic above for brine	see geogenic above for permeate	NA	see geogenic above for permeate
Homopolymer of maleic acid	26009-09-2	NA	NA	COPC present in solids stream; therefore not present in permeate	NA	COPC present in solids stream; therefore not present in brine	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	NA	COPC present in solids stream; therefore not present in permeate	NA	COPC present in solids stream; therefore not present in brine	NA	NA	NA

NA = not applicable  
1 COPC is used as a coagulant; therefore, this COPC would not be present in the permeate or brine streams and any residuals removed by RO  
2 COPC dissociates in permeate stream to background inorganic concentration.  
3 COPC rapidly biodegrades. Anticipated will degrade to levels below detection in permeate and brine streams.  
4 COPC is a homopolymer used for flocculation and coagulation; therefore this COPC would not be present in the permeate or brine streams.  
5 COPC dissociates and reacts to form 0.08 mg/l of phosphate.  
6 COPC will degrade in pond due to retention time in system and pond.  
7 Forty times dilution assumed for mixing in Bohena Creek.  
8 COPC has short half-life and biodegrades rapidly in soil (refer to Table X) therefore, not present in soil.

**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Use	Approximate quantity stored on site (Plant available Storage)		Use in Treatment	Process Use	Laboratory Parameter in Analytical Schedule Appendix C
				tonnes	m <sup>3</sup>			
Osmotreat Si	Proprietary Polymer A Proprietary Ester A	PolymerA-CasRn  EsterA-CasRn	Reverse osmosis scale inhibitor Reverse osmosis scale inhibitor	2.3 T	2m3	Continuous	Primary RO (PRO), Osmoflo Brine Squeezer (OBS) and Brackish Water RO (BWRO) Scale Inhibitor	Dissociates to phosphoric acids, Total Phosphate, and degradable organic acids
Hybind 2002 (alternative Pac 23)	Aluminium Chlorohydrate	1327-41-9	Coagulation	4T	3m3	Continuous	MF Feed and DAF Feed Coagulation	Aluminium
SMBS / SBS	Sodium Meta Bisulphite	7681-57-4	Reducing agent, dechlorination	2.4T	2m3	Intermittent	Continuous use for Dechlorination in PRO & OBS Feed	Releases Sulfur Dioxide (reducing agent), oxidises to SO4 ion.
Hypo	Sodium Hypochlorite NaOCl	7681-52-9	Sanitisation	3.62T	3m3	Intermittent	Used for MF CEB/CIP & Pond water System Sanitisation	Dissociates in water to form Hypochlorous Acid, which reduces to Chloride ion.
Caustic Soda	Sodium Hydroxide NaOH	1310-73-2	pH control agent	2.64T	2m3	Intermittent	Used for MF CEB/CIP & PRO/BWRO/OBS CIP	Hydroxide ion dissociates in water increasing the pH
Citric	Citric Acid, C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	77-92-9	pH control agent	2.4T	2m3	Intermittent	Used for PRO/BWRO/OBS CIP	Dissociates in water releasing the Citrate ion, decreasees the pH.
Hydrochloric / Muratic Acid	Hydrochloric Acid, HCl <sup>3</sup>	7647-01-0	pH control agent	8T	7m3	Continuous	Used for PRO/BWRO/OBS CIP & DAF Feed pH correction	Dissociates in water releasing the Chloride ion, decreasees the pH.

**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Use	Approximate quantity stored on site (Plant available Storage)		Use in Treatment	Process Use	Laboratory Parameter in Analytical Schedule Appendix C
				tonnes	m <sup>3</sup>			
Calcium Chloride	Calcium Chloride, CaCl <sub>2</sub> <sup>4</sup>	10043-52-4	calcium ion source and pH adjustment	3.6T	3m3	Continuous	Used prior to Treated Water Tank Inlet for reducing SAR values	Calcium and Chloride ions dissociate in water
EDTA	Ethylene diamine tetraacetic acid, EDTA (C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>8</sub> )	13235-36-4	Hardness control	1.15T	1m3	Intermittent	Used for PRO/BWRO/OBS CIP	TOC, organic acids
Polydamac	Polydamac	26062-79-3	Flocculating agent	0.03T	0.025m3	Continuous	Used as a Flocculating Agent in DAF	TOC and organic breakdown products. Inert organic substance
Enviro Flocc 4017	Polyacrylamide	9003-05-8	Flocculating agent	0.5T	0.2m3	Continuous	Used as a Flocculating Agent in Centrifuge Feed	TOC and organic breakdown products. Inert organic substance
Nalco 7330	14% 5-chloro-2-methyl-4-isothiazolin-3-one trace 2 methyl-isothiazolin-3 one (Ml) trace sodium phosphinate	26172-55-4 2682-20-4	Biocide Biocide	1.02T	1m3	Intermittent	Inhibits bacterial growth in MF feed & filtrate tanks, disc filters, MF, PRO, OBS & brine transfer system	
Osmocide	10-30% Proprietary Mixture D1 10-30% Proprietary Mixture D2	MixtureD1-CasRn MixtureD2-CasRn	Biocide Biocide	1.3T	1m3	Intermittent	Inhibits bacterial growth in PRO (alternative to Isothiazolinone). Can be used for shock treatment and cleaning	Completely breaks down to bromide bearing compounds, nutrient nitrogen bearing compounds, carbon dioxide and water – bromide, ammonia (as N), ammonium (as N), nitrate
Kuriverter IK-110	Proprietary Mixture A1 Proprietary Mixture A2 Proprietary Mixture A3	MixtureA1-CasRn MixtureA2-CasRn MixtureA3-CasRn	pH control agent	1.2T	1m3	Intermittent	Removes biofilm in MF filtrate tank, PRO, OBS & brine transfer system	
Cleaning Solution Osmoclean CD	Proprietary Mixture B1 Proprietary Mixture B2	MixtureB1-CasRn MixtureB2-CasRn		<0.12T for intermittent use		Intermittent (used in cleaning only)	Used for PRO/BWRO CIP	NA as not in permeate (breaks down/dissociates into non-hazardous constituents in brine)

**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Use	Approximate quantity stored on site (Plant available Storage)		Use in Treatment	Process Use	Laboratory Parameter in Analytical Schedule Appendix C
				tonnes	m <sup>3</sup>			
Cleaning Solution Osmoclean DW	Proprietary Mixture C1 Proprietary Mixture C2	MixtureC1-CasRn MixtureC2-CasRn	pH control agent Hardness control agent Surfactants	<0.12T for intermittent use		Intermittent (used in cleaning only)	Used for PRO/BWRO CIP	NA as not in permeate (breaks down/dissociates into non-hazardous constituents in brine)
Surfactant - NaDDS	Sodium dodecyl sulfate	151-21-3	Surfactant	<0.025T for intermittent use		Intermittent (used in cleaning only)	Used for PRO/BWRO/OBS CIP	NA as not in permeate (breaks down/dissociates into sodium and sulfate)
Salt -Osmotic clean	Sodium chloride	7647-14-5	Hardness control	<1T for intermittent use		Intermittent (used in cleaning only)	Used for PRO/BWRO/OBS CIP	Dissociates in water to form Sodium and Chloride ions
Hydrex 9209	Sodium Polyacrylate Homopolymer of maleic acid, Sodium hydroxide	9003-04-7 26009-09-2 1310-73-2	Floculating agent Scale inhibitor pH control agent	13 (density ~1300 kg/m3)	10	Antiscalant in thermal process	Used in Brine Crystallization	Stable complex and polymers in salt
Sodium Hydroxide	Sodium Hydroxide	1310-73-2	pH control agent	15 (density ~1500 kg/m3)	10	pH adjustment and chemical cleaning of water treatment plant internals	Used in Brine Crystallization	Sodium and pH

**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Chemical Concentration (%)	Active Chemical Concentration (%)	ANNUAL Quantity rejected into Brine/Produced Water Pond Operating at 1.05MLD (kg/year)	Designed Dosage (mg/L)
Osmotreat Si	Proprietary Polymer A Proprietary Ester A	PolymerA-CasRn  EsterA-CasRn	100%	40-90% Proprietary Polymer A 5-10% Proprietary Ester A 0-55% Water	Proprietary Polymer A 3315.5kg Proprietary Ester A 331.5kg	4.7mg/L for PRO 8.7mg/L for OBS 3mg/L for BWRO
Hybind 2002 (alternative Pac 23)	Aluminium Chlorohydrate	1327-41-9	50%	50% Aluminium Chlorohydrate 50% Water	Aluminium Chlorohydrate 13731.3kg	300mg/L for Sludge Dewatering 20mg/L for MF feed
SMBS / SBS	Sodium Meta Bisulphite	7681-57-4	37%	>35% Sodium Metabisulphite 63% Water	Sodium Metabisulphite 529.6kg	2 mg/L for PRO 1 mg/L for OBS
Hypo	Sodium Hypochlorite NaOCl	7681-52-9	12.50%	5-30% Sodium Hypochlorite >60% Water	Sodium Hypochlorite 235.7kg	1000mg/L for MF EFM/CIP
Caustic Soda	Sodium Hydroxide NaOH	1310-73-2	30%	28-32% Sodium Hydroxide 68-72% Water	Sodium Hydroxide 674.9kg	1112 mg/L for MF EFM/CIP 342mg/L for PRO/OBS CIP
Citric	Citric Acid, C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	77-92-9	0.5	50% Citric Acid 50% Water	Citric Acid 7033kg	20000 mg/L for MF CIP 10000mg/L for PRO/OBS CIP
Hydrochloric / Muratic Acid	Hydrochloric Acid, HCl <sup>3</sup>	7647-01-0	30%	30-35% Hydrochloric acid 65-70% Water	Hydrochloric Acid 9679.6kg	351.7 mg/L for DAF Feed 157mg/L for PRO/OBS CIP



**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Chemical Concentration (%)	Active Chemical Concentration (%)	ANNUAL Quantity rejected into Brine/Produced Water Pond Operating at 1.05MLD (kg/year)	Designed Dosage (mg/L)
Calcium Chloride	Calcium Chloride, CaCl <sub>2</sub> <sup>4</sup>	10043-52-4	32%	27-32% Calcium Chloride 68-73% Water	Calcium Chloride 11095.3kg	84mg/L for Treated Water
EDTA	Ethylene diamine tetraacetic acid, EDTA (C <sub>10</sub> H <sub>16</sub> N <sub>2</sub> O <sub>8</sub> )	13235-36-4	30%	30% Ethylene Diamene Tetra Acetate Tetrasodium Salt, Tetrahydrate 70% Water	EDTA 1339.8kg	10000mg/L for PRO/OBS CIP
Polydamac	Polydamac	26062-79-3	50%	15-60% Polydamac >40% Water	Polydamac 915.4kg	2 Kg/T Dry Solids for DAF
Enviro Floc 4017	Polyacrylamide	9003-05-8	100%	100% Polyacrylamide	Polyacrylamide 832.2kg	9Kg/T for Centrifuge
Nalco 7330	14% 5-chloro-2-methyl-4-isothiazolin-3-one trace 2 methyl-isothiazolin-3 one (MI) trace sodium phosphinate	26172-55-4 2682-20-4	14%	14% 5-chloro-2-methyl-4-isothiazolin-3-one, trace 2 methyl-isothiazolin-3 one (MI), trace sodium phosphinate 86% Water	Isothiazoline 76.7kg	100mg/L
Osmocide	10-30% Proprietary Mixture D1 10-30% Proprietary Mixture D2	MixtureD1-CasRn MixtureD2-CasRn	20%	10-30% Proprietary Mixture D1 10-30% Proprietary Mixture D2 40-80% water	Proprietary Mixture D1 0.7kg	170mg/l
Kuriverter IK-110	Proprietary Mixture A1 Proprietary Mixture A2 Proprietary Mixture A3	MixtureA1-CasRn MixtureA2-CasRn MixtureA3-CasRn	100%	10-30% Proprietary Mixture A1, Proprietary Mixture A2 >60% Water	Proprietary Mixture A1 90.3kg Proprietary Mixture A2 90.3kg Proprietary Mixture A3 90.3kg	50mg/l
Cleaning Solution Osmoclean CD	Proprietary Mixture B1 Proprietary Mixture B2	MixtureB1-CasRn MixtureB2-CasRn	100%	Proprietary Mixture B1, Proprietary Mixture B2 Water	Proprietary Mixture B1 684.6kg Proprietary Mixture B2 293.4kg	30000mg/L

**Table F-2**  
**Summary of Water Treatment Chemical Process Uses and Quantities**  
**Narrabri Gas Project**

Proprietary Name	Chemical name	CAS No.	Chemical Concentration (%)	Active Chemical Concentration (%)	ANNUAL Quantity rejected into Brine/Produced Water Pond Operating at 1.05MLD (kg/year)	Designed Dosage (mg/L)
Cleaning Solution Osmoclean DW	Proprietary Mixture C1 Proprietary Mixture C2	MixtureC1-CasRn MixtureC2-CasRn	100%	Proprietary Mixture C2 additives nonhazardous	Proprietary Mixture C1 489kg Proprietary Mixture C2 440.1kg Surfactants 48.9kg	30000mg/L
Surfactant - NaDDS	Sodium dodecyl sulfate	151-21-3	100%	Sodium dodecyl sulphate	Sodium Dodecyl Sulfate 112.3kg	250mg/L
Salt -Osmotic clean	Sodium chloride	7647-14-5	100%	Sodium Chloride	Sodium Chloride 35922kg	80000mg/L
Hydrex 9209	Sodium Polyacrylate Homopolymer of maleic acid, Sodium hydroxide	9003-04-7 26009-09-2 1310-73-2	100%	30 - 60% Polyacrylate, 10-30% Homopolymer of maleic acid, 10-30% sodium hydroxide, remainder water	NA contained in salts from crystallizer	1000 - 10000 mg/L
Sodium Hydroxide	Sodium Hydroxide	1310-73-2	50%	50% Sodium Hydroxide	NA contained in salts from crystallizer	variable

Table F-3  
Summary of Screening of COPCs in Production Water, Peremate, and Discharge to Bohena Creek  
Narrabri Gas Project

Parmeter	Units	Drinking Water Guideline Values (mg/L)			Stock Watering (mg/L)			Aquatic Ecosystems (µg/L)			ANZECC Irrigation Guideline Values (Short Term Values < 20 years)	Produced Water COPC Concentration (mg/l)	Expected Permeate COPC Concentration (mg/l)	Permeate COPC Concentration with Dilution in mixing zone of Bohena Creek (mg/l)		
Total Dissolved Solids (TDS)	mg/L	500	aesthetic	a	5000	-	10000	f		h	Crop Specific - Lucerne (1273-3015)	23800	< 650	< 16		
pH		6.5	-	8.5	a	6.5	-	8.5	d	6.5	-	7.5	6-9	8.57	6-8.5	6-8.5
SAR				b				d			h	Crop specific Lucerne (46-102)	> 100	< 5	NA	
Bicarbonate (as calcium carbonate equivalent)	mg/L as CaCO3			b				d			h	Not referenced	12400	260	6.5	
Carbonate	mg/L as CaCO3			b				d			h	Not referenced	730	2	0.05	
Total Alkalinity	mg/L as CaCO3			b				d			h	Not referenced	12600	262	6.55	
Chloride(Cl)	mg/L	250	(aesthetic)	a				d	230000	as chloride	i	Crop Specific - Lucerne (350 - 700)	2100	< 100	< 2.5	
Sodium (Na)	mg/L	180 (aesthetic); 250 (aesthetic)		a	2000		as sodium	g	680000		j	Crop Specific - Lucerne (230-460)	6500	131	3.275	
Sulphate (SO4)	mg/L				1000			f			h	Not referenced	18	< 5	< 5	
Calcium (Ca)	mg/L			b	1000			f	116000		j	Not referenced	15	< 50	< 1.25	
Magnesium (Mg)	mg/L			b	10			g	1900		f	Not referenced	9.2	0.04	0.001	
Potassium (K)	mg/L			b				d	53000		j	Not referenced	81	< 5	< 0.125	
Strontium (Sr)	mg/L	12 n		RSL				d			h	Not referenced	4.6	< 0.02	< 0.0005	
Barium (Ba)	mg/L	2	(health)	a				d	4		j	Not referenced	15	< 0.1	< 0.0025	
Fluoride (F)	mg/L	1.5		a	2			f			h	2	6.4	< 0.3	< 0.0075	
Silica (SiO2)	mg/L	0.9						d			h	Not referenced	24	< 0.9	< 0.0225	
Boron (B)	mg/L	4		(health)	a	5		f	370		f	Crop dependent - Lucerne (4 - 6)	1.3	0.7	0.0175	
Iron (Fe, dissolved)	mg/L	0.3	(aesthetic)	a	10			g			h	10	0.52	0	0	
Cyanide	mg/L	0.08						d	7		f	Not referenced	0.004	< 0.001	< 0.000025	
Manganese	mg/L	0.5 (health); 0.1 (aesthetic)		a;a	10			g	1900		f	10	0.18	~ 0.02	0.0005	
Aluminium	mg/L	0.2	a		5			f	55		f	20	6.1	~ 0.02	0.0005	
Ammonia	mg/L	0.5	(aesthetic)	a				d	900		f	Crop Specific as N (25-125)	16	6-10	6-10	
Nitrate as N	mg/L	50		a				d	700		f	Crop Specific (25 - 125)	0.1	< 0.1	< 0.0025	
Copper	mg/L	2			0.5			f	1.4		f	5	0.14	< 0.01	< 0.00025	
Nickel	mg/L	0.02			1			f	11		f	2	0.013	< 0.01	< 0.00025	
Arsenic	mg/L	0.007	senic, not specified (health)	a	0.5	-	5	f	24	as arsenic, not specified	f	2.0	0.036	< 0.01	< 0.00025	
Cadmium	mg/L	0.002		(health)	a	0.01		f	0.2		f	0.050	0.036	< 0.002	< 0.00005	
Mercury	mg/L	0.001	(health)	a		0.002		f	0.6		f	0.002	0.015	< 0.001	< 0.000025	
Selenium	mg/L	0.01	(health)	a		0.02		f	11		f	0.05	0.054	< 0.01	< 0.00025	
Zinc	mg/L	3		(aesthetic )	a	20		f	8		f	5	0.15	< 0.01	< 0.00025	
Chromium	mg/L	0.05 (health); 0.1 as total chromium (h		a;k	1	as chromium, not specified		f	1	as chromium VI	f	(see hexavalent chromium below)	0.04	< 0.01	0.00025	
Hexavalent Chromium	mg/L	0.05			1			f	1		f	1	< 0.05	< 0.01	< 0.00025	
Molybdenum	mg/L	0.01	n	RSL	0.15			f			h	0.05	0.0069	< 0.005	< 0.000125	
Antimony	mg/L	0.003	a					d			h	Not referenced	0.0011	< 0.001	< 0.000025	
Tin	mg/L	1.2	n	RSL				d			h	Not referenced	0.0027	< 0.001	< 0.000025	
Uranium	mg/L	6	n	RSL	0.2			f			h	0.1	0.0007	< 0.001	< 0.000025	
Lead	mg/L	0.01 (health)		a	0.1			f	3.4		f	5	0.013	< 0.001	< 0.000025	
Beryllium	mg/L	0.6	a					d			h	0.5	0.001	< 0.001	< 0.000025	
Cobalt	mg/L	0.0006	n	RSL				d			h	0.1	0.0035	< 0.001	< 0.000025	
Iodide	mg/L	15						d			h	Not referenced	0.2	< 0.05	< 0.00125	
Lithium	mg/L	0.004	n	RSL				d			h	2.5	2.9	< 0.01	< 0.00025	
Thallium	mg/L	0.02	n	RSL				d			h	Not referenced	0.0005	< 0.0005	< 0.0000125	
Vanadium	mg/L	0.0086	n	RSL				d			h	0.5	0.016	< 0.01	< 0.00025	
Phosphorus	mg/L	Not referenced						d	20		f	Crop Specific (0.8 to 12)	0.63	< 0.05	0.00125	
Nitrite	mg/L	3			30			f	40		f	Crop Specific as N (25-125)	0.04	< 0.04	< 0.001	

NOTES:  
XXX EXCEEDS DRINKING WATER GUIDELINE VALUES  
XXX EXCEEDS STOCK WATERING LEVELS  
XXX EXCEEDS AQUATIC ECOSYSTEMS LEVELS

Notes for Criteria for DERM:  
aAustralia Drinking Water Guidelines  
Natural Resource Management Ministrial Council. Australian Drinking Water Guidelines 6, Volume 1. National Water Quality Management Strategy. January 2011.  
b No existing guideline based on Drinking Water hierarchy  
cMay contain bromate from naturally occurring sodium bromide (WHO Guidelines for Drinking-water Quality, pp. 187-188). Australian drinking water guideline for bromate is 0.02 mg/L.  
World Health Organization. Guidelines for Drinknig-water Quality, Fourth Edition. WHO Press, Geneva, Switzerland. ISBN 978 92 4 154815 1. pp 189. 2011. Available online at: <http://www.who.int>  
d No existing guideline based on Stock Watering hierarchy  
e API Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons ( cattle/calves, sheep, goat, horse)  
American Petroleum Institute. Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons. Regulatory Analysis and Scientific Affairs. Publication Number 4733. July 2004.  
f Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.  
g Other (Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering.)  
Department of Water Affairs and Forestry. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering. Republic of South Africa. 1993. ISBN 0-7988-5343-3.  
h No existing guideline based on Aquatic Ecosystem hierarchy  
i EPA Ambient Water Quality Criteria  
<http://water.epa.gov/scitech/swguidance/standards/current/>  
j Other (EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks)  
USEPA. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks. 2011. Available online at: <http://www.epa.gov/reg3hwmdd/risk/eco/btag/sbv/fwseed/screenbench.htm>  
k U.S. EPA Maximum Contaminant Levels (MCLs)  
USEPA. National Primary Drinking Water Regulations. EPA 816-F-09-0004. 2009. Available online at: <http://water.epa.gov/drink/contaminants/index.cfm#List>  
l Section 8.3.5.15 Incorporating effects of water hardness of ANZECC & ARMCANZ (2000) notes to compare total to guideline, if exceeds, then compare dissolved  
ANZECC & ARMCANZ. Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper No. 4, Volume 1. National Water Quality Management Strategy. October 2000.  
RSL USEPA. Regional Screening Levels (RSLs)- Residential Soil THQ = 0.1. Available online at: <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-may-2016>  
RSL Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;

Table F-4  
Summary of Screening of COPCs in Soils as a Result of Release or Irrigation  
Narrabri Gas Project

Chemical Name/Use	Health Investigation Levels (HILs) (mg/kg)		USEPA Residential Soil (mg/kg)	Health Screening Levels (HSLs) (mg/kg)		Ecological Screen Levels (mg/kg)		API (Livestock) (mg/kg)	COPC Concentration in Soil from Release of Permeate (mg/kg)	Soil Concentration after 20 years of Irrigation (mg/kg)
	A Residential	C Recreational		A Residential	C Recreational	Areas of Ecological Significance	Urban Residential and open public space			
Total Dissolved Solids (TDS)									NA	NA
pH									NA	NA
SAR									NA	NA
Bicarbonate (as calcium carbonate equivalent)									NA	NA
Carbonate									NA	NA
Total Alkalinity									NA	NA
Chloride(Cl)									< 4.0	21
Sodium (Na)									5.18	28
Sulphate (SO4)									< 0.20	1.053497942
Calcium (Ca)									< 1.98	11
Magnesium (Mg)									0.002	0.01
Potassium (K)									< 0.20	1.05
Strontium (Sr)									< 0.001	0.004
Barium (Ba)			1500 n						< 0.004	0.02
Fluoride (F)			310 n						< 0.01	0.06
Silica (SiO2)									< 0.04	0.19
Boron (B)	4500	20000							0.03	0.15
Iron (Fe, dissolved)			5500 n						< 0.003950617	0.021069959
Cyanide									< 0.00004	0.0002
Manganese	3800	19000							~ 0.0008	0.004
Aluminium			7700 n						~ 0.0008	0.004
Ammonia									1680.24	8961
Nitrate as N			13000 n						< 0.004	0.02
Copper Sulphate									< 0.0004	0.002
Nickel Sulphate									< 0.0004	0.002
Arsenic	100	300				40	100		< 0.0004	0.002
Cadmium	20	90							< 0.00008	0.0004
Mercury	40	80							< 0.00004	0.0002
Selenium	200	700							< 0.0004	0.002
Zinc	7400	30000							< 0.0004	0.002
Chromium	100	300							< 0.0004	0.002
Hexavalent Chromium									< 0.0004	0.002
Molybdenum			39 n						< 0.00020	0.001
Antimony									< 0.00004	0.0002
Tin			4700 n						< 0.00004	0.0002
Uranium									< 0.00004	0.0002
Lead	300	600				470	1100		< 0.00004	0.0002
Beryllium	60	90							< 0.00004	0.0002
Cobalt	100	300							< 0.00004	0.0002
Iodide									< 0.002	0.01
Lithium			16 n						< 0.0004	0.002
Thallium									< 0.00002	0.0001
Vanadium			39 n						< 0.0004	0.002
Phosphorus									< 0.002	0.01
Nitrite									< 0.002	0.01

Notes:  
**XXX** EXCEEDS RESIDENTIAL HILs OR RSLs  
**XXX** EXCEEDS RESIDENTIAL HSLs  
**XXX** EXCEEDS ECOLOGICAL

Resident Soil Notes:  
Key: c = cancer; n = noncancer; \* = where: n RSL < 100X c RSL; \*\* = where n RSL < 10X c SL;

## APPENDIX G PROUCL MODEL OUTPUT

**Appendix G**  
**ProUCL Output for Spent Muds Geogenic Data**

**UCL Statistics for Data Sets with Non-Detects**

User Selected Options  
Date/Time of Computation 8/5/2016 1:21:46 PM  
From File 20160803\_DrillCuttingsFluids\_ProUCLinputs\_b.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

**2-Methylnaphthalene**

**General Statistics**

Total Number of Observations	10	Number of Distinct Observations	8
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	1.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.014	Maximum Non-Detect	1.0000E-4
Variance Detects	2.0945E-5	Percent Non-Detects	10%
Mean Detects	0.00253	SD Detects	0.00458
Median Detects	7.0000E-4	CV Detects	1.807
Skewness Detects	2.449	Kurtosis Detects	6.098
Mean of Logged Detects	-7.253	SD of Logged Detects	1.691

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.607	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.295	Detected Data Not Normal at 5% Significance Level

**Detected Data Not Normal at 5% Significance Level**

**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**

Mean	0.00229	Standard Error of Mean	0.00139
SD	0.00416	95% KM (BCA) UCL	0.00462
95% KM (t) UCL	0.00485	95% KM (Percentile Bootstrap) UCL	0.00462
95% KM (z) UCL	0.00458	95% KM Bootstrap t UCL	0.0211
90% KM Chebyshev UCL	0.00647	95% KM Chebyshev UCL	0.00837
97.5% KM Chebyshev UCL	0.011	99% KM Chebyshev UCL	0.0162

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	0.591	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.771	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.24	<b>Kolmogrov-Smirnoff GOF</b>
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

**Detected data appear Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	0.499	k star (bias corrected MLE)	0.406
Theta hat (MLE)	0.00508	Theta star (bias corrected MLE)	0.00623
nu hat (MLE)	8.974	nu star (bias corrected)	7.316
MLE Mean (bias corrected)	0.00253	MLE Sd (bias corrected)	0.00397

**Gamma Kaplan-Meier (KM) Statistics**

k hat (KM)	0.303	nu hat (KM)	6.066
Approximate Chi Square Value (6.07, $\alpha$ )	1.674	Adjusted Chi Square Value (6.07, $\beta$ )	1.306
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	0.0083	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	0.0106

## Appendix G

### ProUCL Output for Spent Muds Geogenic Data

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.0000E-4	Mean	0.00328
Maximum	0.014	Median	7.5000E-4
SD	0.00492	CV	1.5
k hat (MLE)	0.501	k star (bias corrected MLE)	0.417
Theta hat (MLE)	0.00655	Theta star (bias corrected MLE)	0.00786
nu hat (MLE)	10.01	nu star (bias corrected)	8.344
MLE Mean (bias corrected)	0.00328	MLE Sd (bias corrected)	0.00508
		Adjusted Level of Significance ( $\beta$ )	0.0267
Approximate Chi Square Value (8.34, $\alpha$ )	2.936	Adjusted Chi Square Value (8.34, $\beta$ )	2.407
95% Gamma Approximate UCL (use when n>=50)	0.00932	95% Gamma Adjusted UCL (use when n<50)	0.0114

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.138	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.295	Detected Data appear Lognormal at 5% Significance Level

**Detected Data appear Lognormal at 5% Significance Level**

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00228	Mean in Log Scale	-7.671
SD in Original Scale	0.00439	SD in Log Scale	2.071
95% t UCL (assumes normality of ROS data)	0.00482	95% Percentile Bootstrap UCL	0.00461
95% BCA Bootstrap UCL	0.00596	95% Bootstrap t UCL	0.021
95% H-UCL (Log ROS)	0.186		

#### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-7.449	95% H-UCL (KM -Log)	0.0246
KM SD (logged)	1.622	95% Critical H Value (KM-Log)	4.492
KM Standard Error of Mean (logged)	0.544		

#### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00229	Mean in Log Scale	-7.518
SD in Original Scale	0.00439	SD in Log Scale	1.801
95% t UCL (Assumes normality)	0.00483	95% H-Stat UCL	0.0526

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

#### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Gamma Distributed at 5% Significance Level**

#### Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00837	95% GROS Adjusted Gamma UCL	0.0114
95% Adjusted Gamma KM-UCL	0.0106		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Appendix G**  
**ProUCL Output for Geogenic Spent Mud Solids Data**

**UCL Statistics for Data Sets with Non-Detects**

User Selected Options  
Date/Time of Computation 8/11/2016 7:57:38 AM  
From File 20160811\_DrillCuttingsFluids\_ProUCLinputs\_a.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

**C10-C16**

**General Statistics**

Total Number of Observations	13	Number of Distinct Observations	13
		Number of Missing Observations	1
Number of Detects	12	Number of Non-Detects	1
Number of Distinct Detects	12	Number of Distinct Non-Detects	1
Minimum Detect	0.144	Minimum Non-Detect	0.06
Maximum Detect	198	Maximum Non-Detect	0.06
Variance Detects	3230	Percent Non-Detects	7.692%
Mean Detects	17.57	SD Detects	56.84
Median Detects	0.711	CV Detects	3.235
Skewness Detects	3.461	Kurtosis Detects	11.98
Mean of Logged Detects	0.0584	SD of Logged Detects	1.972

**Normal GOF Test on Detects Only**

Shapiro Wilk Test Statistic	0.344	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.51	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.256	Detected Data Not Normal at 5% Significance Level

**Detected Data Not Normal at 5% Significance Level**

**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**

Mean	16.22	Standard Error of Mean	15.21
SD	52.49	95% KM (BCA) UCL	46.62
95% KM (t) UCL	43.32	95% KM (Percentile Bootstrap) UCL	46.42
95% KM (z) UCL	41.23	95% KM Bootstrap t UCL	1003
90% KM Chebyshev UCL	61.84	95% KM Chebyshev UCL	82.5
97.5% KM Chebyshev UCL	111.2	99% KM Chebyshev UCL	167.5

**Gamma GOF Tests on Detected Observations Only**

A-D Test Statistic	2.22	<b>Anderson-Darling GOF Test</b>
5% A-D Critical Value	0.847	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.383	<b>Kolmogrov-Smirnoff GOF</b>
5% K-S Critical Value	0.268	Detected Data Not Gamma Distributed at 5% Significance Level

**Detected Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics on Detected Data Only**

k hat (MLE)	0.253	k star (bias corrected MLE)	0.245
Theta hat (MLE)	69.56	Theta star (bias corrected MLE)	71.71
nu hat (MLE)	6.062	nu star (bias corrected)	5.88
MLE Mean (bias corrected)	17.57	MLE Sd (bias corrected)	35.49

**Gamma Kaplan-Meier (KM) Statistics**

k hat (KM)	0.0955	nu hat (KM)	2.483
Approximate Chi Square Value (2.48, $\alpha$ )	0.237	Adjusted Chi Square Value (2.48, $\beta$ )	0.175
95% Gamma Approximate KM-UCL (use when $n \geq 50$ )	169.7	95% Gamma Adjusted KM-UCL (use when $n < 50$ )	229.7
Gamma (KM) may not be used when k hat (KM) is $< 0.1$			



## Appendix G

### ProUCL Output for Geogenic Spent Mud Solids Data

#### Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	16.22
Maximum	198	Median	0.66
SD	54.63	CV	3.369
k hat (MLE)	0.233	k star (bias corrected MLE)	0.23
Theta hat (MLE)	69.67	Theta star (bias corrected MLE)	70.4
nu hat (MLE)	6.052	nu star (bias corrected)	5.989
MLE Mean (bias corrected)	16.22	MLE Sd (bias corrected)	33.79
		Adjusted Level of Significance ( $\beta$ )	0.0301
Approximate Chi Square Value (5.99, $\alpha$ )	1.634	Adjusted Chi Square Value (5.99, $\beta$ )	1.333
95% Gamma Approximate UCL (use when n>=50)	59.43	95% Gamma Adjusted UCL (use when n<50)	72.87

#### Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.831	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.173	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.256	Detected Data appear Lognormal at 5% Significance Level

**Detected Data appear Approximate Lognormal at 5% Significance Level**

#### Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	16.22	Mean in Log Scale	-0.287
SD in Original Scale	54.63	SD in Log Scale	2.261
95% t UCL (assumes normality of ROS data)	43.22	95% Percentile Bootstrap UCL	46.37
95% BCA Bootstrap UCL	61.7	95% Bootstrap t UCL	1006
95% H-UCL (Log ROS)	323.4		

#### UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-0.162	95% H-UCL (KM -Log)	86.47
KM SD (logged)	1.968	95% Critical H Value (KM-Log)	4.725
KM Standard Error of Mean (logged)	0.57		

#### DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	16.22	Mean in Log Scale	-0.216
SD in Original Scale	54.63	SD in Log Scale	2.131
95% t UCL (Assumes normality)	43.22	95% H-Stat UCL	179.2

**DL/2 is not a recommended method, provided for comparisons and historical reasons**

#### Nonparametric Distribution Free UCL Statistics

**Detected Data appear Approximate Lognormal Distributed at 5% Significance Level**

#### Suggested UCL to Use

99% KM (Chebyshev) UCL	167.5
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

**Appendix G**  
**ProUCL Output Geogenic Cuttings Data**

**UCL Statistics for Data Sets with Non-Detects**

User Selected Options  
Date/Time of Computation 8/5/2016 12:57:33 PM  
From File 20160803\_DrillCuttingsFluids\_ProUCLinputs.xls  
Full Precision OFF  
Confidence Coefficient 95%  
Number of Bootstrap Operations 2000

**Chromium**

**General Statistics**

Total Number of Observations	25	Number of Distinct Observations	8
		Number of Missing Observations	1
Minimum	9	Mean	17.48
Maximum	103	Median	11
SD	20.23	Std. Error of Mean	4.046
Coefficient of Variation	1.157	Skewness	3.607

**Normal GOF Test**

Shapiro Wilk Test Statistic	0.451	<b>Shapiro Wilk GOF Test</b>
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.447	<b>Lilliefors GOF Test</b>
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level

**Data Not Normal at 5% Significance Level**

**Assuming Normal Distribution**

<b>95% Normal UCL</b>		<b>95% UCLs (Adjusted for Skewness)</b>	
95% Student's-t UCL	24.4	95% Adjusted-CLT UCL (Chen-1995)	27.25
		95% Modified-t UCL (Johnson-1978)	24.89

**Gamma GOF Test**

A-D Test Statistic	4.584	<b>Anderson-Darling Gamma GOF Test</b>
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.442	<b>Kolmogrov-Smirnoff Gamma GOF Test</b>
5% K-S Critical Value	0.177	Data Not Gamma Distributed at 5% Significance Level

**Data Not Gamma Distributed at 5% Significance Level**

**Gamma Statistics**

k hat (MLE)	2.007	k star (bias corrected MLE)	1.793
Theta hat (MLE)	8.71	Theta star (bias corrected MLE)	9.75
nu hat (MLE)	100.3	nu star (bias corrected)	89.64
MLE Mean (bias corrected)	17.48	MLE Sd (bias corrected)	13.06
		Approximate Chi Square Value (0.05)	68.81
Adjusted Level of Significance	0.0395	Adjusted Chi Square Value	67.56

**Assuming Gamma Distribution**

95% Approximate Gamma UCL (use when n>=50))	22.77	95% Adjusted Gamma UCL (use when n<50)	23.19
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**Lognormal GOF Test**

Shapiro Wilk Test Statistic	0.629	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.41	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.177	Data Not Lognormal at 5% Significance Level

**Data Not Lognormal at 5% Significance Level**

**Appendix G**  
**ProUCL Output Geogenic Cuttings Data**

Lognormal Statistics			
Minimum of Logged Data	2.197	Mean of logged Data	2.592
Maximum of Logged Data	4.635	SD of logged Data	0.605
Assuming Lognormal Distribution			
95% H-UCL	20.66	90% Chebyshev (MVUE) UCL	22
95% Chebyshev (MVUE) UCL	24.77	97.5% Chebyshev (MVUE) UCL	28.61
99% Chebyshev (MVUE) UCL	36.15		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	24.14	95% Jackknife UCL	24.4
95% Standard Bootstrap UCL	24.05	95% Bootstrap-t UCL	36.34
95% Hall's Bootstrap UCL	42.63	95% Percentile Bootstrap UCL	24.6
95% BCA Bootstrap UCL	28.2		
90% Chebyshev(Mean, Sd) UCL	29.62	95% Chebyshev(Mean, Sd) UCL	35.12
97.5% Chebyshev(Mean, Sd) UCL	42.75	99% Chebyshev(Mean, Sd) UCL	57.74
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	35.12		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets. For additional insight the user may want to consult a statistician.

**Copper**

General Statistics			
Total Number of Observations	25	Number of Distinct Observations	23
		Number of Missing Observations	1
Minimum	8	Mean	40.68
Maximum	109	Median	34
SD	24.65	Std. Error of Mean	4.93
Coefficient of Variation	0.606	Skewness	1.143
Normal GOF Test			
Shapiro Wilk Test Statistic	0.908	Shapiro Wilk GOF Test	
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	Lilliefors GOF Test	
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	49.11	95% Adjusted-CLT UCL (Chen-1995)	49.99
		95% Modified-t UCL (Johnson-1978)	49.3
Gamma GOF Test			
A-D Test Statistic	0.219	Anderson-Darling Gamma GOF Test	
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.114	Kolmogrov-Smirnoff Gamma GOF Test	
5% K-S Critical Value	0.176	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.969	k star (bias corrected MLE)	2.64

**Appendix G**  
**ProUCL Output Geogenic Cuttings Data**

Theta hat (MLE)	13.7	Theta star (bias corrected MLE)	15.41
nu hat (MLE)	148.5	nu star (bias corrected)	132
MLE Mean (bias corrected)	40.68	MLE Sd (bias corrected)	25.04
		Approximate Chi Square Value (0.05)	106.4
Adjusted Level of Significance	0.0395	Adjusted Chi Square Value	104.9

**Assuming Gamma Distribution**

95% Approximate Gamma UCL (use when n>=50)	50.44	95% Adjusted Gamma UCL (use when n<50)	51.19
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**Lognormal GOF Test**

Shapiro Wilk Test Statistic	0.977	<b>Shapiro Wilk Lognormal GOF Test</b>
5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0795	<b>Lilliefors Lognormal GOF Test</b>
5% Lilliefors Critical Value	0.177	Data appear Lognormal at 5% Significance Level

**Data appear Lognormal at 5% Significance Level**

**Lognormal Statistics**

Minimum of Logged Data	2.079	Mean of logged Data	3.528
Maximum of Logged Data	4.691	SD of logged Data	0.631

**Assuming Lognormal Distribution**

95% H-UCL	54.3	90% Chebyshev (MVUE) UCL	57.73
95% Chebyshev (MVUE) UCL	65.24	97.5% Chebyshev (MVUE) UCL	75.65
99% Chebyshev (MVUE) UCL	96.1		

**Nonparametric Distribution Free UCL Statistics**

**Data appear to follow a Discernible Distribution at 5% Significance Level**

**Nonparametric Distribution Free UCLs**

95% CLT UCL	48.79	95% Jackknife UCL	49.11
95% Standard Bootstrap UCL	48.59	95% Bootstrap-t UCL	50.56
95% Hall's Bootstrap UCL	50.14	95% Percentile Bootstrap UCL	49.08
95% BCA Bootstrap UCL	49.96		
90% Chebyshev(Mean, Sd) UCL	55.47	95% Chebyshev(Mean, Sd) UCL	62.17
97.5% Chebyshev(Mean, Sd) UCL	71.47	99% Chebyshev(Mean, Sd) UCL	89.73

**Suggested UCL to Use**

95% Adjusted Gamma UCL	51.19
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.

For additional insight the user may want to consult a statistician.

## **APPENDIX H CHEMICAL-SPECIFIC PARAMETER EQUATIONS AND OUTPUT**

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Formula to Calculate log K<sub>p</sub>:

**Empirical Predictive Correlation for Permeability Coefficient of Organics**

$$\log K_p = -2.80 + 0.66 \log K_{ow} - 0.0056 MW \quad (r^2 = 0.66) \quad (3.8)$$

where:

Parameter	Definition (units)	Default Value
K <sub>p</sub>	Dermal permeability coefficient of compounds in water (cm/hr)	Chemical-specific, see Appendix B
K <sub>ow</sub>	Octanol/water partition coefficient of the non-ionized species (dimensionless)	Chemical-specific, see Appendix B
MW	Molecular weight (g/mole)	Chemical-specific, see Appendix B

Formula to Calculate B:

$$B = \frac{K_p}{K_{p,ve}} \approx K_p \frac{\sqrt{MW}}{2.6} \quad (\text{as an approximation}) \quad (A.1)$$

where:

Parameter	Definition (units)	Default Value
B	Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (ve)	—
K <sub>p,ve</sub>	Steady-state permeability coefficient through the viable epidermis (ve) (cm/hr)	K <sub>p,ve</sub> = K <sub>ew</sub> D <sub>e</sub> /L <sub>e</sub> , K <sub>ew</sub> = 1 assuming epidermis behaves essentially as water; L <sub>e</sub> = 10 <sup>-2</sup> cm, D <sub>e</sub> = 7.1x10 <sup>-6</sup> /MW cm <sup>2</sup> /s assuming D <sub>e</sub> =10 <sup>-6</sup> cm <sup>2</sup> /s when MW = 50 (Bunge and Cleek, 1995)
K <sub>p</sub>	Dermal permeability coefficient in water (cm/hr)	Equation 3.8
MW	Molecular weight (g/mole)	Chemical-specific
K <sub>ew</sub>	Equilibrium partition coefficient between the epidermis and water for the absorbing chemical (dimensionless)	Chemical-specific
D <sub>e</sub>	Effective diffusivity of the absorbing chemical in the epidermis (cm <sup>2</sup> /hr)	Chemical-specific
L <sub>e</sub>	Effective thickness of the epidermis (cm)	10 <sup>-2</sup>

E WATER PATHWAY

Formula to Calculate  $\tau_{event}$ :

$$\tau_{event} = \frac{l_{sc}^2}{6 D_{sc}} = 0.105 \times 10^{(0.0056 MW)} \quad (A.4)$$

where:

Parameter	Definition (units)	Default Value
$\tau_{event}$	= Lag time per event (hr/event)	Chemical-specific
$D_{sc}$	= Effective diffusion coefficient for chemical transfer through the stratum corneum (cm <sup>2</sup> /hr)	Chemical-specific
$l_{sc}$	= Apparent thickness of stratum corneum (cm)	10 <sup>-3</sup>
MW	= Molecular weight (g/mole)	Chemical-specific

Formula to calculate  $t^*$ :

Calculate  $t^*$ :

$$\text{If } B \leq 0.6, \text{ then } t^* = 2.4 \tau_{event} \quad (A.5)$$

$$\text{If } B > 0.6, \text{ then } t^* = 6 \tau_{event} (b - \sqrt{b^2 - c^2}) \quad (A.6)$$

$$b = \frac{2(1+B)^2}{\pi} - c \quad (A.7)$$

$$c = \frac{1 + 3B + 3B^2}{3(1+B)} \quad (A.8)$$

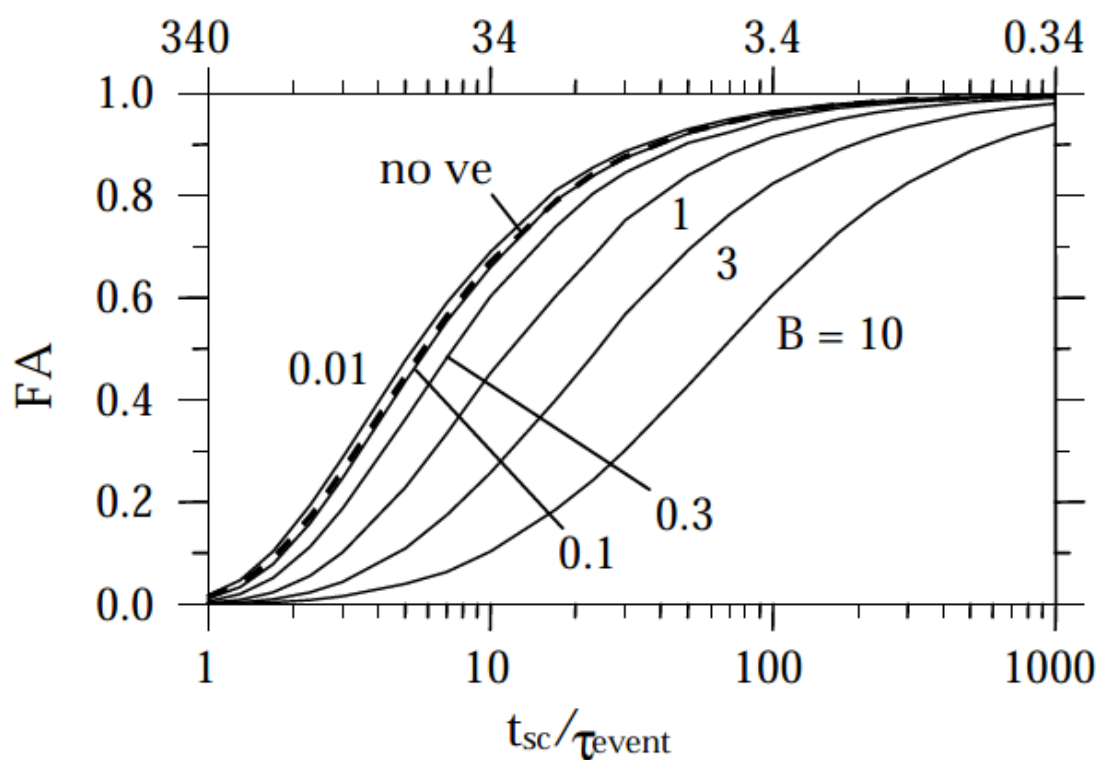
where:

Parameter	Definition (units)	Default Value
B	= Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (ve) (dimensionless).	Chemical-specific
$t^*$	= Time to reach steady-state (hr)	Chemical-specific
$\tau_{event}$	= Lag time per event (hr/event)	Chemical-specific
$D_{sc}$	= Effective diffusion coefficient for chemical transfer through the stratum corneum (cm <sup>2</sup> /hr)	Chemical-specific
$l_{sc}$	= Apparent thickness of stratum corneum (cm)	10 <sup>-3</sup>
b, c	= Correlation coefficients which have been fitted to the Flynn's data to give Equation 3.8	

EXHIBIT A-5

EFFECT OF STRATUM CORNEUM TURNOVER ON FRACTION ABSORBED  
(WATER) AS A FUNCTION OF B

$\tau_{\text{event}}$  (hr) for  $t_{\text{sc}} = 14$  d



no ve: No viable epidermis—A model solution obtained assuming that the stratum corneum is the only barrier to dermal absorption



**Appendix H**  
**Summary of Calculated Chemical-Specific Properties**

Chemical Name	Cas Number	Log Kow	MW (g/mol)	Calculated log Kp	Calculated Kp (cm/hr)	B	tau <sub>event</sub> (hours/event)	b	c	t*	FA
Potassium chloride	7447-40-7	NA	74.55	NA	NA	NA	2.7E-01	NA	NA	NA	1
Copolymer of acrylamide and sodium acrylate	25085-02-3	NA	>100,000	NA	NA	NA	NA	NA	NA	NA	1
Glyoxal	107-22-2	1.62	58.04	-2.1E+00	8.8E-03	2.6E-02	2.2E-01	3.2E-01	3.5E-01	5.3E-01	1
Methanol	67-56-1	-0.77	32.04	-3.5E+00	3.3E-04	7.1E-04	1.6E-01	3.0E-01	3.3E-01	3.8E-01	1
Pentanedial / Glutaraldehyde	111-30-8	-0.36	100.12	-3.6E+00	2.5E-04	9.7E-04	3.8E-01	3.0E-01	3.3E-01	9.2E-01	1
Sodium carbonate	497-19-8	NA	106	NA	NA	NA	4.1E-01	NA	NA	NA	1
Sodium carboxymethyl cellulose	9004-32-4	NA	162.14, 242.16, >21,000 - 500,000	NA	NA	NA	NA	NA	NA	NA	1
Sodium hydroxide	1310-73-2	NA	40	NA	NA	NA	1.8E-01	NA	NA	NA	1
Starch	9005-25-8	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0.3	162.3	-3.5E+00	3.1E-04	1.5E-03	8.5E-01	3.0E-01	3.3E-01	2.0E+00	1
Xanthan gum	11138-66-2	NA	2.00E+06	NA	NA	NA	NA	NA	NA	NA	1
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Polyalkylene	9038-95-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Polypropylene glycol	25322-69-4	<0.3 to 0.9	variable	NA	NA	NA	NA	NA	NA	NA	1
Silicic acid, potassium salt	1312-76-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Sodium Chloride	7647-14-5	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Sodium polyacrylate	9003-04-7	NA	1,000 to 78,000	NA	NA	NA	NA	NA	NA	NA	1
Methylisothiocyanate (MITC)	556-61-6	0.3	73.12	-3.0E+00	9.7E-04	3.2E-03	2.7E-01	3.1E-01	3.4E-01	6.5E-01	1

Notes:

Glyoxal log kow is max of 3 in risk dossier (most conservative)

MITC log kow is max of 2 presented in risk dossier (most conservative)

**APPENDIX I INDIVIDUAL MUD SYSTEM RISK TABLES**

Table I-1  
Comparison of Cumulative Risks for Individual Mud Systems to Composite Mud System  
Narrabri Gas Project

Receptor	Scenario	Composite Mud		5% KCL Polymer PHPA		Inhibited Mud V4 Bore-HIB		Inhibited Mud V4 Glycol	
		Cumulative HI	Risk Drivers	Cumulative HI	Risk Drivers	Cumulative HI	Risk Drivers	Cumulative HI	Risk Drivers
Trespasser	Recovered Drilling Fluids, Day 0	3.1E+00	silicic acid, potassium salt (HI of 2.5) via the incidental ingestion of fluids which accounts for 86 percent of the cumulative HI in day 0 and 78 percent in days 3 and 7	3.6E-03	NA	1.7E+00	Silicic acid, potassium salt (HQ 1.2)	5.4E-01	NA
Trespasser	Recovered Drilling Fluids, Day 3	3.2E+00	silicic acid, potassium salt (HI of 2.5) via the incidental ingestion of water while swimming which accounts for 86 percent of the cumulative HI in day 0 and 78 percent in days 3 and 7	1.2E-03	NA	1.8E+00	Silicic acid, potassium salt (HQ 1.2)	6.7E-01	NA
Trespasser	Recovered Drilling Fluids, Day 7	3.2E+00	silicic acid, potassium salt (HI of 2.5) via the incidental ingestion of water while swimming which accounts for 86 percent of the cumulative HI in day 0 and 78 percent in days 3 and 7	1.1E-03	NA	1.8E+00	Silicic acid, potassium salt (HQ 1.2)	6.7E-01	NA
Trespasser	Drill Cuttings (Surface)	5.4E-03	NA	9.8E-06	NA	2.9E-03	NA	8.4E-04	NA
Trespasser	Drill Cuttings (Buried)	2.7E-03	NA	4.9E-06	NA	1.4E-03	NA	4.2E-04	NA
Worker	Drill Cuttings (Surface)	8.9E-04	NA	1.6E-06	NA	4.7E-04	NA	1.4E-04	NA
Worker	Drill Cuttings (Buried)	4.4E-04	NA	8.0E-07	NA	2.4E-03	NA	6.9E-05	NA
Farmer	Drill Cuttings (Surface)	1.0E-03	NA	1.7E-06	NA	5.5E-04	NA	1.6E-04	NA
Farmer	Drill Cuttings (Buried)	5.2E-04	NA	8.6E-07	NA	2.8E-04	NA	8.0E-05	NA
Kangaroo	Recovered Drilling Fluids, Day 0	3.1E+00	silicic acid, potassium salt with an HI of 1.2 in all exposure scenarios. The remaining COPCs did not individually exceed a HI of 1.0; however, the cumulative HI of the remaining COPCs did exceed the acceptable level (see cattle summary above)	1.2E-02	NA	2.0E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Silicic acid, potassium salt (HQ 0.57)	1.9E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Polyalkylene glycol (HQ 0.5) Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) (HQ 0.25)
Kangaroo	Recovered Drilling Fluids, Day 3	3.5E+00	silicic acid, potassium salt with an HI of 1.2 in all exposure scenarios. The remaining COPCs did not individually exceed a HI of 1.0; however, the cumulative HI of the remaining COPCs did exceed the acceptable level (see cattle summary above)	4.7E-03	NA	2.2E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Silicic acid, potassium salt (HQ 0.57) Methylisothiocyanate (MITC) (HQ 0.51)	2.2E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Polyalkylene glycol (HQ 0.5) Methylisothiocyanate (MITC) (HQ 0.51)
Kangaroo	Recovered Drilling Fluids, Day 7	3.5E+00	silicic acid, potassium salt with an HI of 1.2 in all exposure scenarios. The remaining COPCs did not individually exceed a HI of 1.0; however, the cumulative HI of the remaining COPCs did exceed the acceptable level (see cattle summary above)	4.7E-03	NA	2.2E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Silicic acid, potassium salt (HQ 0.57) Methylisothiocyanate (MITC) (HQ 0.51)	2.2E+00	Pentanedial / Glutaraldehyde (HQ 0.99) Polyalkylene glycol (HQ 0.5) Methylisothiocyanate (MITC) (HQ 0.51)
Dingo	Recovered Drilling Fluids, Day 0	1.3E+00	No individual COPC resulted in the exceedance of the acceptable level; however, the following COPCs accounted for greater than 90 percent of the risk in day 0, 3 and 7: pentanedial/glutaraldehyde, polyalkene glycol, silicic acid, potassium salt, and tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet) (day 0) and MITC (days 3 and 7).	4.9E-03	NA	8.1E-01	NA	7.8E-01	NA
Dingo	Recovered Drilling Fluids, Day 3	1.4E+00	No individual COPC resulted in the exceedance of the acceptable level; however, the following COPCs accounted for greater than 90 percent of the risk in day 0, 3 and 7: pentanedial/glutaraldehyde, polyalkene glycol, silicic acid, potassium salt, and tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet) (day 0) and MITC (days 3 and 7).	1.9E-03	NA	9.1E-01	NA	8.8E-01	NA
Dingo	Recovered Drilling Fluids, Day 7	1.4E+00	No individual COPC resulted in the exceedance of the acceptable level; however, the following COPCs accounted for greater than 90 percent of the risk in day 0, 3 and 7: pentanedial/glutaraldehyde, polyalkene glycol, silicic acid, potassium salt, and tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (dazomet) (day 0) and MITC (days 3 and 7).	1.9E-03	NA	9.1E-01	NA	8.8E-01	NA
Pilliga Mouse	Drill Cuttings (Surface)	2.1E-03		1.6E-05	NA	1.4E-03	NA	1.3E-03	NA
Pilliga Mouse	Drill Cuttings (Buried)	1.1E-03		8.2E-06	NA	6.8E-04	NA	6.6E-04	NA
Rainbow Bee-Eater	Drill Cuttings (Surface)	5.6E+00	Polyalkene (HQ 1.5) Silicic acid, potassium salt (HQ 3.4) Methylisothiocyanate (MITC) (HQ 2.0)	3.6E-02	NA	2.7E+00	Silicic acid, potassium salt (HQ 1.2) Methylisothiocyanate (MITC) (HQ 1.1)	2.5E+00	Polyalkylene (HQ 1.1) Methylisothiocyanate (MITC) (HQ 1.1)
Rainbow Bee-Eater	Drill Cuttings (Buried)	2.8E+00	Polyalkene (HQ 0.74) Silicic acid, potassium salt (HQ 1.7) Methylisothiocyanate (MITC) (HQ 1.0)	1.8E-02	NA	1.3E+00	Silicic acid, potassium salt (HQ 0.61) Methylisothiocyanate (MITC) (HQ 0.54)	1.2E+00	Polyalkylene (HQ 0.53) Methylisothiocyanate (MITC) (HQ 0.54)
Cattle Egret	Drill Cuttings (Surface)	1.6E+00	Polyalkene (HQ 0.31) Silicic acid, potassium salt (HQ 0.72) Methylisothiocyanate (MITC) (HQ 0.41)	1.0E-02	NA	7.3E-01	NA	6.9E-01	NA
Cattle Egret	Drill Cuttings (Buried)	9.7E-01		9.3E-03	NA	5.2E-01	NA	4.9E-01	NA

Notes:

Shaded cumulative HI exceeds acceptable level

Table I-1  
Comparison of Cumulative Risks for Individual Mud Systems to Composite Mud System  
Narrabri Gas Project

Receptor	Scenario	KCL Polymer Mud V4	
		Cumulative HI	Risk Drivers
Trespasser	Recovered Drilling Fluids, Day 0	4.1E-01	NA
Trespasser	Recovered Drilling Fluids, Day 3	6.0E-01	NA
Trespasser	Recovered Drilling Fluids, Day 7	6.0E-01	NA
Trespasser	Drill Cuttings (Surface)	6.7E-04	NA
Trespasser	Drill Cuttings (Buried)	3.4E-04	NA
Worker	Drill Cuttings (Surface)	1.1E-04	NA
Worker	Drill Cuttings (Buried)	5.5E-05	NA
Farmer	Drill Cuttings (Surface)	1.3E-04	NA
Farmer	Drill Cuttings (Buried)	6.4E-05	NA
Kangaroo	Recovered Drilling Fluids, Day 0	1.3E+00	Pentanedial / Glutaraldehyde (HQ 0.83) Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) (HQ 0.35)
Kangaroo	Recovered Drilling Fluids, Day 3	1.7E+00	Pentanedial / Glutaraldehyde (HQ 0.83) Methylisothiocyanate (MITC) (HQ 0.70)
Kangaroo	Recovered Drilling Fluids, Day 7	1.7E+00	Pentanedial / Glutaraldehyde (HQ 0.83) Methylisothiocyanate (MITC) (HQ 0.70)
Dingo	Recovered Drilling Fluids, Day 0	5.4E-01	NA
Dingo	Recovered Drilling Fluids, Day 3	6.8E-01	NA
Dingo	Recovered Drilling Fluids, Day 7	6.8E-01	NA
Pilliga Mouse	Drill Cuttings (Surface)	1.0E-03	
Pilliga Mouse	Drill Cuttings (Buried)	5.1E-04	
Rainbow Bee-Eater	Drill Cuttings (Surface)	1.8E+00	Methylisothiocyanate (MITC) (HQ 1.5)
Rainbow Bee-Eater	Drill Cuttings (Buried)	9.1E-01	NA
Cattle Egret	Drill Cuttings (Surface)	5.0E-01	NA
Cattle Egret	Drill Cuttings (Buried)	4.5E-01	NA

Notes:

Shaded cumulative HI exceeds acceptable level

**Table I-2**  
**Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
Potassium chloride	7447-40-7	517	NA	517	517	517
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	14	14.00	14.00
Glyoxal	107-22-2	0	15	0	0.0	0.0
Methanol	67-56-1	0	15	0	0.04	0.04
Pentanedial / Glutaraldehyde	111-30-8	1	NA	1	1.49	1.49
Sodium carbonate	497-19-8	5	NA	5	4.98	4.98
Sodium carboxymethyl cellulose	9004-32-4	55	150	55	54.05	53.06
Sodium hydroxide	1310-73-2	6	NA	6	6	6
Starch	9005-25-8	110	15	110	95	79
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1	0.21	1.10	0.00	0.00
Methylisothiocyanate (MITC)	556-61-6	-	NA	0.00	0.00	0.00
Xanthan gum	11138-66-2	41	150	41	40	40
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	15	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	NA	NA	NA	NA
Sodium chloride	7647-14-5	NA	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	NA	NA	NA	NA

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table I-3**  
**Summary of Theoretical Concentrations of Vendor Chemicals with Spent Drilling Muds and Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg) (a)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)
Potassium chloride	7447-40-7	310	31	16
Copolymer of acrylamide and sodium acrylate	25085-02-3	8	0.8	0.4
Glyoxal	107-22-2	0	0.00	0.00
Methanol	67-56-1	0	0.0	0.00
Pentanedial / Glutaraldehyde	111-30-8	1	0	0
Sodium carbonate	497-19-8	3	0.3	0.15
Sodium carboxymethyl cellulose	9004-32-4	33	3	1.64
Sodium hydroxide	1310-73-2	4	0	0.18
Starch	9005-25-8	66	7	3.29
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1	0.1	0.03
Methylisothiocyanate (MITC)	556-61-6	1	0.1	0.03
Xanthan gum	11138-66-2	25	2	1.23
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	NA	NA
Polyalkylene	9038-95-3	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	NA	NA
Sodium chloride	7647-14-5	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	NA	NA

a/ Assume 10 percent of residual vendor chemicals remain on cuttings after shaker.

b/ Assume drill cuttings mixed at 1 to 1 ratio with clean fill; therefore, reduction of COPC concentration of 50%.

c/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.

**Table I-4**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 0)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	517	Yes	NA	1.8E+01	6.9E-03	NA	3.9E-04	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	Yes	NA	-	1.9E-04	NA	NA	NA
Glyoxal	107-22-2	0	Yes	4.4E-07	2.5E-01	7.4E-07	7.1E-06	2.9E-06	2.8E-05
Methanol	67-56-1	0	No	1.3E-08	2.0E+00	6.7E-07	2.1E-07	3.3E-07	1.1E-07
Pentanedial / Glutaraldehyde	111-30-8	1	Yes	4.5E-07	4.0E-02	2.0E-05	7.3E-06	5.0E-04	1.8E-04
Sodium carbonate	497-19-8	5	Yes	NA	5.1E+01	6.7E-05	NA	1.3E-06	NA
Sodium carboxymethyl cellulose	9004-32-4	55	Yes	NA	-	7.4E-04	NA	NA	NA
Sodium hydroxide	1310-73-2	6	Yes	NA	5.1E+01	8.2E-05	NA	1.6E-06	NA
Starch	9005-25-8	110	Yes	NA	-	1.5E-03	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1	Yes	6.1E-07	1.0E-02	1.5E-05	9.8E-06	1.5E-03	9.8E-04
Xanthan gum	11138-66-2	41	Yes	NA	1.0E+01	5.5E-04	NA	5.5E-05	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	Yes	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	Yes	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	Yes	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	NA	Yes	NA	5.0E-03	NA	NA	NA	NA

Exposure Pathway HI: **2.4E-03** **1.2E-03**

CADD = chronic absorbed daily dose

Cumulative HI: **3.6E-03**

**Table I-5**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 3)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	517	Yes	NA	1.8E+01	6.9E-03	NA	3.9E-04	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	Yes	NA	-	1.9E-04	NA	NA	NA
Glyoxal	107-22-2	0.05	Yes	3.9E-07	2.5E-01	6.4E-07	6.2E-06	2.6E-06	2.5E-05
Methanol	67-56-1	0.04	No	1.2E-08	2.0E+00	5.8E-07	1.8E-07	2.9E-07	9.2E-08
Pentanedial / Glutaraldehyde	111-30-8	1.49	Yes	4.5E-07	4.0E-02	2.0E-05	7.3E-06	5.0E-04	1.8E-04
Sodium carbonate	497-19-8	5	Yes	NA	5.1E+01	6.7E-05	NA	1.3E-06	NA
Sodium carboxymethyl cellulose	9004-32-4	54	Yes	NA	-	7.3E-04	NA	NA	NA
Sodium hydroxide	1310-73-2	6	Yes	NA	5.1E+01	8.2E-05	NA	1.6E-06	NA
Starch	9005-25-8	95	Yes	NA	-	1.3E-03	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	2.8E-11	1.0E-02	6.8E-10	4.5E-10	6.8E-08	4.5E-08
Xanthan gum	11138-66-2	40	Yes	NA	1.0E+01	5.4E-04	NA	5.4E-05	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	Yes	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	Yes	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	Yes	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	Yes	0.0E+00	5.0E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00

**Exposure Pathway HI: 9.5E-04 2.1E-04**

CADD = chronic absorbed daily dose

**Cumulative HI: 1.2E-03**



**Table I-6**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 7)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7 CW (mg/l)	ET <sub>st</sub> *	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	517	Yes	NA	1.8E+01	6.9E-03	NA	3.9E-04	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	Yes	NA	-	1.9E-04	NA	NA	NA
Glyoxal	107-22-2	0.04	Yes	3.2E-07	2.5E-01	5.3E-07	5.1E-06	2.1E-06	2.1E-05
Methanol	67-56-1	0.04	No	9.6E-09	2.0E+00	4.8E-07	1.5E-07	2.4E-07	7.7E-08
Pentanedial / Glutaraldehyde	111-30-8	1.49	Yes	4.5E-07	4.0E-02	2.0E-05	7.3E-06	5.0E-04	1.8E-04
Sodium carbonate	497-19-8	5	Yes	NA	5.1E+01	6.7E-05	NA	1.3E-06	NA
Sodium carboxymethyl cellulose	9004-32-4	53	Yes	NA	-	7.1E-04	NA	NA	NA
Sodium hydroxide	1310-73-2	6	Yes	NA	5.1E+01	8.2E-05	NA	1.6E-06	NA
Starch	9005-25-8	79	Yes	NA	-	1.1E-03	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	4.7E-17	1.0E-02	1.1E-15	7.5E-16	1.1E-13	7.5E-14
Xanthan gum	11138-66-2	40	Yes	NA	1.0E+01	5.3E-04	NA	5.3E-05	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	Yes	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	Yes	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	Yes	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	Yes	0.0E+00	5.0E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Exposure Pathway HI: **9.4E-04** **2.0E-04**

Cumulative HI: **1.1E-03**

CADD = chronic absorbed daily dose

**Table I-7**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31	1.8E+01	1.7E-06	1.1E-05	9.3E-08	6.1E-07
Copolymer of acrylamide and sodium acrylate	25085-02-3	1	-	4.5E-08	3.0E-07	NA	NA
Glyoxal	107-22-2	0	2.5E-01	1.8E-10	1.2E-09	7.1E-10	4.6E-09
Methanol	67-56-1	0.0	2.0E+00	1.6E-10	1.1E-09	8.0E-11	5.3E-10
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	4.8E-09	3.2E-08	1.2E-07	7.9E-07
Sodium carbonate	497-19-8	0	5.1E+01	1.6E-08	1.1E-07	3.1E-10	2.1E-09
Sodium carboxymethyl cellulose	9004-32-4	3	-	1.8E-07	1.2E-06	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	2.0E-08	1.3E-07	3.8E-10	2.5E-09
Starch	9005-25-8	7	-	3.5E-07	2.3E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	3.5E-09	2.3E-08	3.5E-07	2.3E-06
Xanthan gum	11138-66-2	2	1.0E+01	1.3E-07	8.7E-07	1.3E-08	8.7E-08
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0	5.0E-03	3.5E-09	2.3E-08	7.1E-07	4.7E-06

**1.3E-06      8.5E-06**

CADD = chronic absorbed daily dose

**Cumulative HI:      9.8E-06**

**Table I-8**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Buried Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	16	1.8E+01	8.3E-07	5.5E-06	4.6E-08	3.0E-07
Copolymer of acrylamide and sodium acrylate	25085-02-3	0	-	2.3E-08	1.5E-07	NA	NA
Glyoxal	107-22-2	0	2.5E-01	8.8E-11	5.8E-10	3.5E-10	2.3E-09
Methanol	67-56-1	0.00	2.0E+00	8.0E-11	5.3E-10	4.0E-11	2.6E-10
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	2.4E-09	1.6E-08	6.0E-08	4.0E-07
Sodium carbonate	497-19-8	0	5.1E+01	8.0E-09	5.3E-08	1.6E-10	1.0E-09
Sodium carboxymethyl cellulose	9004-32-4	2	-	8.8E-08	5.8E-07	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	9.8E-09	6.4E-08	1.9E-10	1.3E-09
Starch	9005-25-8	3	-	1.8E-07	1.2E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	1.8E-09	1.2E-08	1.8E-07	1.2E-06
Xanthan gum	11138-66-2	1	1.0E+01	6.6E-08	4.3E-07	6.6E-09	4.3E-08
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0	5.0E-03	1.8E-09	1.2E-08	3.5E-07	2.3E-06
						<b>6.5E-07</b>	<b>4.2E-06</b>
						<b>Cumulative HI:</b>	<b>4.9E-06</b>

CADD = chronic absorbed daily dose

**Table I9**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31	1.8E+01	7.2E-07	1.3E-06	4.0E-08	7.5E-08
Copolymer of acrylamide and sodium acrylate	25085-02-3	1	-	1.9E-08	3.6E-08	NA	NA
Glyoxal	107-22-2	0.0	2.5E-01	7.6E-11	1.4E-10	3.0E-10	5.7E-10
Methanol	67-56-1	0.0	2.0E+00	6.9E-11	1.3E-10	3.5E-11	6.5E-11
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	2.1E-09	3.9E-09	5.2E-08	9.7E-08
Sodium carbonate	497-19-8	0	5.1E+01	6.9E-09	1.3E-08	1.3E-10	2.5E-10
Sodium carboxymethyl cellulose	9004-32-4	3	-	7.6E-08	1.4E-07	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	8.5E-09	1.6E-08	1.6E-10	3.1E-10
Starch	9005-25-8	7	-	1.5E-07	2.8E-07	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	1.5E-09	2.9E-09	1.5E-07	2.9E-07
Xanthan gum	11138-66-2	2	1.0E+01	5.7E-08	1.1E-07	5.7E-09	1.1E-08
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0	5.0E-03	1.5E-09	2.9E-09	3.1E-07	5.7E-07

Exposure Pathway HI:                      5.6E-07      1.0E-06  
Cumulative HI:                                1.6E-06

CADD = chronic absorbed daily dose

**Table I-10**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	16	1.8E+01	3.6E-07	6.7E-07	2.0E-08	3.7E-08
Copolymer of acrylamide and sodium acrylate	25085-02-3	0	-	9.7E-09	1.8E-08	NA	NA
Glyoxal	107-22-2	0	2.5E-01	3.8E-11	7.1E-11	1.5E-10	2.8E-10
Methanol	67-56-1	0.00	2.0E+00	3.5E-11	6.5E-11	1.7E-11	3.2E-11
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	1.0E-09	1.9E-09	2.6E-08	4.8E-08
Sodium carbonate	497-19-8	0	5.1E+01	3.5E-09	6.5E-09	6.7E-11	1.3E-10
Sodium carboxymethyl cellulose	9004-32-4	2	-	3.8E-08	7.1E-08	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	4.2E-09	7.9E-09	8.2E-11	1.5E-10
Starch	9005-25-8	3	-	7.6E-08	1.4E-07	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	7.7E-10	1.4E-09	7.7E-08	1.4E-07
Xanthan gum	11138-66-2	1	1.0E+01	2.8E-08	5.3E-08	2.8E-09	5.3E-09
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0	5.0E-03	7.6E-10	1.4E-09	1.5E-07	2.9E-07

**Exposure Pathway HI: 2.8E-07 5.2E-07**

CADD = chronic absorbed daily dose

**Cumulative HI: 8.0E-07**

**Table I-11**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31	1.8E+01	4.0E-07	1.8E-06	2.2E-08	1.0E-07
Copolymer of acrylamide and sodium acrylate	25085-02-3	1	-	1.1E-08	4.9E-08	NA	NA
Glyoxal	107-22-2	0.0	2.5E-01	4.2E-11	1.9E-10	1.7E-10	7.7E-10
Methanol	67-56-1	0.0	2.0E+00	3.9E-11	1.7E-10	1.9E-11	8.7E-11
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	1.2E-09	5.2E-09	2.9E-08	1.3E-07
Sodium carbonate	497-19-8	0.3	5.1E+01	3.9E-09	1.7E-08	7.5E-11	3.4E-10
Sodium carboxymethyl cellulose	9004-32-4	3	-	4.2E-08	1.9E-07	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	4.7E-09	2.1E-08	9.1E-11	4.1E-10
Starch	9005-25-8	7	-	8.5E-08	3.8E-07	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	8.5E-10	3.9E-09	8.5E-08	3.9E-07
Xanthan gum	11138-66-2	2	1.0E+01	3.2E-08	1.4E-07	3.2E-09	1.4E-08
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0.1	5.0E-03	8.5E-10	3.9E-09	1.7E-07	7.7E-07

Exposure Pathway HI: **3.1E-07** **1.4E-06**  
Cumulative HI: **1.7E-06**

CADD = chronic absorbed daily dose

**Table I-12**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	16	1.8E+01	2.0E-07	9.1E-07	1.1E-08	5.0E-08
Copolymer of acrylamide and sodium acrylate	25085-02-3	0	-	5.4E-09	2.5E-08	NA	NA
Glyoxal	107-22-2	0.0	2.5E-01	2.1E-11	9.6E-11	8.5E-11	3.8E-10
Methanol	67-56-1	0.00	2.0E+00	1.9E-11	8.7E-11	9.6E-12	4.4E-11
Pentanedial / Glutaraldehyde	111-30-8	0	4.0E-02	5.8E-10	2.6E-09	1.4E-08	6.5E-08
Sodium carbonate	497-19-8	0.1	5.1E+01	1.9E-09	8.7E-09	3.7E-11	1.7E-10
Sodium carboxymethyl cellulose	9004-32-4	2	-	2.1E-08	9.6E-08	NA	NA
Sodium hydroxide	1310-73-2	0	5.1E+01	2.4E-09	1.1E-08	4.6E-11	2.1E-10
Starch	9005-25-8	3	-	4.2E-08	1.9E-07	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	1.0E-02	4.3E-10	1.9E-09	4.3E-08	1.9E-07
Xanthan gum	11138-66-2	1	1.0E+01	1.6E-08	7.2E-08	1.6E-09	7.2E-09
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	2.5E+01	NA	NA	NA	NA
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	NA	5.0E-01	NA	NA	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	NA	5.1E+01	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	1.0E+00	NA	NA	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0.0	5.0E-03	4.3E-10	1.9E-09	8.5E-08	3.9E-07

**Exposure Pathway HI: 1.5E-07 7.0E-07**

CADD = chronic absorbed daily dose

**Cumulative HI: 8.6E-07**

**Table I-13**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 0)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	6.3E+02	1.2E+00	1.9E-03
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	3.2E-02	NA
Glyoxal	107-22-2	0	8.6E+00	1.3E-04	1.5E-05
Methanol	67-56-1	0	6.4E+00	1.1E-04	1.8E-05
Pentanedial / Glutaraldehyde	111-30-8	1	1.4E+00	3.4E-03	2.5E-03
Sodium carbonate	497-19-8	5	NA	1.1E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	55	NA	1.3E-01	NA
Sodium hydroxide	1310-73-2	6	NA	1.4E-02	NA
Starch	9005-25-8	110	NA	2.5E-01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1	3.4E-01	2.5E-03	7.4E-03
Xanthan gum	11138-66-2	41	3.4E+02	9.4E-02	2.7E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	8.6E+02	NA	NA
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	1.7E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	3.9E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00

**Cumulative: 1.2E-02**



**Table I-14**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 3)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	6.3E+02	1.2E+00	1.9E-03
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	3.2E-02	NA
Glyoxal	107-22-2	0	8.6E+00	1.1E-04	1.3E-05
Methanol	67-56-1	0	6.4E+00	1.0E-04	1.6E-05
Pentanedial / Glutaraldehyde	111-30-8	1	1.4E+00	3.4E-03	2.5E-03
Sodium carbonate	497-19-8	5	NA	1.1E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	54	NA	1.2E-01	NA
Sodium hydroxide	1310-73-2	6	NA	1.4E-02	NA
Starch	9005-25-8	95	NA	2.2E-01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	1.2E-07	3.4E-07
Xanthan gum	11138-66-2	40	3.4E+02	9.3E-02	2.7E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	8.6E+02	NA	NA
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	1.7E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	3.9E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00

**Cumulative: 4.7E-03**

**Table I-15**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 7)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	6.3E+02	1.2E+00	1.9E-03
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	3.2E-02	NA
Glyoxal	107-22-2	0	8.6E+00	9.1E-05	1.1E-05
Methanol	67-56-1	0	6.4E+00	8.3E-05	1.3E-05
Pentanedial / Glutaraldehyde	111-30-8	1	1.4E+00	3.4E-03	2.5E-03
Sodium carbonate	497-19-8	5	NA	1.1E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	53	NA	1.2E-01	NA
Sodium hydroxide	1310-73-2	6	NA	1.4E-02	NA
Starch	9005-25-8	79	NA	1.8E-01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	1.9E-13	5.7E-13
Xanthan gum	11138-66-2	40	3.4E+02	9.1E-02	2.6E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	8.6E+02	NA	NA
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	1.7E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	3.9E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00

**Cumulative:**

**4.7E-03**

**Table I-16**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 0)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	7.4E+02	5.7E-01	7.8E-04
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	1.5E-02	NA
Glyoxal	107-22-2	0	1.0E+01	6.1E-05	6.0E-06
Methanol	67-56-1	0	7.5E+00	5.5E-05	7.3E-06
Pentanedial / Glutaraldehyde	111-30-8	1	1.6E+00	1.6E-03	1.0E-03
Sodium carbonate	497-19-8	5	NA	5.5E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	55	NA	6.1E-02	NA
Sodium hydroxide	1310-73-2	6	NA	6.7E-03	NA
Starch	9005-25-8	110	NA	1.2E-01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	1	4.1E-01	1.2E-03	3.0E-03
Xanthan gum	11138-66-2	41	4.1E+02	4.5E-02	1.1E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	1.0E+03	NA	NA
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	2.0E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	4.6E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative:**

**4.9E-03**

**Table I-17**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 3)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	7.4E+02	5.7E-01	7.8E-04
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	1.5E-02	NA
Glyoxal	107-22-2	0	1.0E+01	5.3E-05	5.2E-06
Methanol	67-56-1	0	7.5E+00	4.8E-05	6.4E-06
Pentanedial / Glutaraldehyde	111-30-8	1	1.6E+00	1.6E-03	1.0E-03
Sodium carbonate	497-19-8	5	NA	5.5E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	54	NA	6.0E-02	NA
Sodium hydroxide	1310-73-2	6	NA	6.7E-03	NA
Starch	9005-25-8	95	NA	1.1E-01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	5.6E-08	1.4E-07
Xanthan gum	11138-66-2	40	4.1E+02	4.5E-02	1.1E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	1.0E+03	NA	NA
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	2.0E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	4.6E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative: 1.9E-03**

**Table I-18**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 7)**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	517	7.4E+02	5.7E-01	7.8E-04
Copolymer of acrylamide and sodium acrylate	25085-02-3	14	NA	1.5E-02	NA
Glyoxal	107-22-2	0	1.0E+01	4.4E-05	4.3E-06
Methanol	67-56-1	0	7.5E+00	4.0E-05	5.3E-06
Pentanedial / Glutaraldehyde	111-30-8	1	1.6E+00	1.6E-03	1.0E-03
Sodium carbonate	497-19-8	5	NA	5.5E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	53	NA	5.9E-02	NA
Sodium hydroxide	1310-73-2	6	NA	6.7E-03	NA
Starch	9005-25-8	79	NA	8.8E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	9.3E-14	2.3E-13
Xanthan gum	11138-66-2	40	4.1E+02	4.4E-02	1.1E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	1.0E+03	NA	NA
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	2.0E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	4.6E+02	NA	NA
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative: 1.9E-03**

**Table I-19**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Surface Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31	4.2E+03	4.9E-03	1.2E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	1	NA	1.3E-04	NA
Glyoxal	107-22-2	0.0	5.8E+01	5.2E-07	9.0E-09
Methanol	67-56-1	0.0	4.3E+01	4.7E-07	1.1E-08
Pentanedial / Glutaraldehyde	111-30-8	0	9.3E+00	1.4E-05	1.5E-06
Sodium carbonate	497-19-8	0.3	NA	4.7E-05	NA
Sodium carboxymethyl cellulose	9004-32-4	3	NA	5.2E-04	NA
Sodium hydroxide	1310-73-2	0	NA	5.8E-05	NA
Starch	9005-25-8	7	NA	1.0E-03	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	0	2.3E+00	1.0E-05	4.5E-06
Xanthan gum	11138-66-2	2	2.3E+03	3.9E-04	1.7E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	5.8E+03	NA	NA
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	NA	1.2E+03	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	2.6E+03	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0.1	1.2E+00	1.0E-05	9.0E-06

**Exposure Pathway HI: 1.6E-05**

**Table I-20**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Buried Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	16	4.2E+03	2.5E-03	5.8E-07
Copolymer of acrylamide and sodium acrylate	25085-02-3	0	NA	6.7E-05	NA
Glyoxal	107-22-2	0.0	5.8E+01	2.6E-07	4.5E-09
Methanol	67-56-1	0.0	4.3E+01	2.4E-07	5.5E-09
Pentanedial / Glutaraldehyde	111-30-8	0	9.3E+00	7.1E-06	7.6E-07
Sodium carbonate	497-19-8	0.1	NA	2.4E-05	NA
Sodium carboxymethyl cellulose	9004-32-4	2	NA	2.6E-04	NA
Sodium hydroxide	1310-73-2	0	NA	2.9E-05	NA
Starch	9005-25-8	3	NA	5.2E-04	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	0	2.3E+00	5.2E-06	2.2E-06
Xanthan gum	11138-66-2	1	2.3E+03	1.9E-04	8.4E-08
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	5.8E+03	NA	NA
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	NA	1.2E+03	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	2.6E+03	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0.0	1.2E+00	5.2E-06	4.5E-06

**Exposure Pathway HI: 8.2E-06**

**Table I-21**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	31	3.3E+03	1.3E+01	4.0E-03
Copolymer of acrylamide and sodium acrylate	25085-02-3	1	NA	3.6E-01	NA
Glyoxal	107-22-2	0.0	4.5E+01	1.4E-03	3.1E-05
Methanol	67-56-1	0.0	3.3E+01	1.3E-03	3.8E-05
Pentanedial / Glutaraldehyde	111-30-8	0	5.4E+02	3.8E-02	7.0E-05
Sodium carbonate	497-19-8	0.3	NA	1.3E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	3	NA	1.4E+00	NA
Sodium hydroxide	1310-73-2	0	NA	1.5E-01	NA
Starch	9005-25-8	7	NA	2.8E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	0	2.2E+02	2.8E-02	1.3E-04
Xanthan gum	11138-66-2	2	1.8E+03	1.0E+00	5.8E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	4.5E+03	NA	NA
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	9.0E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	2.0E+03	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0.1	9.0E-01	2.8E-02	3.1E-02

**Exposure Pathway HI: 3.6E-02**



**Table I-22**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings**  
**5% KCl Polymer PHPA**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	16	3.3E+03	6.6E+00	2.0E-03
Copolymer of acrylamide and sodium acrylate	25085-02-3	0	NA	1.8E-01	NA
Glyoxal	107-22-2	0.0	4.5E+01	7.0E-04	1.6E-05
Methanol	67-56-1	0.00	3.3E+01	6.3E-04	1.9E-05
Pentanedial / Glutaraldehyde	111-30-8	0	5.4E+02	1.9E-02	3.5E-05
Sodium carbonate	497-19-8	0.1	NA	6.3E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	2	NA	7.0E-01	NA
Sodium hydroxide	1310-73-2	0	NA	7.7E-02	NA
Starch	9005-25-8	3	NA	1.4E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	0	2.2E+02	1.4E-02	6.3E-05
Xanthan gum	11138-66-2	1	1.8E+03	5.2E-01	2.9E-04
Ethylene oxide/propylene oxide copolymer	9003-11-6	NA	4.5E+03	NA	NA
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	NA	9.0E+02	NA	NA
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium polyacrylate	9003-04-7	NA	2.0E+03	NA	NA
Methylisothiocyanate (MITC)	556-61-6	0	9.0E-01	1.4E-02	1.6E-02

**Exposure Pathway HI: 1.8E-02**

**Table I-23**  
**Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
Potassium chloride	7447-40-7	31,700	NA	31700	31700	31700
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	900	900.00	900.00
Glyoxal	107-22-2	36	15	36	31.3	26.1
Methanol	67-56-1	6	15	6	5.22	4.34
Pentanedial / Glutaraldehyde	111-30-8	594	NA	594	594.00	594.00
Sodium carbonate	497-19-8	1,200	NA	1200	1200.00	1200.00
Sodium carboxymethyl cellulose	9004-32-4	3,564	150	3564	3514.93	3450.56
Sodium hydroxide	1310-73-2	NA	NA	NA	NA	NA
Starch	9005-25-8	3,724	15	3724	3242	2695
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	0.21	38.00	0.00	0.00
Methylisothiocyanate (MITC)	556-61-6	-	NA	0.00	38.00	38.00
Xanthan gum	11138-66-2	2,600	150	2600	2564	2564
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	NA	20.00	20.00	20.00
Polyalkylene	9038-95-3	NA	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	80	15	80.0	69.6	69.6
Silicic acid, potassium salt	1312-76-1	18,300	NA	18300	18300	18300
Sodium chloride	7647-14-5	35,700	NA	35700	35700	35700
Sodium polyacrylate	9003-04-7	1,610	NA	1610.00	1610.00	1610.00

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table I-24**  
**Summary of Theoretical Concentrations of Vendor Chemicals with Spent Drilling Muds and Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg) (a)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)
Potassium chloride	7447-40-7	19,020	1902	951
Copolymer of acrylamide and sodium acrylate	25085-02-3	540	54.0	27.0
Glyoxal	107-22-2	22	2.16	1.08
Methanol	67-56-1	4	0.4	0.18
Pentanedial / Glutaraldehyde	111-30-8	356	36	18
Sodium carbonate	497-19-8	720	72.0	36.00
Sodium carboxymethyl cellulose	9004-32-4	2,138	214	106.92
Sodium hydroxide	1310-73-2	NA	NA	NA
Starch	9005-25-8	2,234	223	111.72
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	0.0	0.00
Methylisothiocyanate (MITC)	556-61-6	23	2.3	1.14
Xanthan gum	11138-66-2	1,560	156	78.00
Ethylene oxide/propylene oxide copolymer	9003-11-6	12	1.2	0.60
Polyalkylene	9038-95-3	NA	NA	NA
Polypropylene glycol	25322-69-4	48	4.8	2.40
Silicic acid, potassium salt	1312-76-1	10,980	1098	549.00
Sodium chloride	7647-14-5	21,420	2142	1071.00
Sodium polyacrylate	9003-04-7	966	97	48.30

a/ Assume 10 percent of residual vendor chemicals remain on cuttings after shaker.

b/ Assume drill cuttings mixed at 1 to 1 ratio with clean fill; therefore, reduction of COPC concentration of 50%.

c/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.

**Table I-25**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	36	Yes	2.9E-04	2.5E-01	4.8E-04	4.7E-03	1.9E-03	1.9E-02
Methanol	67-56-1	6	No	1.6E-06	2.0E+00	8.1E-05	2.6E-05	4.0E-05	1.3E-05
Pentanedial / Glutaraldehyde	111-30-8	594	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,200	Yes	NA	5.1E+01	1.6E-02	NA	3.1E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	Yes	NA	-	4.8E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	3,724	Yes	NA	-	5.0E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	Yes	2.1E-05	1.0E-02	5.1E-04	3.4E-04	5.1E-02	3.4E-02
Xanthan gum	11138-66-2	2,600	Yes	NA	1.0E+01	3.5E-02	NA	3.5E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	80	Yes	NA	5.0E-01	1.1E-03	NA	2.1E-03	NA
Silicic acid, potassium salt	1312-76-1	18,300	Yes	NA	2.0E-01	2.5E-01	NA	1.2E+00	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,610	Yes	NA	1.0E+00	2.2E-02	NA	2.2E-02	NA
Methylisothiocyanate (MITC)	556-61-6	NA	Yes	NA	5.0E-03	NA	NA	NA	NA

Exposure Pathway HI:      **1.5E+00      1.2E-01**  
Cumulative HI:      **1.7E+00**

CADD = chronic absorbed daily dose

**Table I-26**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	31.34	Yes	2.5E-04	2.5E-01	4.2E-04	4.1E-03	1.7E-03	1.6E-02
Methanol	67-56-1	5.22	No	1.4E-06	2.0E+00	7.0E-05	2.2E-05	3.5E-05	1.1E-05
Pentanedial / Glutaraldehyde	111-30-8	594.00	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,200	Yes	NA	5.1E+01	1.6E-02	NA	3.1E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	Yes	NA	-	4.7E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	3,242	Yes	NA	-	4.4E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	9.8E-10	1.0E-02	2.4E-08	1.6E-08	2.4E-06	1.6E-06
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	18,300	Yes	NA	2.0E-01	2.5E-01	NA	1.2E+00	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,610	Yes	NA	1.0E+00	2.2E-02	NA	2.2E-02	NA
Methylisothiocyanate (MITC)	556-61-6	38	Yes	3.8E-05	5.0E-03	5.1E-04	6.0E-04	1.0E-01	1.2E-01

**Exposure Pathway HI: 1.6E+00 2.1E-01**

CADD = chronic absorbed daily dose

**Cumulative HI: 1.8E+00**

**Table I-27**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7 CW (mg/l)	ET <sub>st</sub> *	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	26.05	Yes	2.1E-04	2.5E-01	3.5E-04	3.4E-03	1.4E-03	1.4E-02
Methanol	67-56-1	4.34	No	1.2E-06	2.0E+00	5.8E-05	1.8E-05	2.9E-05	9.2E-06
Pentanedial / Glutaraldehyde	111-30-8	594.00	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,200	Yes	NA	5.1E+01	1.6E-02	NA	3.1E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	Yes	NA	-	4.6E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	2,695	Yes	NA	-	3.6E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	1.6E-15	1.0E-02	3.9E-14	2.6E-14	3.9E-12	2.6E-12
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	18,300	Yes	NA	2.0E-01	2.5E-01	NA	1.2E+00	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,610	Yes	NA	1.0E+00	2.2E-02	NA	2.2E-02	NA
Methylisothiocyanate (MITC)	556-61-6	38	Yes	3.8E-05	5.0E-03	5.1E-04	6.0E-04	1.0E-01	1.2E-01

Exposure Pathway HI:                      **1.6E+00**                      **2.1E-01**

Cumulative HI:                      **1.8E+00**

CADD = chronic absorbed daily dose

**Table I-28**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	1.0E-04	6.7E-04	5.7E-06	3.7E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	2.9E-06	1.9E-05	NA	NA
Glyoxal	107-22-2	2	2.5E-01	1.2E-07	7.6E-07	4.6E-07	3.1E-06
Methanol	67-56-1	0.4	2.0E+00	1.9E-08	1.3E-07	9.7E-09	6.4E-08
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	1.9E-06	1.3E-05	4.8E-05	3.1E-04
Sodium carbonate	497-19-8	72	5.1E+01	3.9E-06	2.5E-05	7.5E-08	4.9E-07
Sodium carboxymethyl cellulose	9004-32-4	214	-	1.1E-05	7.6E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	223	-	1.2E-05	7.9E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	8.4E-06	5.5E-05	8.4E-07	5.5E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	6.4E-08	4.2E-07	2.6E-09	1.7E-08
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	5	5.0E-01	2.6E-07	1.7E-06	5.2E-07	3.4E-06
Silicic acid, potassium salt	1312-76-1	1,098	2.0E-01	5.9E-05	3.9E-04	2.9E-04	1.9E-03
Sodium Chloride	7647-14-5	2,142	5.1E+01	1.2E-04	7.6E-04	2.2E-06	1.5E-05
Sodium polyacrylate	9003-04-7	97	1.0E+00	5.2E-06	3.4E-05	5.2E-06	3.4E-05
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	1.2E-07	8.1E-07	2.4E-05	1.6E-04

CADD = chronic absorbed daily dose

**3.8E-04**      **2.5E-03**  
**Cumulative HI:**      **2.9E-03**

**Table I-29**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	5.1E-05	3.4E-04	2.8E-06	1.9E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	1.5E-06	9.5E-06	NA	NA
Glyoxal	107-22-2	1	2.5E-01	5.8E-08	3.8E-07	2.3E-07	1.5E-06
Methanol	67-56-1	0.18	2.0E+00	9.7E-09	6.4E-08	4.8E-09	3.2E-08
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	9.6E-07	6.3E-06	2.4E-05	1.6E-04
Sodium carbonate	497-19-8	36	5.1E+01	1.9E-06	1.3E-05	3.8E-08	2.5E-07
Sodium carboxymethyl cellulose	9004-32-4	107	-	5.7E-06	3.8E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	112	-	6.0E-06	3.9E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	4.2E-06	2.8E-05	4.2E-07	2.8E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	3.2E-08	2.1E-07	1.3E-09	8.5E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	2	5.0E-01	1.3E-07	8.5E-07	2.6E-07	1.7E-06
Silicic acid, potassium salt	1312-76-1	549	2.0E-01	2.9E-05	1.9E-04	1.5E-04	9.7E-04
Sodium Chloride	7647-14-5	1,071	5.1E+01	5.8E-05	3.8E-04	1.1E-06	7.4E-06
Sodium polyacrylate	9003-04-7	48	1.0E+00	2.6E-06	1.7E-05	2.6E-06	1.7E-05
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	6.1E-08	4.0E-07	1.2E-05	8.1E-05
						<b>1.9E-04</b>	<b>1.3E-03</b>
						<b>Cumulative HI:</b>	<b>1.4E-03</b>

CADD = chronic absorbed daily dose



**Table I-30**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	4.4E-05	8.2E-05	2.4E-06	4.6E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	1.3E-06	2.3E-06	NA	NA
Glyoxal	107-22-2	2.2	2.5E-01	5.0E-08	9.4E-08	2.0E-07	3.7E-07
Methanol	67-56-1	0.4	2.0E+00	8.3E-09	1.6E-08	4.2E-09	7.8E-09
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	8.3E-07	1.5E-06	2.1E-05	3.9E-05
Sodium carbonate	497-19-8	72	5.1E+01	1.7E-06	3.1E-06	3.2E-08	6.1E-08
Sodium carboxymethyl cellulose	9004-32-4	214	-	5.0E-06	9.3E-06	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	223	-	5.2E-06	9.7E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	3.6E-06	6.8E-06	3.6E-07	6.8E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	2.8E-08	5.2E-08	1.1E-09	2.1E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	5	5.0E-01	1.1E-07	2.1E-07	2.2E-07	4.2E-07
Silicic acid, potassium salt	1312-76-1	1,098	2.0E-01	2.5E-05	4.8E-05	1.3E-04	2.4E-04
Sodium Chloride	7647-14-5	2,142	5.1E+01	5.0E-05	9.3E-05	9.7E-07	1.8E-06
Sodium polyacrylate	9003-04-7	97	1.0E+00	2.2E-06	4.2E-06	2.2E-06	4.2E-06
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	5.3E-08	9.9E-08	1.1E-05	2.0E-05

Exposure Pathway HI:                      **1.6E-04      3.1E-04**  
Cumulative HI:                                **4.7E-04**

CADD = chronic absorbed daily dose

**Table I-31**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	2.2E-05	4.1E-05	1.2E-06	2.3E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	6.3E-07	1.2E-06	NA	NA
Glyoxal	107-22-2	1	2.5E-01	2.5E-08	4.7E-08	1.0E-07	1.9E-07
Methanol	67-56-1	0.18	2.0E+00	4.2E-09	7.8E-09	2.1E-09	3.9E-09
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	4.1E-07	7.7E-07	1.0E-05	1.9E-05
Sodium carbonate	497-19-8	36	5.1E+01	8.3E-07	1.6E-06	1.6E-08	3.0E-08
Sodium carboxymethyl cellulose	9004-32-4	107	-	2.5E-06	4.6E-06	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	112	-	2.6E-06	4.8E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.8E-06	3.4E-06	1.8E-07	3.4E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	1.4E-08	2.6E-08	5.6E-10	1.0E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	2	5.0E-01	5.6E-08	1.0E-07	1.1E-07	2.1E-07
Silicic acid, potassium salt	1312-76-1	549	2.0E-01	1.3E-05	2.4E-05	6.4E-05	1.2E-04
Sodium Chloride	7647-14-5	1,071	5.1E+01	2.5E-05	4.6E-05	4.8E-07	9.0E-07
Sodium polyacrylate	9003-04-7	48	1.0E+00	1.1E-06	2.1E-06	1.1E-06	2.1E-06
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	2.6E-08	4.9E-08	5.3E-06	9.9E-06

Exposure Pathway HI: 8.2E-05 1.5E-04

CADD = chronic absorbed daily dose

Cumulative HI: 2.4E-04

**Table I-32**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	2.7E-05	1.2E-04	1.5E-06	6.7E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	7.6E-07	3.4E-06	NA	NA
Glyoxal	107-22-2	2.2	2.5E-01	3.0E-08	1.4E-07	1.2E-07	5.5E-07
Methanol	67-56-1	0.4	2.0E+00	5.1E-09	2.3E-08	2.5E-09	1.1E-08
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	5.0E-07	2.3E-06	1.3E-05	5.7E-05
Sodium carbonate	497-19-8	72.0	5.1E+01	1.0E-06	4.6E-06	2.0E-08	8.9E-08
Sodium carboxymethyl cellulose	9004-32-4	214	-	3.0E-06	1.4E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	223	-	3.1E-06	1.4E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	2.2E-06	9.9E-06	2.2E-07	9.9E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	1.7E-08	7.6E-08	6.7E-10	3.1E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	4.8	5.0E-01	6.7E-08	3.1E-07	1.3E-07	6.1E-07
Silicic acid, potassium salt	1312-76-1	1,098	2.0E-01	1.5E-05	7.0E-05	7.7E-05	3.5E-04
Sodium Chloride	7647-14-5	2,142	5.1E+01	3.0E-05	1.4E-04	5.9E-07	2.7E-06
Sodium polyacrylate	9003-04-7	97	1.0E+00	1.4E-06	6.1E-06	1.4E-06	6.1E-06
Methylisothiocyanate (MITC)	556-61-6	2.3	5.0E-03	3.2E-08	1.5E-07	6.4E-06	2.9E-05

Exposure Pathway HI: **1.0E-04** **4.5E-04**  
Cumulative HI: **5.5E-04**

CADD = chronic absorbed daily dose

**Table I-33**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	1.3E-05	6.1E-05	7.4E-07	3.4E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	3.8E-07	1.7E-06	NA	NA
Glyoxal	107-22-2	1.1	2.5E-01	1.5E-08	6.9E-08	6.1E-08	2.8E-07
Methanol	67-56-1	0.18	2.0E+00	2.5E-09	1.1E-08	1.3E-09	5.7E-09
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	2.5E-07	1.1E-06	6.3E-06	2.8E-05
Sodium carbonate	497-19-8	36.0	5.1E+01	5.1E-07	2.3E-06	9.8E-09	4.5E-08
Sodium carboxymethyl cellulose	9004-32-4	107	-	1.5E-06	6.8E-06	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	112	-	1.6E-06	7.1E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.1E-06	5.0E-06	1.1E-07	5.0E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	2.5E+01	8.4E-09	3.8E-08	3.4E-10	1.5E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	2.4	5.0E-01	3.4E-08	1.5E-07	6.7E-08	3.1E-07
Silicic acid, potassium salt	1312-76-1	549	2.0E-01	7.7E-06	3.5E-05	3.9E-05	1.7E-04
Sodium Chloride	7647-14-5	1,071	5.1E+01	1.5E-05	6.8E-05	2.9E-07	1.3E-06
Sodium polyacrylate	9003-04-7	48	1.0E+00	6.8E-07	3.1E-06	6.8E-07	3.1E-06
Methylisothiocyanate (MITC)	556-61-6	1.1	5.0E-03	1.6E-08	7.3E-08	3.2E-06	1.5E-05

**Exposure Pathway HI: 5.0E-05 2.3E-04**

CADD = chronic absorbed daily dose

**Cumulative HI: 2.8E-04**

**Table I-34**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	36	8.6E+00	8.3E-02	9.6E-03
Methanol	67-56-1	6	6.4E+00	1.4E-02	2.2E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,200	NA	2.8E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	NA	8.2E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,724	NA	8.6E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	3.4E-01	8.7E-02	2.5E-01
Xanthan gum	11138-66-2	2,600	3.4E+02	6.0E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	80	1.7E+02	1.8E-01	1.1E-03
Silicic acid, potassium salt	1312-76-1	18,300	7.4E+01	4.2E+01	5.7E-01
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,610	3.9E+02	3.7E+00	9.5E-03
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00
<b>Cumulative:</b>					<b>2.0E+00</b>

**Table I-35**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	31	8.6E+00	7.2E-02	8.4E-03
Methanol	67-56-1	5	6.4E+00	1.2E-02	1.9E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,200	NA	2.8E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	NA	8.1E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,242	NA	7.5E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	4.0E-06	1.2E-05
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	18,300	7.4E+01	4.2E+01	5.7E-01
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,610	3.9E+02	3.7E+00	9.5E-03
Methylisothiocyanate (MITC)	556-61-6	38	1.7E-01	8.7E-02	5.1E-01
<b>Cumulative:</b>					<b>2.2E+00</b>

**Table I-36**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	26	8.6E+00	6.0E-02	7.0E-03
Methanol	67-56-1	4	6.4E+00	1.0E-02	1.6E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,200	NA	2.8E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	NA	7.9E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	2,695	NA	6.2E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	6.7E-12	2.0E-11
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	18,300	7.4E+01	4.2E+01	5.7E-01
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,610	3.9E+02	3.7E+00	9.5E-03
Methylisothiocyanate (MITC)	556-61-6	38	1.7E-01	8.7E-02	5.1E-01

**Cumulative: 2.2E+00**

**Table I-37**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	36	1.0E+01	4.0E-02	3.9E-03
Methanol	67-56-1	6	7.5E+00	6.6E-03	8.8E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,200	NA	1.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	NA	3.9E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,724	NA	4.1E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	4.1E-01	4.2E-02	1.0E-01
Xanthan gum	11138-66-2	2,600	4.1E+02	2.9E+00	7.1E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	80	2.0E+02	8.9E-02	4.4E-04
Silicic acid, potassium salt	1312-76-1	18,300	8.7E+01	2.0E+01	2.3E-01
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,610	4.6E+02	1.8E+00	3.9E-03
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative:**

**8.1E-01**



**Table I-38**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	31	1.0E+01	3.5E-02	3.4E-03
Methanol	67-56-1	5	7.5E+00	5.8E-03	7.7E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,200	NA	1.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	NA	3.9E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,242	NA	3.6E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	1.9E-06	4.8E-06
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	18,300	8.7E+01	2.0E+01	2.3E-01
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,610	4.6E+02	1.8E+00	3.9E-03
Methylisothiocyanate (MITC)	556-61-6	38	2.0E-01	4.2E-02	2.1E-01

**Cumulative:**

**9.1E-01**

**Table I-39**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	26	1.0E+01	2.9E-02	2.8E-03
Methanol	67-56-1	4	7.5E+00	4.8E-03	6.4E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,200	NA	1.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	NA	3.8E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	2,695	NA	3.0E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	3.2E-12	8.0E-12
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	18,300	8.7E+01	2.0E+01	2.3E-01
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,610	4.6E+02	1.8E+00	3.9E-03
Methylisothiocyanate (MITC)	556-61-6	38	2.0E-01	4.2E-02	2.1E-01

**Cumulative: 9.1E-01**

**Table I-40**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	1,902	4.2E+03	3.0E-01	7.1E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	NA	8.6E-03	NA
Glyoxal	107-22-2	2.2	5.8E+01	3.4E-04	5.9E-06
Methanol	67-56-1	0.4	4.3E+01	5.7E-05	1.3E-06
Pentanedial / Glutaraldehyde	111-30-8	36	9.3E+00	5.6E-03	6.1E-04
Sodium carbonate	497-19-8	72.0	NA	1.1E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	214	NA	3.4E-02	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	223	NA	3.5E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	2.3E+03	2.5E-02	1.1E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	5.8E+03	1.9E-04	3.3E-08
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	4.8	1.2E+03	7.6E-04	6.5E-07
Silicic acid, potassium salt	1312-76-1	1,098	5.0E+02	1.7E-01	3.5E-04
Sodium Chloride	7647-14-5	2,142	NA	3.4E-01	NA
Sodium polyacrylate	9003-04-7	97	2.6E+03	1.5E-02	5.8E-06
Methylisothiocyanate (MITC)	556-61-6	2.3	1.2E+00	3.6E-04	3.1E-04

**Exposure Pathway HI: 1.4E-03**

**Table I-41**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	951	4.2E+03	1.5E-01	3.6E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	NA	4.3E-03	NA
Glyoxal	107-22-2	1.1	5.8E+01	1.7E-04	2.9E-06
Methanol	67-56-1	0.2	4.3E+01	2.9E-05	6.6E-07
Pentanedial / Glutaraldehyde	111-30-8	18	9.3E+00	2.8E-03	3.0E-04
Sodium carbonate	497-19-8	36.0	NA	5.7E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	107	NA	1.7E-02	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	112	NA	1.8E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	2.3E+03	1.2E-02	5.3E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	5.8E+03	9.5E-05	1.6E-08
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	2.4	1.2E+03	3.8E-04	3.3E-07
Silicic acid, potassium salt	1312-76-1	549	5.0E+02	8.7E-02	1.7E-04
Sodium Chloride	7647-14-5	1,071	NA	1.7E-01	NA
Sodium polyacrylate	9003-04-7	48	2.6E+03	7.6E-03	2.9E-06
Methylisothiocyanate (MITC)	556-61-6	1.1	1.2E+00	1.8E-04	1.6E-04

**Exposure Pathway HI: 6.8E-04**

**Table I-42**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	1,902	3.3E+03	8.1E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	NA	2.3E+01	NA
Glyoxal	107-22-2	2.2	4.5E+01	9.1E-01	2.0E-02
Methanol	67-56-1	0.4	3.3E+01	1.5E-01	4.6E-03
Pentanedial / Glutaraldehyde	111-30-8	36	5.4E+02	1.5E+01	2.8E-02
Sodium carbonate	497-19-8	72.0	NA	3.0E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	214	NA	9.1E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	223	NA	9.5E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	1.8E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.8E+03	6.6E+01	3.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	5.1E-01	1.1E-04
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	4.8	9.0E+02	2.0E+00	2.3E-03
Silicic acid, potassium salt	1312-76-1	1,098	3.8E+02	4.7E+02	1.2E+00
Sodium Chloride	7647-14-5	2,142	NA	9.1E+02	NA
Sodium polyacrylate	9003-04-7	97	2.0E+03	4.1E+01	2.0E-02
Methylisothiocyanate (MITC)	556-61-6	2.3	9.0E-01	9.7E-01	1.1E+00
Exposure Pathway HI:					2.7E+00

**Table I-43**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4-Bore-HIB**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	951	3.3E+03	4.0E+02	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	NA	1.1E+01	NA
Glyoxal	107-22-2	1.1	4.5E+01	4.6E-01	1.0E-02
Methanol	67-56-1	0.18	3.3E+01	7.6E-02	2.3E-03
Pentanedial / Glutaraldehyde	111-30-8	18	5.4E+02	7.5E+00	1.4E-02
Sodium carbonate	497-19-8	36.0	NA	1.5E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	107	NA	4.5E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	112	NA	4.7E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	1.8E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.8E+03	3.3E+01	1.8E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	4.5E+03	2.5E-01	5.7E-05
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.0E+00	1.1E-03
Silicic acid, potassium salt	1312-76-1	549	3.8E+02	2.3E+02	6.1E-01
Sodium Chloride	7647-14-5	1,071	NA	4.5E+02	NA
Sodium polyacrylate	9003-04-7	48	2.0E+03	2.0E+01	1.0E-02
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	4.8E-01	5.4E-01
Exposure Pathway HI:					1.3E+00

**Table I-44**  
**Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
Potassium chloride	7447-40-7	31,700	NA	31700	31700	31700
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	900	900.00	900.00
Glyoxal	107-22-2	36	15	36	31.3	26.1
Methanol	67-56-1	6	15	6	5.22	4.34
Pentanedial / Glutaraldehyde	111-30-8	594	NA	594	594.00	594.00
Sodium carbonate	497-19-8	1,000	NA	1000	1000.00	1000.00
Sodium carboxymethyl cellulose	9004-32-4	3,564	150	3564	3514.93	3450.56
Sodium hydroxide	1310-73-2	38	NA	38	38	38
Starch	9005-25-8	3,700	15	3700	3221	2677
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	0.21	38.00	0.00	0.00
Methylisothiocyanate (MITC)	556-61-6	-	NA	0.00	38.00	38.00
Xanthan gum	11138-66-2	2,600	150	2600	2564	2564
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	NA	20.00	20.00	20.00
Polyalkylene	9038-95-3	37,100	NA	37100	37100	37100
Polypropylene glycol	25322-69-4	80	15	80.0	69.6	69.6
Silicic acid, potassium salt	1312-76-1	NA	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	NA	35700	35700	35700
Sodium polyacrylate	9003-04-7	1,600	NA	1600.00	1600.00	1600.00

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table I-45**  
**Summary of Theoretical Concentrations of Vendor Chemicals with Spent Drilling Muds and Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg) (a)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)
Potassium chloride	7447-40-7	19,020	1902	951
Copolymer of acrylamide and sodium acrylate	25085-02-3	540	54.0	27.0
Glyoxal	107-22-2	22	2.16	1.08
Methanol	67-56-1	4	0.4	0.18
Pentanedial / Glutaraldehyde	111-30-8	356	36	18
Sodium carbonate	497-19-8	600	60.0	30.00
Sodium carboxymethyl cellulose	9004-32-4	2,138	214	106.92
Sodium hydroxide	1310-73-2	23	2	1.14
Starch	9005-25-8	2,220	222	111.00
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	0.0	0.00
Methylisothiocyanate (MITC)	556-61-6	23	2.3	1.14
Xanthan gum	11138-66-2	1,560	156	78.00
Ethylene oxide/propylene oxide copolymer	9003-11-6	12	1.2	0.60
Polyalkylene	9038-95-3	22,260	2226	1113.00
Polypropylene glycol	25322-69-4	48	4.8	2.40
Silicic acid, potassium salt	1312-76-1	NA	NA	NA
Sodium chloride	7647-14-5	21,420	2142	1071.00
Sodium polyacrylate	9003-04-7	960	96	48.00

a/ Assume 10 percent of residual vendor chemicals remain on cuttings after shaker.

b/ Assume drill cuttings mixed at 1 to 1 ratio with clean fill; therefore, reduction of COPC concentration of 50%.

c/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.



**Table I-46**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	36	Yes	2.9E-04	2.5E-01	4.8E-04	4.7E-03	1.9E-03	1.9E-02
Methanol	67-56-1	6	No	1.6E-06	2.0E+00	8.1E-05	2.6E-05	4.0E-05	1.3E-05
Pentanedial / Glutaraldehyde	111-30-8	594	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,000	Yes	NA	5.1E+01	1.3E-02	NA	2.6E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	Yes	NA	-	4.8E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	38	Yes	NA	5.1E+01	5.1E-04	NA	9.9E-06	NA
Starch	9005-25-8	3,700	Yes	NA	-	5.0E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	Yes	2.1E-05	1.0E-02	5.1E-04	3.4E-04	5.1E-02	3.4E-02
Xanthan gum	11138-66-2	2,600	Yes	NA	1.0E+01	3.5E-02	NA	3.5E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	80	Yes	NA	5.0E-01	1.1E-03	NA	2.1E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,600	Yes	NA	1.0E+00	2.1E-02	NA	2.1E-02	NA
Methylisothiocyanate (MITC)	556-61-6	NA	Yes	NA	5.0E-03	NA	NA	NA	NA

Exposure Pathway HI: **4.1E-01** **1.2E-01**  
Cumulative HI: **5.4E-01**

CADD = chronic absorbed daily dose

**Table I-47**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	31.34	Yes	2.5E-04	2.5E-01	4.2E-04	4.1E-03	1.7E-03	1.6E-02
Methanol	67-56-1	5.22	No	1.4E-06	2.0E+00	7.0E-05	2.2E-05	3.5E-05	1.1E-05
Pentanedial / Glutaraldehyde	111-30-8	594.00	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,000	Yes	NA	5.1E+01	1.3E-02	NA	2.6E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	Yes	NA	-	4.7E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	38	Yes	NA	5.1E+01	5.1E-04	NA	9.9E-06	NA
Starch	9005-25-8	3,221	Yes	NA	-	4.3E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	9.8E-10	1.0E-02	2.4E-08	1.6E-08	2.4E-06	1.6E-06
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,600	Yes	NA	1.0E+00	2.1E-02	NA	2.1E-02	NA
Methylisothiocyanate (MITC)	556-61-6	38	Yes	3.8E-05	5.0E-03	5.1E-04	6.0E-04	1.0E-01	1.2E-01

**Exposure Pathway HI: 4.6E-01 2.1E-01**

CADD = chronic absorbed daily dose

**Cumulative HI: 6.7E-01**

**Table I-48**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7 CW (mg/l)	ET <sub>st</sub> *	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	Yes	NA	-	1.2E-02	NA	NA	NA
Glyoxal	107-22-2	26.05	Yes	2.1E-04	2.5E-01	3.5E-04	3.4E-03	1.4E-03	1.4E-02
Methanol	67-56-1	4.34	No	1.2E-06	2.0E+00	5.8E-05	1.8E-05	2.9E-05	9.2E-06
Pentanedial / Glutaraldehyde	111-30-8	594.00	Yes	1.8E-04	4.0E-02	8.0E-03	2.9E-03	2.0E-01	7.2E-02
Sodium carbonate	497-19-8	1,000	Yes	NA	5.1E+01	1.3E-02	NA	2.6E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	Yes	NA	-	4.6E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	38	Yes	NA	5.1E+01	5.1E-04	NA	9.9E-06	NA
Starch	9005-25-8	2,677	Yes	NA	-	3.6E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	1.6E-15	1.0E-02	3.9E-14	2.6E-14	3.9E-12	2.6E-12
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	Yes	NA	2.5E+01	2.7E-04	NA	1.1E-05	NA
Polyalkylene	9038-95-3	37,100	Yes	NA	5.0E+00	5.0E-01	NA	1.0E-01	NA
Polypropylene glycol	25322-69-4	70	Yes	NA	5.0E-01	9.4E-04	NA	1.9E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,600	Yes	NA	1.0E+00	2.1E-02	NA	2.1E-02	NA
Methylisothiocyanate (MITC)	556-61-6	38	Yes	3.8E-05	5.0E-03	5.1E-04	6.0E-04	1.0E-01	1.2E-01

Exposure Pathway HI: **4.6E-01** **2.1E-01**

Cumulative HI: **6.7E-01**

CADD = chronic absorbed daily dose

**Table I-49**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	1.0E-04	6.7E-04	5.7E-06	3.7E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	2.9E-06	1.9E-05	NA	NA
Glyoxal	107-22-2	2	2.5E-01	1.2E-07	7.6E-07	4.6E-07	3.1E-06
Methanol	67-56-1	0.4	2.0E+00	1.9E-08	1.3E-07	9.7E-09	6.4E-08
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	1.9E-06	1.3E-05	4.8E-05	3.1E-04
Sodium carbonate	497-19-8	60	5.1E+01	3.2E-06	2.1E-05	6.3E-08	4.1E-07
Sodium carboxymethyl cellulose	9004-32-4	214	-	1.1E-05	7.6E-05	NA	NA
Sodium hydroxide	1310-73-2	2	5.1E+01	1.2E-07	8.1E-07	2.4E-09	1.6E-08
Starch	9005-25-8	222	-	1.2E-05	7.8E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	8.4E-06	5.5E-05	8.4E-07	5.5E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	6.4E-08	4.2E-07	2.6E-09	1.7E-08
Polyalkylene	9038-95-3	2,226	5.0E+00	1.2E-04	7.9E-04	2.4E-05	1.6E-04
Polypropylene glycol	25322-69-4	5	5.0E-01	2.6E-07	1.7E-06	5.2E-07	3.4E-06
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	1.2E-04	7.6E-04	2.2E-06	1.5E-05
Sodium polyacrylate	9003-04-7	96	1.0E+00	5.2E-06	3.4E-05	5.2E-06	3.4E-05
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	1.2E-07	8.1E-07	2.4E-05	1.6E-04

CADD = chronic absorbed daily dose

**1.1E-04**  
**Cumulative HI:** **7.3E-04**  
**8.4E-04**

**Table I-50**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	5.1E-05	3.4E-04	2.8E-06	1.9E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	1.5E-06	9.5E-06	NA	NA
Glyoxal	107-22-2	1	2.5E-01	5.8E-08	3.8E-07	2.3E-07	1.5E-06
Methanol	67-56-1	0.18	2.0E+00	9.7E-09	6.4E-08	4.8E-09	3.2E-08
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	9.6E-07	6.3E-06	2.4E-05	1.6E-04
Sodium carbonate	497-19-8	30	5.1E+01	1.6E-06	1.1E-05	3.1E-08	2.1E-07
Sodium carboxymethyl cellulose	9004-32-4	107	-	5.7E-06	3.8E-05	NA	NA
Sodium hydroxide	1310-73-2	1	5.1E+01	6.1E-08	4.0E-07	1.2E-09	7.8E-09
Starch	9005-25-8	111	-	6.0E-06	3.9E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	4.2E-06	2.8E-05	4.2E-07	2.8E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	3.2E-08	2.1E-07	1.3E-09	8.5E-09
Polyalkylene	9038-95-3	1,113	5.0E+00	6.0E-05	3.9E-04	1.2E-05	7.9E-05
Polypropylene glycol	25322-69-4	2	5.0E-01	1.3E-07	8.5E-07	2.6E-07	1.7E-06
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	#VALUE!	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	5.8E-05	3.8E-04	1.1E-06	7.4E-06
Sodium polyacrylate	9003-04-7	48	1.0E+00	2.6E-06	1.7E-05	2.6E-06	1.7E-05
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	6.1E-08	4.0E-07	1.2E-05	8.1E-05

**Exposure Pathway HI: 5.6E-05 3.7E-04**

CADD = chronic absorbed daily dose

**Cumulative HI: 4.2E-04**

**Table I-51**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	4.4E-05	8.2E-05	2.4E-06	4.6E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	1.3E-06	2.3E-06	NA	NA
Glyoxal	107-22-2	2.2	2.5E-01	5.0E-08	9.4E-08	2.0E-07	3.7E-07
Methanol	67-56-1	0.4	2.0E+00	8.3E-09	1.6E-08	4.2E-09	7.8E-09
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	8.3E-07	1.5E-06	2.1E-05	3.9E-05
Sodium carbonate	497-19-8	60	5.1E+01	1.4E-06	2.6E-06	2.7E-08	5.1E-08
Sodium carboxymethyl cellulose	9004-32-4	214	-	5.0E-06	9.3E-06	NA	NA
Sodium hydroxide	1310-73-2	2	5.1E+01	5.3E-08	9.9E-08	1.0E-09	1.9E-09
Starch	9005-25-8	222	-	5.1E-06	9.6E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	3.6E-06	6.8E-06	3.6E-07	6.8E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	2.8E-08	5.2E-08	1.1E-09	2.1E-09
Polyalkylene	9038-95-3	2,226	5.0E+00	5.2E-05	9.6E-05	1.0E-05	1.9E-05
Polypropylene glycol	25322-69-4	5	5.0E-01	1.1E-07	2.1E-07	2.2E-07	4.2E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	5.0E-05	9.3E-05	9.7E-07	1.8E-06
Sodium polyacrylate	9003-04-7	96	1.0E+00	2.2E-06	4.2E-06	2.2E-06	4.2E-06
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	5.3E-08	9.9E-08	1.1E-05	2.0E-05

Exposure Pathway HI:                      4.8E-05      9.0E-05  
Cumulative HI:                                1.4E-04

CADD = chronic absorbed daily dose

**Table I-52**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	2.2E-05	4.1E-05	1.2E-06	2.3E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	6.3E-07	1.2E-06	NA	NA
Glyoxal	107-22-2	1	2.5E-01	2.5E-08	4.7E-08	1.0E-07	1.9E-07
Methanol	67-56-1	0.18	2.0E+00	4.2E-09	7.8E-09	2.1E-09	3.9E-09
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	4.1E-07	7.7E-07	1.0E-05	1.9E-05
Sodium carbonate	497-19-8	30	5.1E+01	7.0E-07	1.3E-06	1.4E-08	2.5E-08
Sodium carboxymethyl cellulose	9004-32-4	107	-	2.5E-06	4.6E-06	NA	NA
Sodium hydroxide	1310-73-2	1	5.1E+01	2.6E-08	4.9E-08	5.1E-10	9.6E-10
Starch	9005-25-8	111	-	2.6E-06	4.8E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.8E-06	3.4E-06	1.8E-07	3.4E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	1.4E-08	2.6E-08	5.6E-10	1.0E-09
Polyalkylene	9038-95-3	1,113	5.0E+00	2.6E-05	4.8E-05	5.2E-06	9.6E-06
Polypropylene glycol	25322-69-4	2	5.0E-01	5.6E-08	1.0E-07	1.1E-07	2.1E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	2.5E-05	4.6E-05	4.8E-07	9.0E-07
Sodium polyacrylate	9003-04-7	48	1.0E+00	1.1E-06	2.1E-06	1.1E-06	2.1E-06
Methylisothiocyanate (MITC)	556-61-6	1	5.0E-03	2.6E-08	4.9E-08	5.3E-06	9.9E-06

Exposure Pathway HI: **2.4E-05** **4.5E-05**

CADD = chronic absorbed daily dose

Cumulative HI: **6.9E-05**

**Table I-53**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	2.7E-05	1.2E-04	1.5E-06	6.7E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	-	7.6E-07	3.4E-06	NA	NA
Glyoxal	107-22-2	2.2	2.5E-01	3.0E-08	1.4E-07	1.2E-07	5.5E-07
Methanol	67-56-1	0.4	2.0E+00	5.1E-09	2.3E-08	2.5E-09	1.1E-08
Pentanedial / Glutaraldehyde	111-30-8	36	4.0E-02	5.0E-07	2.3E-06	1.3E-05	5.7E-05
Sodium carbonate	497-19-8	60.0	5.1E+01	8.4E-07	3.8E-06	1.6E-08	7.4E-08
Sodium carboxymethyl cellulose	9004-32-4	214	-	3.0E-06	1.4E-05	NA	NA
Sodium hydroxide	1310-73-2	2	5.1E+01	3.2E-08	1.5E-07	6.2E-10	2.8E-09
Starch	9005-25-8	222	-	3.1E-06	1.4E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	2.2E-06	9.9E-06	2.2E-07	9.9E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	1.7E-08	7.6E-08	6.7E-10	3.1E-09
Polyalkylene	9038-95-3	2,226	5.0E+00	3.1E-05	1.4E-04	6.3E-06	2.8E-05
Polypropylene glycol	25322-69-4	4.8	5.0E-01	6.7E-08	3.1E-07	1.3E-07	6.1E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	3.0E-05	1.4E-04	5.9E-07	2.7E-06
Sodium polyacrylate	9003-04-7	96	1.0E+00	1.3E-06	6.1E-06	1.3E-06	6.1E-06
Methylisothiocyanate (MITC)	556-61-6	2.3	5.0E-03	3.2E-08	1.5E-07	6.4E-06	2.9E-05

Exposure Pathway HI:                      **2.9E-05**                      **1.3E-04**  
Cumulative HI:                                      **1.6E-04**

CADD = chronic absorbed daily dose



**Table I-54**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	1.3E-05	6.1E-05	7.4E-07	3.4E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	-	3.8E-07	1.7E-06	NA	NA
Glyoxal	107-22-2	1.1	2.5E-01	1.5E-08	6.9E-08	6.1E-08	2.8E-07
Methanol	67-56-1	0.18	2.0E+00	2.5E-09	1.1E-08	1.3E-09	5.7E-09
Pentanedial / Glutaraldehyde	111-30-8	18	4.0E-02	2.5E-07	1.1E-06	6.3E-06	2.8E-05
Sodium carbonate	497-19-8	30.0	5.1E+01	4.2E-07	1.9E-06	8.2E-09	3.7E-08
Sodium carboxymethyl cellulose	9004-32-4	107	-	1.5E-06	6.8E-06	NA	NA
Sodium hydroxide	1310-73-2	1	5.1E+01	1.6E-08	7.3E-08	3.1E-10	1.4E-09
Starch	9005-25-8	111	-	1.6E-06	7.1E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.1E-06	5.0E-06	1.1E-07	5.0E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	2.5E+01	8.4E-09	3.8E-08	3.4E-10	1.5E-09
Polyalkylene	9038-95-3	1,113	5.0E+00	1.6E-05	7.1E-05	3.1E-06	1.4E-05
Polypropylene glycol	25322-69-4	2.4	5.0E-01	3.4E-08	1.5E-07	6.7E-08	3.1E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	1.5E-05	6.8E-05	2.9E-07	1.3E-06
Sodium polyacrylate	9003-04-7	48	1.0E+00	6.7E-07	3.1E-06	6.7E-07	3.1E-06
Methylisothiocyanate (MITC)	556-61-6	1.1	5.0E-03	1.6E-08	7.3E-08	3.2E-06	1.5E-05

**Exposure Pathway HI: 1.5E-05 6.6E-05**

CADD = chronic absorbed daily dose

**Cumulative HI: 8.0E-05**

**Table I-55**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	36	8.6E+00	8.3E-02	9.6E-03
Methanol	67-56-1	6	6.4E+00	1.4E-02	2.2E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,000	NA	2.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	NA	8.2E+00	NA
Sodium hydroxide	1310-73-2	38	NA	8.7E-02	NA
Starch	9005-25-8	3,700	NA	8.5E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	3.4E-01	8.7E-02	2.5E-01
Xanthan gum	11138-66-2	2,600	3.4E+02	6.0E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	80	1.7E+02	1.8E-01	1.1E-03
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,600	3.9E+02	3.7E+00	9.4E-03
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00

**Cumulative: 1.9E+00**

**Table I-56**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	31	8.6E+00	7.2E-02	8.4E-03
Methanol	67-56-1	5	6.4E+00	1.2E-02	1.9E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,000	NA	2.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	NA	8.1E+00	NA
Sodium hydroxide	1310-73-2	38	NA	8.7E-02	NA
Starch	9005-25-8	3,221	NA	7.4E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	4.0E-06	1.2E-05
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,600	3.9E+02	3.7E+00	9.4E-03
Methylisothiocyanate (MITC)	556-61-6	38	1.7E-01	8.7E-02	5.1E-01
<b>Cumulative:</b>					<b>2.2E+00</b>

**Table I-57**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	2.1E+00	NA
Glyoxal	107-22-2	26	8.6E+00	6.0E-02	7.0E-03
Methanol	67-56-1	4	6.4E+00	1.0E-02	1.6E-03
Pentanedial / Glutaraldehyde	111-30-8	594	1.4E+00	1.4E+00	9.9E-01
Sodium carbonate	497-19-8	1,000	NA	2.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	NA	7.9E+00	NA
Sodium hydroxide	1310-73-2	38	NA	8.7E-02	NA
Starch	9005-25-8	2,677	NA	6.2E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	6.7E-12	2.0E-11
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	8.6E+02	4.6E-02	5.4E-05
Polyalkylene	9038-95-3	37,100	1.7E+02	8.5E+01	5.0E-01
Polypropylene glycol	25322-69-4	70	1.7E+02	1.6E-01	9.3E-04
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,600	3.9E+02	3.7E+00	9.4E-03
Methylisothiocyanate (MITC)	556-61-6	38	1.7E-01	8.7E-02	5.1E-01

**Cumulative: 2.2E+00**

**Table I-58**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 0)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	36	1.0E+01	4.0E-02	3.9E-03
Methanol	67-56-1	6	7.5E+00	6.6E-03	8.8E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,000	NA	1.1E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,564	NA	3.9E+00	NA
Sodium hydroxide	1310-73-2	38	NA	4.2E-02	NA
Starch	9005-25-8	3,700	NA	4.1E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	38	4.1E-01	4.2E-02	1.0E-01
Xanthan gum	11138-66-2	2,600	4.1E+02	2.9E+00	7.1E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	80	2.0E+02	8.9E-02	4.4E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,600	4.6E+02	1.8E+00	3.8E-03
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative:**

**7.8E-01**

**Table I-59**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 3)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	31	1.0E+01	3.5E-02	3.4E-03
Methanol	67-56-1	5	7.5E+00	5.8E-03	7.7E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,000	NA	1.1E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,515	NA	3.9E+00	NA
Sodium hydroxide	1310-73-2	38	NA	4.2E-02	NA
Starch	9005-25-8	3,221	NA	3.6E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	1.9E-06	4.8E-06
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,600	4.6E+02	1.8E+00	3.8E-03
Methylisothiocyanate (MITC)	556-61-6	38	2.0E-01	4.2E-02	2.1E-01

**Cumulative:**

**8.8E-01**

**Table I-60**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 7)**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	900	NA	1.0E+00	NA
Glyoxal	107-22-2	26	1.0E+01	2.9E-02	2.8E-03
Methanol	67-56-1	4	7.5E+00	4.8E-03	6.4E-04
Pentanedial / Glutaraldehyde	111-30-8	594	1.6E+00	6.6E-01	4.1E-01
Sodium carbonate	497-19-8	1,000	NA	1.1E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	3,451	NA	3.8E+00	NA
Sodium hydroxide	1310-73-2	38	NA	4.2E-02	NA
Starch	9005-25-8	2,677	NA	3.0E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	3.2E-12	8.0E-12
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	20	1.0E+03	2.2E-02	2.2E-05
Polyalkylene	9038-95-3	37,100	2.0E+02	4.1E+01	2.0E-01
Polypropylene glycol	25322-69-4	70	2.0E+02	7.7E-02	3.8E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,600	4.6E+02	1.8E+00	3.8E-03
Methylisothiocyanate (MITC)	556-61-6	38	2.0E-01	4.2E-02	2.1E-01

**Cumulative: 8.8E-01**

**Table I-61**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	1,902	4.2E+03	3.0E-01	7.1E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	NA	8.6E-03	NA
Glyoxal	107-22-2	2.2	5.8E+01	3.4E-04	5.9E-06
Methanol	67-56-1	0.4	4.3E+01	5.7E-05	1.3E-06
Pentanedial / Glutaraldehyde	111-30-8	36	9.3E+00	5.6E-03	6.1E-04
Sodium carbonate	497-19-8	60.0	NA	9.5E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	214	NA	3.4E-02	NA
Sodium hydroxide	1310-73-2	2	NA	3.6E-04	NA
Starch	9005-25-8	222	NA	3.5E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	2.3E+03	2.5E-02	1.1E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	5.8E+03	1.9E-04	3.3E-08
Polyalkylene	9038-95-3	2,226	1.2E+03	3.5E-01	3.0E-04
Polypropylene glycol	25322-69-4	4.8	1.2E+03	7.6E-04	6.5E-07
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	2,142	NA	3.4E-01	NA
Sodium polyacrylate	9003-04-7	96	2.6E+03	1.5E-02	5.8E-06
Methylisothiocyanate (MITC)	556-61-6	2.3	1.2E+00	3.6E-04	3.1E-04

**Exposure Pathway HI: 1.3E-03**



**Table I-62**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	951	4.2E+03	1.5E-01	3.6E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	NA	4.3E-03	NA
Glyoxal	107-22-2	1.1	5.8E+01	1.7E-04	2.9E-06
Methanol	67-56-1	0.2	4.3E+01	2.9E-05	6.6E-07
Pentanedial / Glutaraldehyde	111-30-8	18	9.3E+00	2.8E-03	3.0E-04
Sodium carbonate	497-19-8	30.0	NA	4.8E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	107	NA	1.7E-02	NA
Sodium hydroxide	1310-73-2	1	NA	1.8E-04	NA
Starch	9005-25-8	111	NA	1.8E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	2.3E+03	1.2E-02	5.3E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	5.8E+03	9.5E-05	1.6E-08
Polyalkylene	9038-95-3	1,113	1.2E+03	1.8E-01	1.5E-04
Polypropylene glycol	25322-69-4	2.4	1.2E+03	3.8E-04	3.3E-07
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	1,071	NA	1.7E-01	NA
Sodium polyacrylate	9003-04-7	48	2.6E+03	7.6E-03	2.9E-06
Methylisothiocyanate (MITC)	556-61-6	1.1	1.2E+00	1.8E-04	1.6E-04

**Exposure Pathway HI: 6.6E-04**

**Table I-63**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	1,902	3.3E+03	8.1E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	54	NA	2.3E+01	NA
Glyoxal	107-22-2	2.2	4.5E+01	9.1E-01	2.0E-02
Methanol	67-56-1	0.4	3.3E+01	1.5E-01	4.6E-03
Pentanedial / Glutaraldehyde	111-30-8	36	5.4E+02	1.5E+01	2.8E-02
Sodium carbonate	497-19-8	60.0	NA	2.5E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	214	NA	9.1E+01	NA
Sodium hydroxide	1310-73-2	2	NA	9.7E-01	NA
Starch	9005-25-8	222	NA	9.4E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.8E+03	6.6E+01	3.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	5.1E-01	1.1E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	9.4E+02	1.1E+00
Polypropylene glycol	25322-69-4	4.8	9.0E+02	2.0E+00	2.3E-03
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	2,142	NA	9.1E+02	NA
Sodium polyacrylate	9003-04-7	96	2.0E+03	4.1E+01	2.0E-02
Methylisothiocyanate (MITC)	556-61-6	2.3	9.0E-01	9.7E-01	1.1E+00
Exposure Pathway HI:					2.5E+00

**Table I-64**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings**  
**Inhibited Mud V4 Glycol**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	951	3.3E+03	4.0E+02	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	27	NA	1.1E+01	NA
Glyoxal	107-22-2	1.1	4.5E+01	4.6E-01	1.0E-02
Methanol	67-56-1	0.18	3.3E+01	7.6E-02	2.3E-03
Pentanedial / Glutaraldehyde	111-30-8	18	5.4E+02	7.5E+00	1.4E-02
Sodium carbonate	497-19-8	30.0	NA	1.3E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	107	NA	4.5E+01	NA
Sodium hydroxide	1310-73-2	1	NA	4.8E-01	NA
Starch	9005-25-8	111	NA	4.7E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.8E+03	3.3E+01	1.8E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	0.6	4.5E+03	2.5E-01	5.7E-05
Polyalkylene	9038-95-3	1,113	9.0E+02	4.7E+02	5.3E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.0E+00	1.1E-03
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	1,071	NA	4.5E+02	NA
Sodium polyacrylate	9003-04-7	48	2.0E+03	2.0E+01	1.0E-02
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	4.8E-01	5.4E-01
Exposure Pathway HI:					1.2E+00

**Table I-65**  
**Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In flowback Including Biodegradation Half-Life (mg/l)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
Potassium chloride	7447-40-7	31,700	NA	31700	31700	31700
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1170	1170.00	1170.00
Glyoxal	107-22-2	5	15	5	4.5	3.8
Methanol	67-56-1	5	15	5	4.35	3.62
Pentanedial / Glutaraldehyde	111-30-8	495	NA	495	495.00	495.00
Sodium carbonate	497-19-8	1,100	NA	1100	1100.00	1100.00
Sodium carboxymethyl cellulose	9004-32-4	5,194	150	5194	5122.49	5028.68
Sodium hydroxide	1310-73-2	NA	NA	NA	NA	NA
Starch	9005-25-8	5,090	15	5090	4431	3683
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	52	0.21	52.00	0.00	0.00
Methylisothiocyanate (MITC)	556-61-6	-	NA	0.00	52.00	52.00
Xanthan gum	11138-66-2	2,600	150	2600	2564	2564
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	NA	40.00	40.00	40.00
Polyalkylene	9038-95-3	NA	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	60	15	60.0	52.2	52.2
Silicic acid, potassium salt	1312-76-1	NA	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	NA	35700	35700	35700
Sodium polyacrylate	9003-04-7	1,820	NA	1820.00	1820.00	1820.00

a/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation.

**Table I-66**  
**Summary of Theoretical Concentrations of Vendor Chemicals with Spent Drilling Muds and Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration with Spent Drilling Muds (mg/kg)	Estimated Residual Vendor Chemical Concentration with Surface Drill Cuttings (mg/kg) (a)	Estimated Residual Vendor Chemical Concentration with Buried Drill Cuttings (mg/kg) (b)
Potassium chloride	7447-40-7	19,020	1902	951
Copolymer of acrylamide and sodium acrylate	25085-02-3	702	70.2	35.1
Glyoxal	107-22-2	3	0.31	0.16
Methanol	67-56-1	3	0.3	0.15
Pentanedial / Glutaraldehyde	111-30-8	297	30	15
Sodium carbonate	497-19-8	660	66.0	33.00
Sodium carboxymethyl cellulose	9004-32-4	3,116	312	155.82
Sodium hydroxide	1310-73-2	NA	NA	NA
Starch	9005-25-8	3,054	305	152.70
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	0.0	0.00
Methylisothiocyanate (MITC)	556-61-6	31	3.1	1.56
Xanthan gum	11138-66-2	1,560	156	78.00
Ethylene oxide/propylene oxide copolymer	9003-11-6	24	2.4	1.20
Polyalkylene	9038-95-3	NA	NA	NA
Polypropylene glycol	25322-69-4	36	3.6	1.80
Silicic acid, potassium salt	1312-76-1	NA	NA	NA
Sodium chloride	7647-14-5	21,420	2142	1071.00
Sodium polyacrylate	9003-04-7	1,092	109	54.60

a/ Assume 10 percent of residual vendor chemicals remain on cuttings after shaker.

b/ Assume drill cuttings mixed at 1 to 1 ratio with clean fill; therefore, reduction of COPC concentration of 50%.

c/ Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione hydrolyzes/metabolizes to 100% MITC after 3-5 days based on degradation. Therefore, mass of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione in muds will be assumed to be 0 mg/kg.

**Table I-67**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 0)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	5	Yes	4.2E-05	2.5E-01	7.0E-05	6.7E-04	2.8E-04	2.7E-03
Methanol	67-56-1	5	No	1.3E-06	2.0E+00	6.7E-05	2.1E-05	3.4E-05	1.1E-05
Pentanedial / Glutaraldehyde	111-30-8	495	Yes	1.5E-04	4.0E-02	6.6E-03	2.4E-03	1.7E-01	6.0E-02
Sodium carbonate	497-19-8	1,100	Yes	NA	5.1E+01	1.5E-02	NA	2.9E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	5,194	Yes	NA	-	7.0E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	5,090	Yes	NA	-	6.8E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	52	Yes	2.9E-05	1.0E-02	7.0E-04	4.6E-04	7.0E-02	4.6E-02
Xanthan gum	11138-66-2	2,600	Yes	NA	1.0E+01	3.5E-02	NA	3.5E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	60	Yes	NA	5.0E-01	8.1E-04	NA	1.6E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	NA	Yes	NA	5.0E-03	NA	NA	NA	NA

Exposure Pathway HI: **3.0E-01** **1.1E-01**  
Cumulative HI: **4.1E-01**

CADD = chronic absorbed daily dose

**Table I-68**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 3)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3 CW (mg/l)	ET≤t*	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	4.53	Yes	3.7E-05	2.5E-01	6.1E-05	5.9E-04	2.4E-04	2.3E-03
Methanol	67-56-1	4.35	No	1.2E-06	2.0E+00	5.8E-05	1.9E-05	2.9E-05	9.3E-06
Pentanedial / Glutaraldehyde	111-30-8	495.00	Yes	1.5E-04	4.0E-02	6.6E-03	2.4E-03	1.7E-01	6.0E-02
Sodium carbonate	497-19-8	1,100	Yes	NA	5.1E+01	1.5E-02	NA	2.9E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	5,122	Yes	NA	-	6.9E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	4,431	Yes	NA	-	6.0E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	1.3E-09	1.0E-02	3.2E-08	2.1E-08	3.2E-06	2.1E-06
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	52	Yes	NA	5.0E-01	7.0E-04	NA	1.4E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	52	Yes	5.1E-05	5.0E-03	7.0E-04	8.2E-04	1.4E-01	1.6E-01

Exposure Pathway HI: **3.7E-01** **2.3E-01**

CADD = chronic absorbed daily dose

Cumulative HI: **6.0E-01**

**Table I-69**  
**Risk Estimates for Trespasser from Vendor Chemicals in Mud Pits (Day 7)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7 CW (mg/l)	ET <sub>st</sub> *	DA <sub>event</sub> (µg/cm <sup>2</sup> -event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADD <sub>oral</sub>	CADD <sub>derm</sub>	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	31,700	Yes	NA	1.8E+01	4.3E-01	NA	2.4E-02	NA
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	Yes	NA	-	1.6E-02	NA	NA	NA
Glyoxal	107-22-2	3.76	Yes	3.0E-05	2.5E-01	5.1E-05	4.9E-04	2.0E-04	2.0E-03
Methanol	67-56-1	3.62	No	9.6E-07	2.0E+00	4.9E-05	1.5E-05	2.4E-05	7.7E-06
Pentanedial / Glutaraldehyde	111-30-8	495.00	Yes	1.5E-04	4.0E-02	6.6E-03	2.4E-03	1.7E-01	6.0E-02
Sodium carbonate	497-19-8	1,100	Yes	NA	5.1E+01	1.5E-02	NA	2.9E-04	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	Yes	NA	-	6.8E-02	NA	NA	NA
Sodium hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	3,683	Yes	NA	-	4.9E-02	NA	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	Yes	2.2E-15	1.0E-02	5.4E-14	3.6E-14	5.4E-12	3.6E-12
Xanthan gum	11138-66-2	2,564	Yes	NA	1.0E+01	3.4E-02	NA	3.4E-03	NA
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	Yes	NA	2.5E+01	5.4E-04	NA	2.1E-05	NA
Polyalkylene	9038-95-3	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	52	Yes	NA	5.0E-01	7.0E-04	NA	1.4E-03	NA
Silicic acid, potassium salt	1312-76-1	NA	Yes	NA	2.0E-01	NA	NA	NA	NA
Sodium chloride	7647-14-5	35,700	Yes	NA	5.1E+01	4.8E-01	NA	9.3E-03	NA
Sodium polyacrylate	9003-04-7	1,820	Yes	NA	1.0E+00	2.4E-02	NA	2.4E-02	NA
Methylisothiocyanate (MITC)	556-61-6	52	Yes	5.1E-05	5.0E-03	7.0E-04	8.2E-04	1.4E-01	1.6E-01

Exposure Pathway HI: **3.7E-01** **2.3E-01**

Cumulative HI: **6.0E-01**

CADD = chronic absorbed daily dose



**Table I-70**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Surface Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	1.0E-04	6.7E-04	5.7E-06	3.7E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	3.8E-06	2.5E-05	NA	NA
Glyoxal	107-22-2	0	2.5E-01	1.7E-08	1.1E-07	6.7E-08	4.4E-07
Methanol	67-56-1	0.3	2.0E+00	1.6E-08	1.1E-07	8.1E-09	5.3E-08
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	1.6E-06	1.0E-05	4.0E-05	2.6E-04
Sodium carbonate	497-19-8	66	5.1E+01	3.5E-06	2.3E-05	6.9E-08	4.5E-07
Sodium carboxymethyl cellulose	9004-32-4	312	-	1.7E-05	1.1E-04	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	305	-	1.6E-05	1.1E-04	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	8.4E-06	5.5E-05	8.4E-07	5.5E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	2	2.5E+01	1.3E-07	8.5E-07	5.2E-09	3.4E-08
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	4	5.0E-01	1.9E-07	1.3E-06	3.9E-07	2.5E-06
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	1.2E-04	7.6E-04	2.2E-06	1.5E-05
Sodium polyacrylate	9003-04-7	109	1.0E+00	5.9E-06	3.9E-05	5.9E-06	3.9E-05
Methylisothiocyanate (MITC)	556-61-6	3	5.0E-03	1.7E-07	1.1E-06	3.4E-05	2.2E-04

**8.9E-05      5.8E-04**

CADD = chronic absorbed daily dose

**Cumulative HI:      6.7E-04**

**Table I-71**  
**Risk Estimates for Trespasser from Residual Vendor Chemicals with Buried Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	5.1E-05	3.4E-04	2.8E-06	1.9E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	1.9E-06	1.2E-05	NA	NA
Glyoxal	107-22-2	0	2.5E-01	8.4E-09	5.5E-08	3.4E-08	2.2E-07
Methanol	67-56-1	0.15	2.0E+00	8.1E-09	5.3E-08	4.0E-09	2.7E-08
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	8.0E-07	5.2E-06	2.0E-05	1.3E-04
Sodium carbonate	497-19-8	33	5.1E+01	1.8E-06	1.2E-05	3.4E-08	2.3E-07
Sodium carboxymethyl cellulose	9004-32-4	156	-	8.4E-06	5.5E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	153	-	8.2E-06	5.4E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	4.2E-06	2.8E-05	4.2E-07	2.8E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	6.4E-08	4.2E-07	2.6E-09	1.7E-08
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	2	5.0E-01	9.7E-08	6.4E-07	1.9E-07	1.3E-06
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	5.8E-05	3.8E-04	1.1E-06	7.4E-06
Sodium polyacrylate	9003-04-7	55	1.0E+00	2.9E-06	1.9E-05	2.9E-06	1.9E-05
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	8.4E-08	5.5E-07	1.7E-05	1.1E-04
						<b>4.4E-05</b>	<b>2.9E-04</b>
						<b>Cumulative HI:</b>	<b>3.4E-04</b>

CADD = chronic absorbed daily dose

**Table I-72**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	4.4E-05	8.2E-05	2.4E-06	4.6E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	1.6E-06	3.0E-06	NA	NA
Glyoxal	107-22-2	0.3	2.5E-01	7.2E-09	1.4E-08	2.9E-08	5.4E-08
Methanol	67-56-1	0.3	2.0E+00	7.0E-09	1.3E-08	3.5E-09	6.5E-09
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	6.9E-07	1.3E-06	1.7E-05	3.2E-05
Sodium carbonate	497-19-8	66	5.1E+01	1.5E-06	2.9E-06	3.0E-08	5.6E-08
Sodium carboxymethyl cellulose	9004-32-4	312	-	7.2E-06	1.3E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	305	-	7.1E-06	1.3E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	3.6E-06	6.8E-06	3.6E-07	6.8E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	2.5E+01	5.6E-08	1.0E-07	2.2E-09	4.2E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	4	5.0E-01	8.3E-08	1.6E-07	1.7E-07	3.1E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	5.0E-05	9.3E-05	9.7E-07	1.8E-06
Sodium polyacrylate	9003-04-7	109	1.0E+00	2.5E-06	4.7E-06	2.5E-06	4.7E-06
Methylisothiocyanate (MITC)	556-61-6	3	5.0E-03	7.2E-08	1.4E-07	1.4E-05	2.7E-05

Exposure Pathway HI:                      **3.8E-05      7.1E-05**  
Cumulative HI:                                **1.1E-04**

CADD = chronic absorbed daily dose

**Table I-73**  
**Risk Estimates for Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	2.2E-05	4.1E-05	1.2E-06	2.3E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	8.1E-07	1.5E-06	NA	NA
Glyoxal	107-22-2	0	2.5E-01	3.6E-09	6.8E-09	1.4E-08	2.7E-08
Methanol	67-56-1	0.15	2.0E+00	3.5E-09	6.5E-09	1.7E-09	3.2E-09
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	3.4E-07	6.4E-07	8.6E-06	1.6E-05
Sodium carbonate	497-19-8	33	5.1E+01	7.7E-07	1.4E-06	1.5E-08	2.8E-08
Sodium carboxymethyl cellulose	9004-32-4	156	-	3.6E-06	6.7E-06	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	153	-	3.5E-06	6.6E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.8E-06	3.4E-06	1.8E-07	3.4E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1	2.5E+01	2.8E-08	5.2E-08	1.1E-09	2.1E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	2	5.0E-01	4.2E-08	7.8E-08	8.3E-08	1.6E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	2.5E-05	4.6E-05	4.8E-07	9.0E-07
Sodium polyacrylate	9003-04-7	55	1.0E+00	1.3E-06	2.4E-06	1.3E-06	2.4E-06
Methylisothiocyanate (MITC)	556-61-6	2	5.0E-03	3.6E-08	6.8E-08	7.2E-06	1.4E-05

Exposure Pathway HI: **1.9E-05** **3.6E-05**

CADD = chronic absorbed daily dose

Cumulative HI: **5.5E-05**

**Table I-74**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Surface Drill Cuttings**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	1,902	1.8E+01	2.7E-05	1.2E-04	1.5E-06	6.7E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	-	9.9E-07	4.5E-06	NA	NA
Glyoxal	107-22-2	0.3	2.5E-01	4.4E-09	2.0E-08	1.8E-08	7.9E-08
Methanol	67-56-1	0.3	2.0E+00	4.2E-09	1.9E-08	2.1E-09	9.5E-09
Pentanedial / Glutaraldehyde	111-30-8	30	4.0E-02	4.2E-07	1.9E-06	1.0E-05	4.7E-05
Sodium carbonate	497-19-8	66.0	5.1E+01	9.3E-07	4.2E-06	1.8E-08	8.2E-08
Sodium carboxymethyl cellulose	9004-32-4	312	-	4.4E-06	2.0E-05	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	305	-	4.3E-06	1.9E-05	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.0E+01	2.2E-06	9.9E-06	2.2E-07	9.9E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	2.5E+01	3.4E-08	1.5E-07	1.3E-09	6.1E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	3.6	5.0E-01	5.1E-08	2.3E-07	1.0E-07	4.6E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	2,142	5.1E+01	3.0E-05	1.4E-04	5.9E-07	2.7E-06
Sodium polyacrylate	9003-04-7	109	1.0E+00	1.5E-06	7.0E-06	1.5E-06	7.0E-06
Methylisothiocyanate (MITC)	556-61-6	3.1	5.0E-03	4.4E-08	2.0E-07	8.8E-06	4.0E-05

Exposure Pathway HI:                      **2.3E-05**                      **1.0E-04**  
Cumulative HI:                                      **1.3E-04**

CADD = chronic absorbed daily dose

**Table I-75**  
**Risk Estimates for Agricultural Worker from Residual Vendor Chemicals with Buried Drill Cuttings**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Potassium chloride	7447-40-7	951	1.8E+01	1.3E-05	6.1E-05	7.4E-07	3.4E-06
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	-	4.9E-07	2.2E-06	NA	NA
Glyoxal	107-22-2	0.2	2.5E-01	2.2E-09	9.9E-09	8.8E-09	4.0E-08
Methanol	67-56-1	0.15	2.0E+00	2.1E-09	9.5E-09	1.1E-09	4.8E-09
Pentanedial / Glutaraldehyde	111-30-8	15	4.0E-02	2.1E-07	9.5E-07	5.2E-06	2.4E-05
Sodium carbonate	497-19-8	33.0	5.1E+01	4.6E-07	2.1E-06	9.0E-09	4.1E-08
Sodium carboxymethyl cellulose	9004-32-4	156	-	2.2E-06	9.9E-06	NA	NA
Sodium hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Starch	9005-25-8	153	-	2.1E-06	9.7E-06	NA	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	-	1.0E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.0E+01	1.1E-06	5.0E-06	1.1E-07	5.0E-07
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	2.5E+01	1.7E-08	7.6E-08	6.7E-10	3.1E-09
Polyalkylene	9038-95-3	NA	5.0E+00	NA	NA	NA	NA
Polypropylene glycol	25322-69-4	1.8	5.0E-01	2.5E-08	1.1E-07	5.1E-08	2.3E-07
Silicic acid, potassium salt	1312-76-1	NA	2.0E-01	NA	NA	NA	NA
Sodium Chloride	7647-14-5	1,071	5.1E+01	1.5E-05	6.8E-05	2.9E-07	1.3E-06
Sodium polyacrylate	9003-04-7	55	1.0E+00	7.7E-07	3.5E-06	7.7E-07	3.5E-06
Methylisothiocyanate (MITC)	556-61-6	1.6	5.0E-03	2.2E-08	9.9E-08	4.4E-06	2.0E-05

**Exposure Pathway HI: 1.2E-05 5.2E-05**

CADD = chronic absorbed daily dose

**Cumulative HI: 6.4E-05**

**Table I-76**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 0)**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	5	8.6E+00	1.2E-02	1.4E-03
Methanol	67-56-1	5	6.4E+00	1.2E-02	1.8E-03
Pentanedial / Glutaraldehyde	111-30-8	495	1.4E+00	1.1E+00	8.3E-01
Sodium carbonate	497-19-8	1,100	NA	2.5E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,194	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	5,090	NA	1.2E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	52	3.4E-01	1.2E-01	3.5E-01
Xanthan gum	11138-66-2	2,600	3.4E+02	6.0E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	60	1.7E+02	1.4E-01	8.0E-04
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	-	1.7E-01	0.0E+00	0.0E+00

**Cumulative: 1.3E+00**

**Table I-77**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 3)**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	5	8.6E+00	1.0E-02	1.2E-03
Methanol	67-56-1	4	6.4E+00	1.0E-02	1.6E-03
Pentanedial / Glutaraldehyde	111-30-8	495	1.4E+00	1.1E+00	8.3E-01
Sodium carbonate	497-19-8	1,100	NA	2.5E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,122	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	4,431	NA	1.0E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	5.5E-06	1.6E-05
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	52	1.7E+02	1.2E-01	7.0E-04
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	52	1.7E-01	1.2E-01	7.0E-01
<b>Cumulative:</b>					<b>1.7E+00</b>



**Table I-78**  
**Risk Estimates for Kangaroo from Vendor Chemicals in Mud Pits (Day 7)**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	6.3E+02	7.3E+01	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	2.7E+00	NA
Glyoxal	107-22-2	4	8.6E+00	8.7E-03	1.0E-03
Methanol	67-56-1	4	6.4E+00	8.3E-03	1.3E-03
Pentanedial / Glutaraldehyde	111-30-8	495	1.4E+00	1.1E+00	8.3E-01
Sodium carbonate	497-19-8	1,100	NA	2.5E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	NA	1.2E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,683	NA	8.5E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	3.4E-01	9.2E-12	2.7E-11
Xanthan gum	11138-66-2	2,564	3.4E+02	5.9E+00	1.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	8.6E+02	9.2E-02	1.1E-04
Polyalkylene	9038-95-3	NA	1.7E+02	NA	NA
Polypropylene glycol	25322-69-4	52	1.7E+02	1.2E-01	7.0E-04
Silicic acid, potassium salt	1312-76-1	NA	7.4E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	8.2E+01	NA
Sodium polyacrylate	9003-04-7	1,820	3.9E+02	4.2E+00	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	52	1.7E-01	1.2E-01	7.0E-01

**Cumulative: 1.7E+00**

**Table I-79**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 0)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	5	1.0E+01	5.8E-03	5.7E-04
Methanol	67-56-1	5	7.5E+00	5.5E-03	7.4E-04
Pentanedial / Glutaraldehyde	111-30-8	495	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	1,100	NA	1.2E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,194	NA	5.7E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	5,090	NA	5.6E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	52	4.1E-01	5.8E-02	1.4E-01
Xanthan gum	11138-66-2	2,600	4.1E+02	2.9E+00	7.1E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	60	2.0E+02	6.6E-02	3.3E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	-	2.0E-01	0.0E+00	0.0E+00

**Cumulative:**

**5.4E-01**

**Table I-80**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 3)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 3	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	5	1.0E+01	5.0E-03	4.9E-04
Methanol	67-56-1	4	7.5E+00	4.8E-03	6.4E-04
Pentanedial / Glutaraldehyde	111-30-8	495	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	1,100	NA	1.2E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,122	NA	5.7E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	4,431	NA	4.9E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	2.7E-06	6.6E-06
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	52	2.0E+02	5.8E-02	2.9E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	52	2.0E-01	5.8E-02	2.8E-01

**Cumulative:**

**6.8E-01**

**Table I-81**  
**Risk Estimates for Dingo from Vendor Chemicals in Mud Pits (Day 7)**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Day 7	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	31,700	7.4E+02	3.5E+01	4.8E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	1,170	NA	1.3E+00	NA
Glyoxal	107-22-2	4	1.0E+01	4.2E-03	4.1E-04
Methanol	67-56-1	4	7.5E+00	4.0E-03	5.3E-04
Pentanedial / Glutaraldehyde	111-30-8	495	1.6E+00	5.5E-01	3.4E-01
Sodium carbonate	497-19-8	1,100	NA	1.2E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	5,029	NA	5.6E+00	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	3,683	NA	4.1E+00	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	0	4.1E-01	4.4E-12	1.1E-11
Xanthan gum	11138-66-2	2,564	4.1E+02	2.8E+00	7.0E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	40	1.0E+03	4.4E-02	4.4E-05
Polyalkylene	9038-95-3	NA	2.0E+02	NA	NA
Polypropylene glycol	25322-69-4	52	2.0E+02	5.8E-02	2.9E-04
Silicic acid, potassium salt	1312-76-1	NA	8.7E+01	NA	NA
Sodium Chloride	7647-14-5	35,700	NA	3.9E+01	NA
Sodium polyacrylate	9003-04-7	1,820	4.6E+02	2.0E+00	4.4E-03
Methylisothiocyanate (MITC)	556-61-6	52	2.0E-01	5.8E-02	2.8E-01

**Cumulative: 6.8E-01**

**Table I-82**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Surface Drill Cuttings**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	1,902	4.2E+03	3.0E-01	7.1E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	1.1E-02	NA
Glyoxal	107-22-2	0.3	5.8E+01	4.9E-05	8.5E-07
Methanol	67-56-1	0.3	4.3E+01	4.8E-05	1.1E-06
Pentanedial / Glutaraldehyde	111-30-8	30	9.3E+00	4.7E-03	5.1E-04
Sodium carbonate	497-19-8	66.0	NA	1.0E-02	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	4.9E-02	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	305	NA	4.8E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	2.3E+03	2.5E-02	1.1E-05
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	5.8E+03	3.8E-04	6.5E-08
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	3.6	1.2E+03	5.7E-04	4.9E-07
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	2,142	NA	3.4E-01	NA
Sodium polyacrylate	9003-04-7	109	2.6E+03	1.7E-02	6.5E-06
Methylisothiocyanate (MITC)	556-61-6	3.1	1.2E+00	4.9E-04	4.3E-04

**Exposure Pathway HI: 1.0E-03**

**Table I-83**  
**Risk Estimates for Mouse from Residual Vendor Chemicals with Buried Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Potassium chloride	7447-40-7	951	4.2E+03	1.5E-01	3.6E-05
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	5.6E-03	NA
Glyoxal	107-22-2	0.2	5.8E+01	2.5E-05	4.3E-07
Methanol	67-56-1	0.2	4.3E+01	2.4E-05	5.5E-07
Pentanedial / Glutaraldehyde	111-30-8	15	9.3E+00	2.4E-03	2.5E-04
Sodium carbonate	497-19-8	33.0	NA	5.2E-03	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	2.5E-02	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	153	NA	2.4E-02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.3E+00	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	2.3E+03	1.2E-02	5.3E-06
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	5.8E+03	1.9E-04	3.3E-08
Polyalkylene	9038-95-3	NA	1.2E+03	NA	NA
Polypropylene glycol	25322-69-4	1.8	1.2E+03	2.9E-04	2.5E-07
Silicic acid, potassium salt	1312-76-1	NA	5.0E+02	NA	NA
Sodium Chloride	7647-14-5	1,071	NA	1.7E-01	NA
Sodium polyacrylate	9003-04-7	55	2.6E+03	8.6E-03	3.3E-06
Methylisothiocyanate (MITC)	556-61-6	1.6	1.2E+00	2.5E-04	2.1E-04

**Exposure Pathway HI: 5.1E-04**

**Table I-84**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings**  
**KCI Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	1,902	3.3E+03	8.1E+02	2.5E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	3.0E+01	NA
Glyoxal	107-22-2	0.3	4.5E+01	1.3E-01	3.0E-03
Methanol	67-56-1	0.3	3.3E+01	1.3E-01	3.8E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	1.3E+01	2.3E-02
Sodium carbonate	497-19-8	66.0	NA	2.8E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	1.3E+02	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	305	NA	1.3E+02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	156	1.8E+03	6.6E+01	3.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	1.0E+00	2.3E-04
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	3.6	9.0E+02	1.5E+00	1.7E-03
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	2,142	NA	9.1E+02	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	4.6E+01	2.3E-02
Methylisothiocyanate (MITC)	556-61-6	3.1	9.0E-01	1.3E+00	1.5E+00
Exposure Pathway HI:					1.8E+00

**Table I-85**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings**  
**KCl Polymer Mud V4**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	951	3.3E+03	4.0E+02	1.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	1.5E+01	NA
Glyoxal	107-22-2	0.2	4.5E+01	6.6E-02	1.5E-03
Methanol	67-56-1	0.15	3.3E+01	6.4E-02	1.9E-03
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	6.3E+00	1.2E-02
Sodium carbonate	497-19-8	33.0	NA	1.4E+01	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	6.6E+01	NA
Sodium hydroxide	1310-73-2	NA	NA	NA	NA
Starch	9005-25-8	153	NA	6.5E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	78	1.8E+03	3.3E+01	1.8E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	5.1E-01	1.1E-04
Polyalkylene	9038-95-3	NA	9.0E+02	NA	NA
Polypropylene glycol	25322-69-4	1.8	9.0E+02	7.6E-01	8.5E-04
Silicic acid, potassium salt	1312-76-1	NA	3.8E+02	NA	NA
Sodium Chloride	7647-14-5	1,071	NA	4.5E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	2.3E+01	1.1E-02
Methylisothiocyanate (MITC)	556-61-6	2	9.0E-01	6.6E-01	7.4E-01

**Exposure Pathway HI: 9.1E-01**



## **APPENDIX J PREY RATIO SENSITIVITY ANALYSIS**

**Table J-1**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 0.25)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	4,152	3.3E+03	1.3E+03	3.9E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	2.1E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	9.4E-01	2.1E-02
Methanol	67-56-1	0.3	3.3E+01	9.2E-02	2.8E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	9.2E+00	1.7E-02
Sodium carbonate	497-19-8	7.8	NA	2.4E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	9.5E+01	NA
Sodium hydroxide	1310-73-2	30	NA	9.2E+00	NA
Starch	9005-25-8	306	NA	9.4E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	9.4E+01	5.2E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	7.3E-01	1.6E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	6.8E+02	7.6E-01
Polypropylene glycol	25322-69-4	4.8	9.0E+02	1.5E+00	1.6E-03
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	6.8E+02	1.8E+00
Sodium Chloride	7647-14-5	4,560	NA	1.4E+03	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	3.3E+01	1.6E-02
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	9.2E-01	1.0E+00
Exposure Pathway HI:					4.1E+00

**Table J-1**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 0.25)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	4,152	3.3E+03	2.8E+02	8.5E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	4.7E+00	NA
Glyoxal	107-22-2	3.1	4.5E+01	2.0E-01	4.6E-03
Methanol	67-56-1	0.3	3.3E+01	2.0E-02	6.0E-04
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	2.0E+00	3.7E-03
Sodium carbonate	497-19-8	7.8	NA	5.2E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	2.1E+01	NA
Sodium hydroxide	1310-73-2	30	NA	2.0E+00	NA
Starch	9005-25-8	306	NA	2.0E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	2.0E+01	1.1E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	1.6E-01	3.6E-05
Polyalkylene	9038-95-3	2,226	9.0E+02	1.5E+02	1.7E-01
Polypropylene glycol	25322-69-4	4.8	9.0E+02	3.2E-01	3.6E-04
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	1.5E+02	3.9E-01
Sodium Chloride	7647-14-5	4,560	NA	3.0E+02	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	7.3E+00	3.6E-03
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	2.0E-01	2.2E-01

**Exposure Pathway HI: 8.9E-01**

**Table J-2**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 0.25)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	2,076	3.3E+03	6.4E+02	1.9E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	1.1E+01	NA
Glyoxal	107-22-2	1.5	4.5E+01	4.7E-01	1.0E-02
Methanol	67-56-1	0.15	3.3E+01	4.6E-02	1.4E-03
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	4.6E+00	8.5E-03
Sodium carbonate	497-19-8	3.9	NA	1.2E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	4.8E+01	NA
Sodium hydroxide	1310-73-2	15	NA	4.6E+00	NA
Starch	9005-25-8	153	NA	4.7E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	4.7E+01	2.6E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	3.7E-01	8.2E-05
Polyalkylene	9038-95-3	1,113	9.0E+02	3.4E+02	3.8E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	7.3E-01	8.2E-04
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	3.4E+02	8.9E-01
Sodium Chloride	7647-14-5	2,280	NA	7.0E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	1.7E+01	8.2E-03
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	4.6E-01	5.1E-01
Exposure Pathway HI:					2.0E+00

**Table J-2**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 0.25)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	2,076	3.3E+03	1.4E+02	4.2E-02
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	2.3E+00	NA
Glyoxal	107-22-2	1.5	4.5E+01	1.0E-01	2.3E-03
Methanol	67-56-1	0.15	3.3E+01	1.0E-02	3.0E-04
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	1.0E+00	1.9E-03
Sodium carbonate	497-19-8	3.9	NA	2.6E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	1.0E+01	NA
Sodium hydroxide	1310-73-2	15	NA	1.0E+00	NA
Starch	9005-25-8	153	NA	1.0E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	1.0E+01	5.7E-03
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	8.0E-02	1.8E-05
Polyalkylene	9038-95-3	1,113	9.0E+02	7.4E+01	8.3E-02
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.6E-01	1.8E-04
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	7.4E+01	1.9E-01
Sodium Chloride	7647-14-5	2,280	NA	1.5E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	3.6E+00	1.8E-03
Methylisothiocyanate (MITC)	556-61-6	3	9.0E-01	2.0E-01	2.2E-01
				0.0E+00	5.5E-01

**Table J-3**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 0.25)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	6.3E-02	NA
Proprietary Ester A	EsterA-CasRn	0.0052	6.9E+02	1.6E-03	2.3E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.7E+03	NA	NA
Sodium Hypochlorite	7681-52-9	NA	3.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.1E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	3.8E-02	NA
Polydadmac	26062-79-3	NA	3.6E+03	NA	NA
Polyacrylamide	9003-05-8	NA	9.0E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	1.3E+02	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	1.3E+02	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	2.3E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	3.6E+03	8.4E-03	2.3E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	2.0E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.8E+03	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	2.0E+03	NA	NA

Exposure Pathway HI: 4.6E-06

**Table J-3**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 0.25)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	1.4E-02	NA
Proprietary Ester A	EsterA-CasRn	0.0052	3.7E+02	3.4E-04	9.2E-07
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	9.3E+02	NA	NA
Sodium Hypochlorite	7681-52-9	NA	2.1E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	8.3E-03	NA
Polydadmac	26062-79-3	NA	1.9E+03	NA	NA
Polyacrylamide	9003-05-8	NA	4.9E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	7.2E+01	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	7.2E+01	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	1.2E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	1.9E+03	1.8E-03	9.4E-07
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.1E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	9.7E+02	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.1E+03	NA	NA

Exposure Pathway HI: 1.9E-06

**Table J-4**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 0.75)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	4,152	3.3E+03	2.2E+03	6.9E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	3.8E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	1.7E+00	3.7E-02
Methanol	67-56-1	0.3	3.3E+01	1.6E-01	4.9E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	1.6E+01	3.0E-02
Sodium carbonate	497-19-8	7.8	NA	4.2E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	1.7E+02	NA
Sodium hydroxide	1310-73-2	30	NA	1.6E+01	NA
Starch	9005-25-8	306	NA	1.7E+02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	1.7E+02	9.2E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	1.3E+00	2.9E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	1.2E+03	1.3E+00
Polypropylene glycol	25322-69-4	4.8	9.0E+02	2.6E+00	2.9E-03
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	1.2E+03	3.1E+00
Sodium Chloride	7647-14-5	4,560	NA	2.5E+03	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	5.9E+01	2.9E-02
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	1.6E+00	1.8E+00

**Exposure Pathway HI: 7.2E+00**



**Table J-4**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 0.75)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	4,152	3.3E+03	6.9E+02	2.1E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	1.2E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	5.1E-01	1.1E-02
Methanol	67-56-1	0.3	3.3E+01	5.0E-02	1.5E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	5.0E+00	9.3E-03
Sodium carbonate	497-19-8	7.8	NA	1.3E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	5.2E+01	NA
Sodium hydroxide	1310-73-2	30	NA	5.0E+00	NA
Starch	9005-25-8	306	NA	5.1E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	5.1E+01	2.9E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	4.0E-01	9.0E-05
Polyalkylene	9038-95-3	2,226	9.0E+02	3.7E+02	4.2E-01
Polypropylene glycol	25322-69-4	4.8	9.0E+02	8.0E-01	9.0E-04
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	3.7E+02	9.7E-01
Sodium Chloride	7647-14-5	4,560	NA	7.6E+02	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	1.8E+01	9.0E-03
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	5.0E-01	5.6E-01

**Exposure Pathway HI: 2.2E+00**

**Table J-5**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 0.75)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	2,076	3.3E+03	1.1E+03	3.4E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	1.9E+01	NA
Glyoxal	107-22-2	1.5	4.5E+01	8.3E-01	1.8E-02
Methanol	67-56-1	0.15	3.3E+01	8.1E-02	2.4E-03
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	8.1E+00	1.5E-02
Sodium carbonate	497-19-8	3.9	NA	2.1E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	8.4E+01	NA
Sodium hydroxide	1310-73-2	15	NA	8.1E+00	NA
Starch	9005-25-8	153	NA	8.3E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	8.3E+01	4.6E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	6.5E-01	1.5E-04
Polyalkylene	9038-95-3	1,113	9.0E+02	6.0E+02	6.7E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.3E+00	1.5E-03
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	6.0E+02	1.6E+00
Sodium Chloride	7647-14-5	2,280	NA	1.2E+03	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	3.0E+01	1.5E-02
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	8.1E-01	9.1E-01
Exposure Pathway HI:					3.6E+00

**Table J-5**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 0.75)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	2,076	3.3E+03	3.5E+02	1.1E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	5.9E+00	NA
Glyoxal	107-22-2	1.5	4.5E+01	2.6E-01	5.7E-03
Methanol	67-56-1	0.15	3.3E+01	2.5E-02	7.6E-04
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	2.5E+00	4.7E-03
Sodium carbonate	497-19-8	3.9	NA	6.5E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	2.6E+01	NA
Sodium hydroxide	1310-73-2	15	NA	2.5E+00	NA
Starch	9005-25-8	153	NA	2.6E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	2.6E+01	1.4E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	2.0E-01	4.5E-05
Polyalkylene	9038-95-3	1,113	9.0E+02	1.9E+02	2.1E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	4.0E-01	4.5E-04
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	1.9E+02	4.8E-01
Sodium Chloride	7647-14-5	2,280	NA	3.8E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	9.1E+00	4.5E-03
Methylisothiocyanate (MITC)	556-61-6	3	9.0E-01	5.0E-01	5.6E-01
Exposure Pathway HI:					1.4E+00

**Table J-6**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 0.75)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	1.1E-01	NA
Proprietary Ester A	EsterA-CasRn	0.0052	6.9E+02	2.8E-03	4.1E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.7E+03	NA	NA
Sodium Hypochlorite	7681-52-9	NA	3.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.1E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	6.7E-02	NA
Polydadmac	26062-79-3	NA	3.6E+03	NA	NA
Polyacrylamide	9003-05-8	NA	9.0E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	1.3E+02	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	1.3E+02	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	2.3E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	3.6E+03	1.5E-02	4.2E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	2.0E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.8E+03	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	2.0E+03	NA	NA

**Exposure Pathway HI: 8.2E-06**

**Table J-6**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 0.75)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	3.4E-02	NA
Proprietary Ester A	EsterA-CasRn	0.0052	3.7E+02	8.6E-04	2.3E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	9.3E+02	NA	NA
Sodium Hypochlorite	7681-52-9	NA	2.1E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	2.1E-02	NA
Polydadmac	26062-79-3	NA	1.9E+03	NA	NA
Polyacrylamide	9003-05-8	NA	4.9E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	7.2E+01	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	7.2E+01	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	1.2E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	1.9E+03	4.6E-03	2.4E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.1E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	9.7E+02	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.1E+03	NA	NA

Exposure Pathway HI: 4.7E-06

**Table J-7**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 1)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	4,152	3.3E+03	2.7E+03	8.4E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	4.6E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	2.0E+00	4.5E-02
Methanol	67-56-1	0.3	3.3E+01	2.0E-01	5.9E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	2.0E+01	3.7E-02
Sodium carbonate	497-19-8	7.8	NA	5.1E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	2.1E+02	NA
Sodium hydroxide	1310-73-2	30	NA	2.0E+01	NA
Starch	9005-25-8	306	NA	2.0E+02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	2.0E+02	1.1E-01
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	1.6E+00	3.5E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	1.5E+03	1.6E+00
Polypropylene glycol	25322-69-4	4.8	9.0E+02	3.2E+00	3.5E-03
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	1.5E+03	3.8E+00
Sodium Chloride	7647-14-5	4,560	NA	3.0E+03	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	7.2E+01	3.5E-02
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	2.0E+00	2.2E+00

**Exposure Pathway HI: 8.7E+00**

**Table J-7**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Surface Drill Cuttings (Prey Ratio 1)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Surface Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	4,152	3.3E+03	9.0E+02	2.8E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	70	NA	1.5E+01	NA
Glyoxal	107-22-2	3.1	4.5E+01	6.7E-01	1.5E-02
Methanol	67-56-1	0.3	3.3E+01	6.5E-02	2.0E-03
Pentanedial / Glutaraldehyde	111-30-8	30	5.4E+02	6.5E+00	1.2E-02
Sodium carbonate	497-19-8	7.8	NA	1.7E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	312	NA	6.8E+01	NA
Sodium hydroxide	1310-73-2	30	NA	6.5E+00	NA
Starch	9005-25-8	306	NA	6.7E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	306	1.8E+03	6.7E+01	3.7E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	2.4	4.5E+03	5.2E-01	1.2E-04
Polyalkylene	9038-95-3	2,226	9.0E+02	4.8E+02	5.4E-01
Polypropylene glycol	25322-69-4	4.8	9.0E+02	1.0E+00	1.2E-03
Silicic acid, potassium salt	1312-76-1	2,220	3.8E+02	4.8E+02	1.3E+00
Sodium Chloride	7647-14-5	4,560	NA	9.9E+02	NA
Sodium polyacrylate	9003-04-7	109	2.0E+03	2.4E+01	1.2E-02
Methylisothiocyanate (MITC)	556-61-6	3.0	9.0E-01	6.5E-01	7.3E-01

**Exposure Pathway HI: 2.9E+00**

**Table J-8**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 1)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Potassium chloride	7447-40-7	2,076	3.3E+03	1.4E+03	4.2E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	2.3E+01	NA
Glyoxal	107-22-2	1.5	4.5E+01	1.0E+00	2.3E-02
Methanol	67-56-1	0.15	3.3E+01	9.9E-02	3.0E-03
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	9.9E+00	1.8E-02
Sodium carbonate	497-19-8	3.9	NA	2.6E+00	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	1.0E+02	NA
Sodium hydroxide	1310-73-2	15	NA	9.9E+00	NA
Starch	9005-25-8	153	NA	1.0E+02	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	1.0E+02	5.6E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	7.9E-01	1.8E-04
Polyalkylene	9038-95-3	1,113	9.0E+02	7.3E+02	8.2E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	1.6E+00	1.8E-03
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	7.3E+02	1.9E+00
Sodium Chloride	7647-14-5	2,280	NA	1.5E+03	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	3.6E+01	1.8E-02
Methylisothiocyanate (MITC)	556-61-6	1	9.0E-01	9.9E-01	1.1E+00

**Exposure Pathway HI: 4.4E+00**



**Table J-8**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Buried Drill Cuttings (Prey Ratio 1)**  
**Drilling Fluid System**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Buried Cuttings	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Potassium chloride	7447-40-7	2,076	3.3E+03	4.5E+02	1.4E-01
Copolymer of acrylamide and sodium acrylate	25085-02-3	35	NA	7.6E+00	NA
Glyoxal	107-22-2	1.5	4.5E+01	3.3E-01	7.4E-03
Methanol	67-56-1	0.15	3.3E+01	3.3E-02	9.8E-04
Pentanedial / Glutaraldehyde	111-30-8	15	5.4E+02	3.3E+00	6.1E-03
Sodium carbonate	497-19-8	3.9	NA	8.5E-01	NA
Sodium carboxymethyl cellulose	9004-32-4	156	NA	3.4E+01	NA
Sodium hydroxide	1310-73-2	15	NA	3.3E+00	NA
Starch	9005-25-8	153	NA	3.3E+01	NA
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	-	2.2E+02	0.0E+00	0.0E+00
Xanthan gum	11138-66-2	153	1.8E+03	3.3E+01	1.9E-02
Ethylene oxide/propylene oxide copolymer	9003-11-6	1.2	4.5E+03	2.6E-01	5.8E-05
Polyalkylene	9038-95-3	1,113	9.0E+02	2.4E+02	2.7E-01
Polypropylene glycol	25322-69-4	2.4	9.0E+02	5.2E-01	5.8E-04
Silicic acid, potassium salt	1312-76-1	1,110	3.8E+02	2.4E+02	6.3E-01
Sodium Chloride	7647-14-5	2,280	NA	5.0E+02	NA
Sodium polyacrylate	9003-04-7	55	2.0E+03	1.2E+01	5.8E-03
Methylisothiocyanate (MITC)	556-61-6	3	9.0E-01	6.5E-01	7.3E-01
Exposure Pathway HI:					1.8E+00

**Table J-9**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 1)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Rainbow Bee-Eater					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	1.4E-01	NA
Proprietary Ester A	EsterA-CasRn	0.0052	6.9E+02	3.4E-03	4.9E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	1.7E+03	NA	NA
Sodium Hypochlorite	7681-52-9	NA	3.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	2.1E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	8.1E-02	NA
Polydadmac	26062-79-3	NA	3.6E+03	NA	NA
Polyacrylamide	9003-05-8	NA	9.0E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	1.3E+02	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	1.3E+02	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	2.3E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	3.6E+03	1.8E-02	5.1E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	2.0E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	1.8E+03	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	2.0E+03	NA	NA

Exposure Pathway HI: 1.0E-05

**Table J-9**  
**Risk Estimates for Avian Receptors from Residual Vendor Chemicals with Soils Irrigated with Permeate (Prey Ratio 1)**  
**Water Treatment Chemicals**  
**Narrabri Gas Project**

Constituent Name	CAS No.	EPC Irrigated Soil	Toxicity	Total Intake	Hazard Quotient
		CW (mg/kg)	TRVs		Incidental Ingestion
Cattle Egret					
Proprietary Polymer A	PolymerA-CasRn	0.21	NA	4.5E-02	NA
Proprietary Ester A	EsterA-CasRn	0.0052	3.7E+02	1.1E-03	3.0E-06
Aluminium Chlorohydrate	1327-41-9	NA	NA	NA	NA
Sodium Meta Bisulphite	7681-57-4	NA	9.3E+02	NA	NA
Sodium Hypochlorite	7681-52-9	NA	2.1E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Citric Acid	77-92-9	NA	1.2E+03	NA	NA
Hydrochloric Acid	7647-01-0	NA	NA	NA	NA
Calcium Chloride	10043-52-4	NA	NA	NA	NA
Ethylene diamine tetraacetic acid, EDTA	64-02-8	0.12	NA	2.7E-02	NA
Polydadmac	26062-79-3	NA	1.9E+03	NA	NA
Polyacrylamide	9003-05-8	NA	4.9E+03	NA	NA
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	NA	7.2E+01	NA	NA
2 methyl-isothiazolin-3 one	2682-20-4	NA	7.2E+01	NA	NA
Proprietary Mixture D1	MixtureD1-CasRn	NA	1.2E+02	NA	NA
Proprietary Mixture D2	MixtureD2-CasRn	0.03	1.9E+03	6.0E-03	3.1E-06
Sodium Chloride	7647-14-5	NA	NA	NA	NA
Sodium dodecyl sulfate	151-21-3	NA	1.1E+02	NA	NA
Proprietary Mixture A2	MixtureA2-CasRn	NA	9.7E+02	NA	NA
Homopolymer of maleic acid	26009-09-2	NA	NA	NA	NA
Magnesium nitrate	10377-60-3	NA	NA	NA	NA
Proprietary Mixture A3	MixtureA3-CasRn	NA	NA	NA	NA
Sodium Polyacrylate	9003-04-7	NA	1.1E+03	NA	NA
Exposure Pathway HI:					6.1E-06

