Qualitative Tier 2 Assessment

PolyDADMAC

In accordance with the Chemical Risk Assessment Framework (CRAF), chemicals assigned a Tier 2 designation require a hazard assessment and qualitative assessment of risk.

Consistent with National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the human health hazards for each chemical are characterised by analysing the toxicokinetics (the absorption, distribution, metabolism and excretion of the chemical in humans or laboratory animals), acute toxicity, irritation and corrosivity, repeat dose toxicity, genotoxicity, carcinogenicity, reproductive toxicity, and other health effects. The environmental hazards for each chemical are characterized by analysing the environmental fate properties (such as mobility, persistence, bioavailability and bioaccumulation), acute toxicity and chronic toxicity. In support of the hazard assessment, a risk assessment dossier is prepared for each of the chemicals included in the assessment.

The qualitative assessment of risk evaluates exposure to the vendor chemical that may occur during activities that do not intentionally result in a release to the environment, but where a potential release may occur. For this evaluation, these potential releases primarily are focused on the vendor chemical transported to the well pad site or water management facility (WMF), chemicals utilised in drilling fluid systems that may impact groundwater, residual chemicals that may be present in hydraulic flowback and workover fluids and chemicals and chemicals and residues of chemicals that may be present in water undergoing treatment or beneficially re-used.

Potentially complete exposure pathways (in that a source, a migration pathway, a mechanism for exposure, and a potential receptor are present) are assessed herein to determine the potential for risk (an incomplete pathway precludes an exposure occurring and an associated potential risk). In this context, site setting and management protocols associated with the action are evaluated. Key controls limiting the potential for exposure include:

- Engineering controls (including fencing and secondary containment);
- Storage (drums, totes and storage tanks) constructed in accordance with Australian standards and managed and monitored in accordance with regulatory requirements;
- Maintenance of access control restrictions during site activities that will preclude access by the public, livestock and large native fauna; and,
- Australia SafeWork Place and Santos Occupational Safety Guidance used to minimise human health exposure.

As a result, the assessment for this Tier 2 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No Effect Concentrations (PNECs) for water and soil; and, providing a qualitative discussion of risk. Each of these components is detailed within this memorandum.

Background

Cationic polymers are a component in a Water Management Facility (WMF) product (MAK MFC1) used as a coagulant during oily water treatment. A safety data sheet (SDS) for the WMF product is included as **Attachment 1**. Process and usage information for this chemical is included in **Attachment 2** and summarised in **Table 1**.

Table 1 Water Management Facility Chemicals

Proprietary Name	Chemical Name	CAS No.	Use	Approximate Quantity Stored On-Site (plant available storage)
MAK MFC1 (multi floc coagulant)	Cationic Polymer[a] Aluminium Hydroxychloride Water	n/a 1327-41-9 7732-18-5	Polymer / coagulant	2 x 1000 L (IBC)

[a] Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC (CAS No. 26062-79-3)].
CAS No = Chemical Abstracts Service Number
IBC = intermediate bulk container
L = litre
n/a = not available

As noted above and detailed in the SDS, the identity of the cationic polymer in the vendor product is unknown. Therefore, a read-across to polyDADMAC (CAS RN 26062-79-3)[1] was conducted for this assessment. Information compiled for polyDADMAC is provided in the risk assessment dossier included as **Attachment 3**. Results of the screening assessment are included in the dossier.

The assessment of toxicity of this chemical was used to develop initial screening criteria for human health exposure scenarios and is presented in **Attachment 3**. PolyDADMAC is not a carcinogen, and, as a result, only a non-carcinogenic oral reference dose (RfD) was calculated. A detailed discussion of the derivation of the oral RfD and drinking water guideline values is presented in the attachment. **Table 2** provides a summary of the derivation.

Table 2 Oral Reference Doses and Derived Drinking Water Guidelines

Constituent (CAS No.)	Study	Critical Effect/ Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (mg/L)
Cationic polymer[a]	6-month rat dietary study	None	2,000	600	3.3	12

[a] Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC] (CAS No. 26062-79-3).
CAS = Chemical Abstracts Service
mg/L = milligrams per litre
mg/kg-day = milligrams per litre-day
NOAEL = No observed adverse effect level
Refer to **Attachment 3** for information on the key studies selected for oral reference dose and drinking water level development.

[1] CAS RN - Chemical Abstracts Service Registry Number

For ecological receptors, the 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.

The determination of toxicological reference values (TRVs) was conducted according to the PNEC guidance in the *Environmental Risk Assessment Guidance Manual for Industrial Chemicals* prepared by the Australian Environmental Agency (AEA, 2009). PNECs for freshwater and sediment were developed to assess aquatic receptors, and PNECs for soil were developed for terrestrial receptors.

Table 3 present the chemical, the endpoint, no observable effects concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). A PNEC for soil was not calculated for the chemical. Refer to **Attachment 3** for the development of PNECs, or the rational for PNECs that do not have a calculated PNEC.

Table 3 PNECs Water

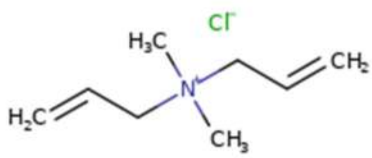
Constituents	Endpoint	EC_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
Cationic polymer[a]	Acute fish	6.5	50	0.13

[a] Identity unknown. Read-across to polydiallyldimethylammonium chloride polyDADMAC (CAS No. 26062-79-3).
EC_{50} = effects concentration – 50%
mg/L = milligrams per litre
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

A detailed assessment of the risks posed by this Tier 2 chemical is provided in the following sections.

General Overview

PolyDADMAC is a highly charged cationic homopolymer with high molecular weights; those used in water treatment may have molecular weights less than 500,000 daltons (Lyons and Vasconcellos, 1997). The molecular structure of polyDADMAC is presented in **Figure 1**.



(monomer shown)

Figure 1 Molecular Structure of PolyDADMAC[2]

Synthetic polymers are persistent in the environment. They are 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

[2] Source https://chem.nlm.nih.gov/chemidplus/rn/26062-79-3

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 and partitioning behaviour), polyDADMAC is not expected to bioaccumulate.

The PBT assessment for polyDADMAC is included in the dossier provided in **Attachment 3**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that polyDADMAC is not a PBT substance.

Human Health Hazards

There is a low concern for human health hazards. PolyDADMAC is not acutely toxic to humans by the oral route (LD_{50} > 5,000 mg/kg bw)[3]. Likewise, there are no adverse effects observed from repeated exposures through ingestion (lowest observed adverse effect level [LOAEL] of 1,000 milligrams per kilogram per day [mg/kg-day], a no observed adverse effect level [NOAEL] was not established).

Based on a review of repeated dose toxicity studies, TRVs were derived for polyDADMAC. The drinking water guideline value derived using the non-carcinogenic oral RfD is 12 mg/L (see **Table 2**). A detailed discussion of the drinking water guideline values is presented in **Attachment 3**.

The life cycle of chemicals, including polyDADMAC, used during the treatment of produced water at the WMF includes the following general categories: transportation of chemicals; beneficial reuse, which is post-treatment transfer (pipeline or trucking) and use of water; and, storage of brine post treatment. During the water treatment, water conveyance and beneficial reuse processes, there is the potential for human receptors to be exposed to water treatment chemicals. Based on an assessment of land use and an understanding of the project description provided in the Environmental Impact Statement (EIS) (URS, 2014) and the CRAF developed for the GFD Project Area, potential human receptors include:

1. Workers at the WMF including operators, maintenance staff and supervisors.
2. Agricultural workers/residents at irrigation areas.

Based on the treatment process described in **Attachment 2**, the cationic polymers would be bound to the solids present in the oily water and removed during clarification. As a result, this chemical would not be present in permeate, brine or treated water. Therefore, exposure pathways associated with the beneficial reuse of treated water and management of brine waste would be incomplete. Beneficial reuse of treated water includes project reuse (dust suppression, construction activities, drilling and completions), irrigation and stock watering.

In terms of risks associated with transport of chemicals and wastes, this risk is considered to be managed to a level as low as reasonably practicable. This is because the potential for a release is controlled through implementation of traffic management principles including use of designated trucking routes, vehicle signage, vehicle management systems (to manage speed and driving behaviour/habits) and in the unlikely event of a vehicular accident, implementation of incident and spill response procedures. Given the highly regulated nature of transportation of chemicals (at both a Commonwealth and State level), transport-related scenarios are not evaluated further in this

[3] LD50 = lethal dose of 50 percent of population; mg/kg bw – milligrams per kilogram body weight

assessment. However, the outcomes of the assessment should be used to inform emergency response actions.

Exposure of potential human receptors to polyDADMAC is possible via inadvertent spills and leaks. However, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion. In addition, Australia SafeWork Place and Santos Occupational Safety Guidance are used to minimise human health exposure. As a result, petroleum workers, are also excluded from assessment. No potentially complete exposure pathways were identified.

The management of chemicals and wastes is conducted using drums, totes and engineered tanks designed to contain the fluids. In the unlikely event of a release to ground, the potential for exposures (other than workers) is limited. The WMF is fenced and access is controlled, which limits access to the public. If water treatment chemicals are spilled to the ground then investigation, remediation and rehabilitation activities would be implemented to address soil impacts.

As a result, potential exposures during treatment activities are low due to the employment of mechanical equipment/processes, engineering controls (including secondary containment) and other mitigation and management strategies. Similarly, there is a low potential for human receptors exposed to surface water bodies that may receive runoff from beneficial reuse applications. Finally, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is very low.

PolyDADMAC is listed in Attachment B (Substances Considered Not To Require Control By Scheduling) of the *Standard for the Uniform Scheduling of Medicines and Poisons* (SUSMP) (Therapeutic Goods Administration [TGA], 2014). The reason given for the listing in Attachment B is 'Low Toxicity' and the area of use of the chemical is 'Water treatment' (NICNAS, 2017a). NICNAS identified polyDADMAC as a low concern for workers and the public under the operational scenarios assessed. Best practice chemical management was recommended to minimise worker and public exposure (NICNAS, 2017a).

Environmental Hazards

In standard acute aquatic toxicity tests, polyDADMAC, as a highly charged cationic polymer, is very toxic to aquatic life. PolyDADMAC will dissociate into polyammonium cations and chloride anions in the aquatic environment. Chloride ions are an essential constituent of electrolytes in all biological fluids responsible for maintaining acid/base balance, transmitting nerve impulses and regulating fluid in and out of cells (NCBI, 2015). The concentration of chloride ions is naturally regulated within organisms. Therefore, the toxicity of cationic polymers to fish is from the binding of the polyammonium cations in the polymer to the gill tissue, disrupting gill structure and function. Physical damage to fish gill by cationic polymers has been shown by Beisinger and Stokes (1986).

However, under environmental conditions, the toxicity of these polymers is mitigated by the presence of dissolved organic carbon (DOC) and suspended solids. Cationic polymers react with DOC in environmental waters to form insoluble complexes, which settle out of water and therefore are not bioavailable to cause toxic effects. It has previously been established that a reduction in likely toxicity by a factor of 110 is appropriate to apply to laboratory test results for cationic polymers with a high charge density to account for the mitigating effects of DOC on toxicity in natural environmental waters (Boethling and Nabholz, 1997). In addition, based on engineering and management controls outlined in the previous section, there is a low potential for ecological receptors exposed to surface water bodies that may receive runoff from an accidental release. As discussed earlier, exposure pathways associated with the beneficial reuse of treated water and management of brine waste would be incomplete.

These findings are consistent with an assessment completed by NICNAS in 2017. Based on an assessment of environmental hazards, NICNAS identified polyDADMAC as a chemical of low concern to the environment (NICNAS, 2017b). Chemicals of low concern are unlikely to have adverse environmental effects if they are released to the environment from coal seam gas operations.

References

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Attachment 1 Safety Data Sheet

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name	**MAK-MFC1**
Synonyms	MAK MFC1

1.2 Uses and uses advised against

Uses	WASTE WATER COAGULANT

1.3 Details of the supplier of the product

Supplier name	**MAK INDUSTRIAL WATER SOLUTIONS PTY LTD**
Address	2/24 Mercantile Way, Malaga, Western Australia, 6090, AUSTRALIA
Telephone	+61 8 9249 8007
Fax	+61 8 9249 8004
Email	service.wa@makwater.com.au
Website	http://makwater.com.au

1.4 Emergency telephone numbers

Emergency	+61 8 9249 8007

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

Physical Hazards

Not classified as a Physical Hazard

Health Hazards

Skin Corrosion/Irritation: Category 2
Serious Eye Damage / Eye Irritation: Category 2A

Environmental Hazards

Not classified as an Environmental Hazard

2.2 GHS Label elements

Signal word **WARNING**

Pictograms

Hazard statements

H315	Causes skin irritation.
H319	Causes serious eye irritation.

Prevention statements

P264	Wash thoroughly after handling.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Response statements

P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P321	Specific treatment is advised - see first aid instructions.
P332 + P337 + P313	If skin or eye irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before re-use.

Storage statements

None allocated.

Disposal statements

None allocated.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
PROPRIETARY INGREDIENT(S)	-	-	20 to 40%
ALUMINUM HYDROXYCHLORIDE	1324-41-9	-	40 to 60%
WATER	7732-18-5	231-791-2	20 to 60%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye	If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.
Inhalation	If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.
Skin	If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.
Ingestion	For advice, contact a Poisons Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.
First aid facilities	Eye wash facilities and safety shower are recommended.

4.2 Most important symptoms and effects, both acute and delayed

Irritating to the eyes and skin.

4.3 Immediate medical attention and special treatment needed

Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters

Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

6.4 Reference to other sections
See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities
Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills.

7.3 Specific end uses
No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters
Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls
Engineering controls Avoid inhalation. Use in well ventilated areas. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face	Wear splash-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Not required under normal conditions of use.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	CLEAR TO SLIGHTLY HAZY LIQUID
Odour	SLIGHT ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	100°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT RELEVANT
pH	3.5 to 4.0 (neat)

9.1 Information on basic physical and chemical properties

Vapour density	NOT AVAILABLE
Specific gravity	1.33 to 1.35
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

% Volatiles	50 %

10. STABILITY AND REACTIVITY

10.1 Reactivity

May evolve chlorine gas when in contact with very strong oxidising agents. There is some heat liberated when in contact with strong acids.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

Severe overheating may release hydrogen chloride gas and aluminium oxides once water has evaporated.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity	Acute oral exposure may result in irritation of the mouth, throat, oesophagus and gastrointestinal tract.
Skin	Contact may result in irritation, redness, rash and dermatitis.
Eye	Contact may result in irritation, lacrimation, pain and redness.
Sensitisation	Not classified as causing skin or respiratory sensitisation.
Mutagenicity	Not classified as a mutagen.
Carcinogenicity	Not classified as a carcinogen.
Reproductive	Not classified as a reproductive toxin.
STOT - single exposure	Over exposure may result in irritation of the nose and throat, coughing, dizziness, drowsiness and headache.
STOT - repeated exposure	Not classified as causing organ damage from repeated exposure. Adverse effects are generally associated with single exposure.
Aspiration	Not classified as causing aspiration.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Not a persistent pollutant; can cause coagulation of solids in aqueous suspension, especially when highly diluted by the water in which the solids are suspended. Aluminium compounds are common in most soils and are the principle components of Bauxite and Gibbsite, which are common, naturally occurring minerals. When diluted by copious quantities of water (for example, to the point that the concentration is less than about 100 grams per cubic meter), this product will hydrolyse rapidly to form aluminium hydroxide, which can be expected to become a part of the natural soil profile if not recovered. When not highly diluted with water, this product may be slow to hydrolyse and may form a mixture of partially soluble aluminium species and heavy floc of aluminium hydroxide. Until further diluted, this mixture could affect marine life by clogging sensitive respiratory mechanisms in a similar fashion to muds and clays and possibly by toxic effects that are not yet well understood.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal For small amounts, absorb with sand, vermiculite or similar and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information if disposing of large quantities (if required). Prevent contamination of drains and waterways as aquatic life may be threatened and environmental damage may result. This product can be neutralised with alkali to form a mixture of aluminium hydroxide and the chloride salt of the alkali. The resulting mixture is non-hazardous providing the resulting pH is between roughly 5 and 10.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None allocated.	None allocated.	None allocated.
14.2 Proper Shipping Name	None allocated.	None allocated.	None allocated.
14.3 Transport hazard class	None allocated.	None allocated.	None allocated.
14.4 Packing Group	None allocated.	None allocated.	None allocated.

14.5 Environmental hazards

No information provided.

14.6 Special precautions for user

Hazchem code None allocated.

Other information There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

Inventory listings

AUSTRALIA: AICS (Australian Inventory of Chemical Substances)
All components are listed on AICS, or are exempt.
UNITED STATES: TSCA (US Toxic Substances Control Act)
All components are listed on the TSCA inventory, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as form of product, method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: form of product; frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
EMS	Emergency Schedules (Emergency Procedures for Ships Carrying Dangerous Goods)
GHS	Globally Harmonized System
GTEPG	Group Text Emergency Procedure Guide
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

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[End of SDS]

Attachment 2 Vendor WMF Chemicals and Exposure Point Concentration

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

Product Name	Chemical Name	CAS Number	%	Proper Shipping Name	Supplier	Area	Transport		Onsite Storage		Operation		Annual Usage (ROP volumes based on peak rate of 10ML/d)
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration	
MAK MFC1 (multi floc coagulant)	Cationic Polymer	n/a	20-40%	MAK MFC1	MAK Water Industrial	Oily Water Treatment Plant	1000L IBC		2 x 1000L (IBC)		0.8mg/L (AVG)		
	Aluminium Hydroxychloride	1327-41-9	40-60%										
	Water	7732-18-5	20-60%										

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concern
IBC = intermediate bulk container
L = litres
mg/kg = milligrams per kilogram
mg/L = milligrams per litre
ML/d = millilitre per day
NA = not applicable
ROP = reverse osmosis process

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

Product Name	Chemical Name	CAS Number	Purpose / Function	Fate	Permeate Concentration (mg/L)	Permeate notes	COPC concentration in soil from release of permeate (mg/kg)	COPC concentration in soil from 20 years of irrigation mg/kg	Brine Concentration (mg/L)
MAK MFC1 (multi floc coagulant)	Cationic Polymer	n/a	polymer / coagulant	Removed with oily water sludge (solid waste)	NA	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA
	Aluminium Hydroxychloride	1327-41-9			NA	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA
	Water	7732-18-5			NA		NA	NA	NA

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concern
IBC = intermediate bulk container
L = litres
mg/kg = milligrams per kilogram
mg/L = milligrams per litre
ML/d = millilitre per day
NA = not applicable
ROP = reverse osmosis process

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

Product Name	Chemical Name	CAS Number	Brine Notes
MAK MFC1 (multi floc coagulant)	Cationic Polymer	n/a	The oily water is clarified to seperate solids and oils; then run through the RO system. Estimate 5% residual in brine, the balance is sludge.
	Aluminium Hydroxychloride	1327-41-9	The oily water is clarified to seperate solids and oils; then run through the RO system. Estimate 5% residual in brine, the balance is sludge. Estimate that chemical will dissociate to aluminium (Al) and Cl- at 40% Al and 55% Cl-.
	Water	7732-18-5	

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concern
IBC = intermediate bulk container
L = litres
mg/kg = milligrams per kilogram
mg/L = milligrams per litre
ML/d = millilitre per day
NA = not applicable
ROP = reverse osmosis process

Attachment 3 Risk Assessment Dossier

POLYDADMAC
[POLYDIALLYLDIMETHYLAMMONIUM CHLORIDE]

This dossier on polyDADMAC presents the most critical studies pertinent to the risk assessment of polyDADMAC in its use in water treatment systems. It does not represent an exhaustive or critical review of all available data. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – PolyDADMAC was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. PolyDADMAC was assessed as a tier 2 chemical for acute and chronic toxicity. Therefore, polyDADMAC is classified overall as a **tier 2** chemical and requires a hazard assessment and qualitative assessment of risk.

1. BACKGROUND

Polydiallyldimethylammonium chloride (polyDADMAC) are highly charged cationic polymers with high molecular weights. They are 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 acutely toxic to humans 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. The toxicity of these polymers is mitigated by the presence of dissolved organic carbon (DOC) and suspended solids. Cationic polymers react with DOC in environmental waters to form insoluble complexes, which settle out of water and therefore are not bioavailable to cause toxic effects.

2. CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): 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-diallyammonium chloride; polyquaternium-6

3. PHYSICO-CHEMICAL PROPERTIES

PolyDADMAC are highly charged cationic homopolymers with high molecular weights; those used in water treatment may have molecular weights less than 500,000 daltons (Lyons and Vasconcellos, 1997).

Limited information is available on the physico-chemical properties of polyDADMAC. The information contained in Table 1 is based on diallyldimethylammonium chloride (DADMAC) (CAS No. 7398-69-8). PolyDADMAC is a homopolymer of DADMAC.

Table 1 Overview of the Physico-chemical Properties of DADMAC

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Liquid	-	ECHA
Melting Point/Freezing Point	-25 °C @ 101.3 kPa	1	ECHA
Boiling Point	118 °C @ 101.3 kPa	1	ECHA
Density	1,030 – 1,050 kg/m^3 @ 25°C	1	ECHA
Partition Coefficient (log K_{ow})	Estimated to be -2.49 @ 20°C using KOWWIN	2	ECHA
Water Solubility	Estimated to be 1,000 g/L @ 25°C	2	ECHA

4. DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. PolyDADMAC is also listed in Appendix B (Substances Considered Not To Require Control By Scheduling) of the *Standard for the Uniform Scheduling of Medicines and Poisons* (SUSMP) (Therapeutic Goods Administration [TGA], 2014). The reason given for listing in Appendix B is 'Low Toxicity' and the area of use of the chemical is 'Water treatment' (NICNAS, 2017a). No other specific environmental regulatory controls or concerns were identified within Australia and internationally for polyDADMAC.

Table 2 Existing International Controls

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

5. ENVIRONMENTAL FATE SUMMARY

A. Summary

PolyDADMAC are highly charged cationic polymers with high molecular weights. They are 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).

PolyDADMAC will dissociate into polyammonium cations and chloride anions in the aquatic environment. Chloride ions are an essential constituent of electrolytes in all biological fluids responsible for maintaining acid/base balance, transmitting nerve impulses and regulating fluid in and out of cells (NCBI, 2015). The concentration of chloride ions is naturally regulated within organisms. Therefore, consistent with NICNAS (NICNAS, 2017b), this discussion is focused on the environmental fate and effects of the synthetic polyammonium cations.

B. Biodegradation

Due to its physical properties (i.e., molecular size), polyDADMAC is expected to be poorly degraded. This finding is consistent with DADMAC which is not readily biodegradable according to the OECD criteria (ECHA). [Kl. score = 1]

C. Bioaccumulation

Due to its physical properties (*i.e.*, molecular size), polyDADMAC is not expected to bioaccumulate.

6. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

PolyDADMAC is not acutely 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 LD50 in rats is >5,000 mg/kg (USEPA, 2016a).

C. Irritation

No studies were located.

D. Sensitisation

No studies were located.

E. Repeated Dose Toxicity

<u>Oral</u>

Male and female Sprague Dawley (SD) rats were fed 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 >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 LOAEL for this study is 1,000 mg/kg-day based on reduced body weights and body weight gain; a NOAEL was not established (USEPA, 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.

I. 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).

Non-Cancer

PolyDADMAC was tested in a six-month rat feeding study. No target organs were identified, and a NOAEL was not established. The LOAEL was 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)

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

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 2

Oral RfD = 2,000/(10 x 10 x 1 x 3 x 2) = 2,000/600 = 3.3 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 = (3.3 x 70 x 0.1)/2 = 12 mg/L

Cancer

No carcinogenicity studies were located; thus, a cancer reference value was not derived.

J. Human Health Hazard Assessment of Physico-Chemical Properties

PolyDADMAC does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

7. ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

PolyDADMAC exhibits a moderate toxicity concern to aquatic organisms. However, under environmental conditions, the toxicity of these polymers is mitigated by the presence of DOC and suspended solids. Cationic polymers react with DOC in environmental waters to form insoluble complexes, which settle out of water and therefore are not bioavailable to cause toxic effects. It has previously been established that a reduction in likely toxicity by a factor of 110 is appropriate to apply to laboratory test results for cationic polymers with a high charge density to account for the mitigating effects of DOC on toxicity in natural environmental waters (Boethling and Nabholz, 1997).

B. Aquatic Toxicity

Acute Studies

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

Table 3 Acute Aquatic Toxicity Studies on polyDADMAC

Test Species	Endpoint	Results (mg/L)	Reference
Bluegill	96-hour LC_{50}	0.9	USEPA, 2016c
Bluegill	96-hour LC_{50}	0.32	USEPA, 2016d
Rainbow trout	96-hour LC_{50}	0.32	USEPA, 2016d
Rainbow trout	96-hour LC_{50}	0.42	USEPA, 2016e
Rainbow trout	96-hour LC_{50}	0.77	USEPA, 2016f
Fathead minnow	96-hour LC_{50}	0.3	USEPA, 2016g
Fathead minnow	96-hour LC_{50}	6.51*	USEPA, 2016g
Fathead minnow	96-hour LC_{50}	0.46	Cary et al., (1987)
Fathead minnow	96-hour LC_{50}	6.5***	Cary et al., (1987)
Daphnia magna	48-hour EC_{50}	0.23	USEPA, 2016g
Daphnia magna	48-hour EC_{50}	11.8**	USEPA, 2016g
Daphnia magna	48-hour EC_{50}	0.33	USEPA, 2016h
Daphnia magna	48-hour EC_{50}	0.2	Cary et al., (1987)
Daphnia magna	48-hour EC_{50}	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 magna*. 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 Biesinger and Stokes (1986).

The presence of dissolved organic carbon and suspended solids is known to significantly mitigate the toxicity of cationic polymers under typical environmental exposure conditions (Boethling and Nabholz, 1997). Table 3 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 EC_{50} 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 EC_{50} 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-hour TL_{50} 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 EC_{50} values are available for fish (0.2 mg/L) and *Daphnia magna* (0.3 mg/L) in standard laboratory water; and for fish (6.5 mg/L) and *Daphnia magna* (11.8 mg/L) in standard laboratory water with the addition of humic acid or TOC. The PNEC water will be based on the EC_{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. 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 EC_{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 be estimated 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 be estimated using QSAR models because of the high molecular weight of polyDADMAC. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$.

8. CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; 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 EC_{50} values of fish and *Daphnia magna* for acute toxicity tests conducted with humic acid or TOC in dilution water were >1 mg/L. Thus, polyDADMAC does not meet the screening criteria for toxicity.

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

B. Other Characteristics of Concern

No other characteristics of concern were identified for polyDADMAC.

9. SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment [1]	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required[3]
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity [2]	Chronic Toxicity[2]	
PolyDADMAC	26062-79-3	Not a PBT	No	No	Yes	No	No	No	2	2	2

Footnotes:

1 - PBT Assessment based on PBT Framework.

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

3 - Tier 2 - Hazard Assessment and Qualitative Assessment Only. Develop toxicological profile and PNECs for water and soil and provide qualitative discussion of risk.

Notes:

PBT = Persistent, Bioaccumulative and Toxic
B = bioaccumulative
P = persistent
T = toxic

10. REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

ADWG	Australian Drinking Water Guidelines
AICS	Australian Inventory of Chemical Substances
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
DOC	dissolved organic carbon
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
kg/m^3	kilogram per cubic metre
kg	kilogram
Kl	Klimisch scoring system
KOWWIN	USEPA program to estimate the organic carbon-normalized sorption coefficient for soil and sediment
kPa	kilopascal
LC	lethal concentration
LD	lethal dose
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
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
PNEC	Predicted No Effect Concentration
QSAR	quantitative structure activity relationship
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SD	Sprague Dawley

SGG	Synthetic Greenhouse Gases
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
TGA	Therapeutic Good Administration
TL_{50}	time required for 50% of inoculated population to die
TOC	total organic carbon
USEPA	United States Environmental Protection Agency