Qualitative and Quantitative Tier 3 Assessment

Dialuminium Chloride Pentahydroxide

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

Background

Dialuminium chloride pentahydroxide (also known as aluminium chlorohydrate) is a component in a Water Management Facility (WMF) product (Aluminium Chlorohydrate 50%) 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 – Tier 3 Chemicals

Proprietary Name	Chemical Name	CAS No.	Use	Approximate Quantity Stored On-Site (plant available storage)
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate Water	12042-91-0 7732-18-5	Coagulant	20000 L

CAS No = Chemical Abstracts Service Number
L = litre

The assessment of toxicity of this chemical was used to evaluate human health exposure scenarios and is presented in **Attachment 3**. Since an Australian Drinking Water Guideline (ADWG) Value is available (see **Table 2**), toxicological reference values (TRVs) were not derived for the chemical. A detailed discussion of the drinking water guideline values is presented in **Attachment 3**.

Table 2 Australian Drinking Water Screening Values

Constituent (CAS No.)	Drinking Water Screening Guideline	Drinking Water Screening Value
Aluminium chlorohydrate (12042-91-0)	Aluminium; chloride	0.2 mg/L (aesthetics); 250 mg/L (aesthetics)

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

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

The determination of 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 are developed to assess aquatic receptors, and PNECs for soil are 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 – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
Aluminium chlorohydrate (12042-91-0)	-	-	-	0.0008[a]

[a] PNECwater for aluminium chlorohydrate is the Water Quality Guideline – Freshwater Trigger Value for aluminium (ANZECC & ARMCANZ, 2000)..
EC_{50} = effects concentration – 50%
mg/L = milligram per litre
NOEC = no observed 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 3 chemical is provided in the following sections.

General Overview

Polyaluminium coagulants, which have been developed for water treatment applications, have the general formula $(Al_n(OH)_mCl(3_{n-m})_x)$. The length of the polymerised chain, molecular weight, and the number of ionic charges is determined by the degree of polymerisation (Gebbie, 2001). The molecular structure of dialuminium chloride pentahydroxide (n=2; m=5) is presented in **Figure 1.**

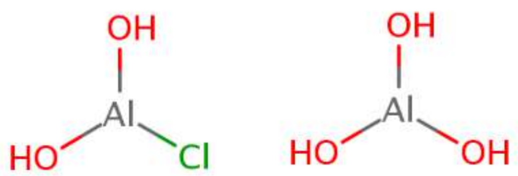

Figure 1 Molecular Structure of Dialuminium Chloride Pentahyroxide[1]

[1] Source https://comptox.epa.gov/dashboard/dsstoxdb/results?search=DTXSID0051609

Dialuminium chloride pentahydroxide is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to dialuminium chloride pentahydroxide. Both chloride ions and aluminium hydroxide ionic species can be found naturally in the environment. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter.

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). Chloride ions are essential to all living organisms, and their intracellular and extracellular concentrations are actively regulated. Thus, dialuminium chloride pentahydroxide is not expected to bioaccumulate in aquatic organisms.

The Persistent, Bioaccumulative and Toxic (PBT) assessment for dialuminium chloride pentahydroxide is included in the dossier provided in **Attachment 3**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that dialuminium chloride pentahydroxide is not a PBT substance.

Human Health Hazards

Dialuminium chloride pentahydroxide 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 milligrams per kilogram day (mg/kg-day) aluminium hydroxychloride (a structurally similar compound) in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Dialuminium chloride pentahydroxide is not genotoxic.

Toxicological reference values were not derived for dialuminium chloride pentahydroxide. The ADWG values for aluminium (acid-soluble) is 0.2 milligrams per litre (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 ADWG value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

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, 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**, dialuminium chloride pentahydroxide is removed with Actiflo sludge (solid waste) during water treatment. As a result, this chemical is not directed to the permeate or brine waste streams and 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 assessment. However, the outcome of the assessment should be used to inform emergency response actions.

Exposure of workers to dialuminium chloride pentahydroxide 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.

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.

Exposure of potential receptors (other than workers) is also possible to residual chemicals in areas adjacent to a well lease that have been used for the application of materials for beneficial reuse. However, Environmental Authority (EA) or Beneficial Use Approval conditions regulate project reuse. A plan for the beneficial reuse of materials has been developed by a Suitably Qualified Person (SQP) in accordance with the EA conditions which require materials of a certain quality and controls the maximum volumes that can be applied to land. In addition, the application techniques and location of application are controlled with specific monitoring required. Irrigation areas are designed to manage the risk of pooling and runoff with a general deficit irrigation strategy employed; and, are fitted with monitoring bores to manage the risk of vertical and horizontal migration.

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.

Environmental Hazards

In the aquatic environment, aluminium compound toxicity is intimately related to ambient pH; changes in ambient acidity may affect aluminium compound solubility, dissolved aluminium compound speciation and organism sensitivity to aluminium compounds. In acute toxicity tests, the pH significantly alters the speciation and therefore bioavailability of the aluminium such that acutely toxic concentrations occur below a pH of 6 but that above 6 the bioavailable concentration necessary to achieve immobilisation in an acute study cannot be achieved.

Toxicity testing on a similar aluminium salt compound (sulfuric acid, aluminium salt (3:2), octadecahydrate [CAS No. 7784-31-8]) identified a low toxicity concern for terrestrial invertebrates.

In developing a water quality guideline for aluminium (ANZECC & ARMCANZ, 2000), the screened freshwater toxicity data were separated into those conducted at pH >6.5 and those at pH <6.5. The guideline for freshwater with a pH > 6.5 is 55 micrograms per litre (µg/L). This is identified as a moderate reliability trigger level. A freshwater low-reliability trigger value of 0.8 µg/L was derived for a pH < 6.5. This low-reliability value should only be used as an indicative interim working level.

No experimental toxicity data on sediment or soil organisms are available. Octanol/water partition coefficient (K_{ow}) and organic carbon-water partition coefficient (K_{oc}) parameters do not readily apply to inorganics, such as dialuminium chloride pentahydroxide. Thus, the equilibrium partitioning method cannot be used to calculate PNECs for soil or sediment. Based on its properties, dialuminium chloride pentahydroxide is not expected to significantly adsorb to soil or sediment, and the assessment of these compartments is covered by the aquatic assessment.

During water treatment, water conveyance and beneficial reuse processes, there is the potential for environmental receptors to be exposed to water treatment chemicals such as dialuminium chloride pentahydroxide. Pipelines (where treated water is conveyed) can transect sensitive ecological areas (including Matters of National Environmental Significance [MNES]). At the WMF, the potential for exposure of sensitive receptors (including MNES) is considered low as these facilities are existing and are operational industrial facilities (and thereby provide no habitat value). The industrial activities and operation of equipment do not make it a setting conducive to incursion of fauna. For instance, the WMF is fenced and access is controlled, which precludes entry by livestock.

Based on the engineering and management controls described in the previous section (Human Health Hazards), 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.

Risk Characterisation

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

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

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

Release Scenario Assessment

As previously noted, dialuminium chloride pentahydroxide is not directed to the permeate or brine waste streams and would not be present in permeate, brine or treated water. Therefore, EPCs were not developed for permeate beneficial use scenarios; and likewise, further quantitative analysis (i.e., calculation of hazards) for permeate beneficial reuse via direct contact by agricultural workers, residents and non-MNES (mammals and avian receptors) was not conducted.

Cumulative Impacts

The potential for cumulative impacts associated with chemicals proposed for this project is limited based on the distance between well pad sites where the chemicals are being used. Modelling has demonstrated that the migration of drilling chemicals is limited in the subsurface with no potential to interact with those from other wells and hydraulic fracturing chemicals are contained within the target units. Residual chemicals may be entrained within produced water and subsequently transported for water treatment at a WMF. However, these chemicals are removed by the treatment systems; and, therefore, no additional risk is provided during beneficial reuse, including irrigation. Likewise, the presence of water treatment chemicals at the point of produced water storage or during beneficial reuse also poses no significant increase in risk.

Only Tier 3 chemicals which trigger persistence and bioacummulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted earlier and discussed in detail in the dossier (**Attachment 3**), dialuminium chloride pentahydroxide does not meet the criteria for persistence or bioaccumulation. Thus, there is negligible incremental risk posed by the use of this Tier 3 chemical and the existing (and proposed) management and monitoring controls are appropriate to ensure that the risk to MNES (and non MNES) receptors remains low.

Uncertainty Analysis

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

The discussion detailed in **Table 4** provides an evaluation of uncertainty for this Tier 3 assessment, including elements previously discussed within this assessment.

Table 4 Evaluation of Uncertainty – Dialuminium Chloride Pentahydroxide

Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment – Chemical additive COPC concentrations	The concentrations of COPCs in the water treatment process were estimated based on previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with Santos occurred to identify a conservative estimate of the COPC; however, there is the potential that the empirical concentrations would differ than those presented in the risk assessment.	Low	This assumption may overestimate or underestimate the calculated risks to receptors, dependent on-site-specific conditions.
Hazard Assessment – Chemical additive COPC concentrations	Concentrations of COPCs evaluated in the quantitative risk assessment were assumed to be 100 percent of mass used in the water treatment process. This is a conservative assumption for chemicals that may degrade rapidly or volatilise.	Medium	This assumption may overestimate the calculated risks to receptors.
Toxicity Assessment	The absence of terrestrial toxicity data and the lack of a Koc value to calculate a PNEC in soil or sediment.	Medium	Medium to high potential to underestimate risks.

References

Australian Environmental Agency (AEA). (2009). Environmental Risk Assessment Guidance Manual for Industrial Chemicals, Commonwealth of Australia.

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 August 2018.

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 and Energy (DoEE). (2017). Exposure draft: Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction. Commonwealth of Australia, available at http://www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

Gebbie, P. (2001). Using Polyaluminium coagulants in water treatment, 64th Annual Water Industry Engineers and Operator's Conference. Available at: http://wioa.org.au/conference_papers/2001/pdf/paper6.pdf

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.

URS. (2014). Santos GLNG Project: Gas Field Development Project Environmental Impact Statement. Available online at: http://www.santosglng.com/environment-and-water/gas-field-development-project-eis.aspx

Attachment 1 Safety Data Sheet

1. IDENTIFICATION

Product Name	**Aluminium Chlorohydrate Liquid - Water Treatment Grade**
Other Names	ALUMINIUM CHLORIDE, BASIC; Aluminium hydroxy chlorosulphate; Aluminium hydroxychloride; Polyaluminium chlorosulphate
Uses	No Data Available
Chemical Family	No Data Available
Chemical Formula	No Data Available
Chemical Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Product Description	No Data Available

Contact Details of the Supplier of this Safety Data Sheet

Organisation	Location	Telephone
Redox Pty Ltd	2 Swettenham Road Minto NSW 2566 Australia	+61-2-97333000
Redox Pty Ltd	11 Mayo Road Wiri Auckland 2104 New Zealand	+64-9-2506222
Redox Inc.	2132A E. Dominguez Street Carson CA 90810 USA	+1-424-675-3200
Redox Chemicals Sdn Bhd	No. 8, Block G, Ground Floor, Taipan 2 Jalan PJU 1A/3 Ara Damansara 47301, Petaling Jaya, Selangor, Malaysia	+60-3-7843-6833

Emergency Contact Details

For emergencies only; DO NOT contact these companies for general product advice.

Organisation	Location	Telephone
Poisons Information Centre	Westmead NSW	1800-251525 131126
Chemcall	Australia	1800-127406 +64-4-9179888
Chemcall	Malaysia	+64-4-9179888
Chemcall	New Zealand	0800-243622 +64-4-9179888
National Poisons Centre	New Zealand	0800-764766
CHEMTREC	USA & Canada	1-800-424-9300 CN723420 +1-703-527-3887

2. HAZARD IDENTIFICATION

Poisons Schedule (Aust) Not scheduled

Globally Harmonised System

Hazard Classification Hazardous according to the criteria of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS)

Hazard Categories		Serious Eye Damage/Irritation - Category 1 Corrosive to Metals - Category 1	
Pictograms			
Signal Word		Danger	
Hazard Statements		**H290**	May be corrosive to metals.
		H318	Causes serious eye damage.
Precautionary Statements	Prevention	**P234**	Keep only in original container.
		P280	Wear protective gloves/protective clothing.
	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.
	Storage	**P406**	Store in corrosive resistant container with a resistant inner liner.

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification — NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Entity	Formula	CAS Number	Proportion
Water	No Data Available	7732-18-5	50.00 - 52.00 %
Aluminium chlorohydrate	No Data Available	1327-41-9	48.00 - 50.00 %

4. FIRST AID MEASURES

Description of necessary measures according to routes of exposure

Swallowed	Rinse mouth with water. Give water to drink. Do NOT induce vomiting. Neutralization may be accomplished by using aluminum hydroxide gel or milk of magnesia. Seek medical attention.
Eye	Immediately flush eyes with plenty of water for 15 minutes, holding eyelids open. In all cases of eye contamination, it is a sensible precaution to seek medical advice.
Skin	Remove contaminated clothing. Flush affected area with plenty of water. If irritation persists, seek medical attention
Inhaled	Remove victim from exposure to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Seek medical attention if effects persist.
Advice to Doctor	Treat symptomatically based on judgement of doctor and individual reactions of patient.
Medical Conditions Aggravated by Exposure	No information available on medical conditions aggravated by exposure to this product.

5. FIRE FIGHTING MEASURES

General Measures	If safe to do so, remove containers from the path of fire.
Flammability Conditions	Non-flammable liquid.
Extinguishing Media	In case of fire, use appropriate extinguishing media most suitable for surrounding fire conditions.
Fire and Explosion Hazard	Non-Combustible.
Hazardous Products of Combustion	If mix with Sodium Hypochlorite (NaOCl) can produce toxic chlorine gas.
Special Fire Fighting Instructions	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.
Personal Protective Equipment	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) or chemical splash suit.
Flash Point	No Data Available
Lower Explosion Limit	No Data Available
Upper Explosion Limit	No Data Available
Auto Ignition Temperature	No Data Available
Hazchem Code	No Data Available

6. ACCIDENTAL RELEASE MEASURES

General Response Procedure	Eliminate all sources of ignition. Increase ventilation. Avoid walking through spilled product as it may be slippery. Use clean, non-sparking tools and equipment.
Clean Up Procedures	Soak up spilled product using absorbent non-combustible material such as sand or soil. Avoid using sawdust or cellulose. When saturated, collect the material and transfer to a suitable, labelled chemical waste container and dispose of promptly.
Containment	Stop leak if safe to do so.
Decontamination	Neutralize with slake lime, soda ash or calcium carbonate. Wash affected area with water.
Environmental Precautionary Measures	Do not allow product to reach drains, sewers or waterways. If product does enter a waterway, advise the Environmental Protection Authority or your local Waste Authority.
Evacuation Criteria	Clear area of all unprotected personnel
Personal Precautionary Measures	Personnel involved in the clean up should wear full protective clothing as listed in section 8.

7. HANDLING AND STORAGE

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 fumes. The usual precaution for handling with acidity chemical should be observed. Transfer: Use feeding pump with non-acid property.
Storage	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. In a storage tank lined with non corrosive material. This product is not classified dangerous for transport according to The Australian Code for the Transport of Dangerous Goods By Road and Rail.
Container	Store in original packaging as approved by manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

General	No exposure standard has been established for this product by the Australian Safety and Compensation Council (ASCC). NOTE: The exposure value at the TWA is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week. These 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 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
Exposure Limits	No Data Available
Biological Limits	No information available on biological limit values for this product.
Engineering Measures	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 Equipment	RESPIRATOR: No respirator generally required (AS1715/1716). EYES: Chemical safety goggles (AS1336/1337). HANDS: Protective gloves (AS2161). CLOTHING: Long-sleeved protective clothing and rubber boots (AS3765/2210).
Work Hygienic Practices	Avoid contact with eyes and skin. Avoid prolonged or repeated exposure. Always wash hands before smoking, eating, drinking or using the toilet.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Clear to Slightly Hazy Liquid
Odour	No Data Available
Colour	Clear to Slightly Hazy
pH	3.5 - 5.0
Vapour Pressure	No Data Available
Relative Vapour Density	No Data Available
Boiling Point	No Data Available
Melting Point	No Data Available
Freezing Point	No Data Available
Solubility	Very soluble
Specific Gravity	No Data Available
Flash Point	No Data Available
Auto Ignition Temp	No Data Available
Evaporation Rate	No Data Available
Bulk Density	No Data Available
Corrosion Rate	No Data Available
Decomposition Temperature	No Data Available
Density	No Data Available
Specific Heat	No Data Available
Molecular Weight	No Data Available
Net Propellant Weight	No Data Available
Octanol Water Coefficient	No Data Available
Particle Size	No Data Available
Partition Coefficient	No Data Available
Saturated Vapour Concentration	No Data Available
Vapour Temperature	No Data Available
Viscosity	No Data Available
Volatile Percent	No Data Available
VOC Volume	No Data Available
Additional Characteristics	Un-ignitable, incombustible, non-oxidative, non-self reactive and inactive liquid of extreme stability.
Potential for Dust Explosion	Product is a liquid.
Fast or Intensely Burning Characteristics	No Data Available
Flame Propagation or Burning Rate of Solid Materials	No Data Available

Non-Flammables That Could Contribute Unusual Hazards to a Fire	No Data Available
Properties That May Initiate or Contribute to Fire Intensity	No Data Available
Reactions That Release Gases or Vapours	No Data Available
Release of Invisible Flammable Vapours and Gases	No Data Available

10. STABILITY AND REACTIVITY

General Information	Non-combustible liquid
Chemical Stability	tends to gradually hydrolyze to a white turbid solution and lose the effectiveness, when it is kept long as diluted solution of less than 3% Aluminium oxide.
Conditions to Avoid	None known.
Materials to Avoid	Strong bases, such as Sodium Hydroxide (NaOH), Calcium carbonate ($CaCO_3$), Sodium Hypochlorite (NaOCl).
Hazardous Decomposition Products	If mix with Sodium Hypochlorite (NaOCl) can produce toxic chlorine gas.
Hazardous Polymerisation	Has not been reported.

11. TOXICOLOGICAL INFORMATION

General Information	Acute oral toxicity: LD50 oral, rat > 12.79 gm/kg
EyeIrritant	May cause serious eye damage.
Inhalation	Irritating to respiratory system.
Carcinogen Category	No Data Available

12. ECOLOGICAL INFORMATION

Ecotoxicity	The chemical is decomposed into aluminum hydroxide ($Al(OH)_3$) and hydrochloric acid (HCl) by hydrolysis.
Persistence/Degradability	No Data Available
Mobility	No Data Available
Environmental Fate	No Data Available
Bioaccumulation Potential	No Data Available
Environmental Impact	No Data Available

13. DISPOSAL CONSIDERATIONS

General Information	If utilisation or recycling of the product is not possible, it should be disposed 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. Dispose of the chemical after neutralization with a chemical like slake lime, calcium carbonate or soda ash.
Special Precautions for Land Fill	Contact a specialist disposal company or the local waste regulator for advice. Incinerate at an approved site following all local regulations. This material may be suitable for approved landfill.

14. TRANSPORT INFORMATION

Land Transport (Australia)
ADG

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (Malaysia)
ADR Code

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (New Zealand)
NZS5433

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (United States of America)
US DOT

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Sea Transport
IMDG

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available
EMS	No Data Available
Marine Pollutant	No

Air Transport
IATA

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

15. REGULATORY INFORMATION

General Information	No Data Available
Poisons Schedule (Aust)	Not scheduled

Environmental Protection Authority (New Zealand)
Hazardous Substances and New Organisms Amendment Act 2015

Approval Code	Not Assessed

National/Regional Inventories

Australia (AICS)	Listed
Canada (DSL)	Not Determined
Canada (NDSL)	Not Determined
China (IECSC)	Not Determined
Europe (EINECS)	Not Determined
Europe (REACh)	Not Determined
Japan (ENCS/METI)	Not Determined

Korea (KECI)	Not Determined
Malaysia (EHS Register)	Not Determined
New Zealand (NZIoC)	Not Determined
Philippines (PICCS)	Not Determined
Switzerland (Giftliste 1)	Not Determined
Switzerland (Inventory of Notified Substances)	Not Determined
Taiwan (NCSR)	Not Determined
USA (TSCA)	Not Determined

16. OTHER INFORMATION

Related Product Codes
ALCHHY5000, ALCHHY5100, ALCHHY5200, ALCHHY5500, ALCHHY8000, ALCHHY9000, ALCHHY4000, ALCHHY3100, ALCHHY3110, ALCHHY3130, ALCHHY3200, ALCHHY3115

Revision
1

Revision Date
17 Jul 2014

Key/Legend

< Less Than
> Greater Than
AICS Australian Inventory of Chemical Substances
atm Atmosphere
CAS Chemical Abstracts Service (Registry Number)
cm² Square Centimetres
CO2 Carbon Dioxide
COD Chemical Oxygen Demand
deg C (°C) Degrees Celcius
EPA (New Zealand) Environmental Protection Authority of New Zealand
deg F (°F) Degrees Farenheit
g Grams
g/cm³ Grams per Cubic Centimetre
g/l Grams per Litre
HSNO Hazardous Substance and New Organism
IDLH Immediately Dangerous to Life and Health
immiscible Liquids are insoluable in each other.
inHg Inch of Mercury
inH2O Inch of Water
K Kelvin
kg Kilogram
kg/m³ Kilograms per Cubic Metre
lb Pound
LC50 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.
LD50 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.
ltr or **L** Litre
m³ Cubic Metre
mbar Millibar
mg Milligram
mg/24H Milligrams per 24 Hours
mg/kg Milligrams per Kilogram
mg/m³ Milligrams per Cubic Metre
Misc or **Miscible** Liquids form one homogeneous liquid phase regardless of the amount of either component present.
mm Millimetre
mmH2O Millimetres of Water
mPa.s Millipascals per Second
N/A Not Applicable
NIOSH National Institute for Occupational Safety and Health
NOHSC National Occupational Heath and Safety Commission
OECD Organisation for Economic Co-operation and Development
Oz Ounce
PEL Permissible Exposure Limit

Pa Pascal
ppb Parts per Billion
ppm Parts per Million
ppm/2h Parts per Million per 2 Hours
ppm/6h Parts per Million per 6 Hours
psi Pounds per Square Inch
R Rankine
RCP Reciprocal Calculation Procedure
STEL Short Term Exposure Limit
TLV Threshold Limit Value
tne Tonne
TWA Time Weighted Average
ug/24H Micrograms per 24 Hours
UN United Nations
wt Weight

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)	Purpose / Function
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration		
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate Water	12042-91-0 7732-18-5	48-50% 50-52%	Aluminium Chlorohydrate	REDOX	Reverse Osmosis	10000L	50%	20000L	50%	13-17L/hour	50%	150000L	coagulant

CAS = Chemical Abstracts Service
COPC = constituent of potential concern
L = litres
L/hour = litre per hour
mg/kg = milograms per kilogram
mg/L = milligrams per litre
ML/d = millillitre 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	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)
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate	12042-91-0	Removed with Actiflo sludge (solid waste)	NA	This product is not directed to the permeate stream.	NA	NA	NA
	Water	7732-18-5		NA	This product is not directed to the permeate stream.	NA	NA	NA

CAS = Chemical Abstracts Service
COPC = constituent of potential concern
L = litres
L/hour = litre per hour
mg/kg = milograms per kilogram
mg/L = milligrams per litre
ML/d = millillitre 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
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate	12042-91-0	This product not directed to brine dams.
	Water	7732-18-5	This product not directed to brine dams.

CAS = Chemical Abstracts Service
COPC = constituent of potential concern
L = litres
L/hour = litre per hour
mg/kg = milograms per kilogram
mg/L = milligrams per litre
ML/d = millillitre per day
NA = not applicable
ROP = reverse osmosis process

Attachment 3 Risk Assessment Dossier

DIALUMINIUM CHLORIDE PENTAHYDROXIDE

This dossier on dialuminium chloride pentahydroxide presents the most critical studies pertinent to the risk assessment of dialuminium chloride pentahydroxide in water treatment systems. It does not represent an exhaustive or critical review of all available data. 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).

Screening Assessment Conclusion – Dialuminium chloride pentahydroxide was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. Dialuminium chloride pentahydroxide was assessed as a tier 3 chemical for acute toxicity and as a tier 1 chemical for chronic toxicity. Therefore, dialuminium chloride pentahydroxide is classified overall as a **tier 3** chemical and requires a quantitative risk assessment for end uses.

1 BACKGROUND

Dialuminium chloride pentahydroxide is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to dialuminium chloride pentahydroxide. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Dialuminium chloride pentahydroxide is not expected to bioaccumulate in aquatic organisms. Dialuminium chloride pentahydroxide 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 hydroxychloride (a structurally similar compound) in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Dialuminium chloride pentahydroxide is not genotoxic. The Australian drinking water guideline (ADWG) 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 (ANZECC & ARMCANZ, 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.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Dialuminium chloride pentahydroxide

CAS RN: 12042-91-0

Molecular formula: $Al_2ClH_5O_5$; general formula $Al(OH)_x(Cl)_{(3-x)}$ with x between 2.3 and 2.6

Molecular weight: 174.45

Synonyms: Dialuminium chloride pentahydroxide; dialuminium chloride pentahydroxide; aluminium chlorohydroxide; aluminium hydroxychloride dehydrate; aluminium chloride hydroxide, dihydrate

3 PHYSICO-CHEMICAL PROPERTIES

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

Table 1 Overview of the Physico-chemical Properties of Dialuminium Chloride Pentahydroxide

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^3 @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	-	-	-
Water Solubility	>1,000 g/L @ 20°C (sample pH was 3.3)	1	ECHA
Auto flammability	Not auto flammable.	1	ECHA

Polyaluminium coagulants, which have been developed for water treatment applications, have the general formula $(Al_n(OH)_mCl_{(3n-m)})_x$. The length of the polymerised chain, molecular weight, and the number of ionic charges is determined by the degree of polymerisation. The polyaluminium coagulants include polyaluminium chloride (n=2; m=3), dialuminium chloride pentahydroxide (n=2; m=5), and polydialuminium chloride pentahydroxide (similar to dialuminium chloride pentahydroxide) (Gebbie, 2001).

On hydrolysis, various mono- and polymeric species are formed, with an important cation being $Al_{13}O_4(OH)_{24}^{7+}$. A less predominant species is $Al_8(OH)_{20}^{4+}$.

Depending on the pH, the following reaction takes place (Gebbie, 2005):

$$Al_2(OH)_5Cl \rightarrow Al_2(OH)_5^+ + Cl^- + H_2O \rightarrow 2Al(OH)_3 + H^+ + Cl^-$$

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, 2005).

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

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

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

Dialuminium chloride pentahydroxide is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to dialuminium chloride pentahydroxide. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Dialuminium chloride pentahydroxide is not expected to bioaccumulate in aquatic organisms.

B. Biodegradation

Biodegradation is not applicable to dialuminium chloride pentahydroxide.

C. 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.

6 HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Dialuminium chloride pentahydroxide 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 hydroxychloride (a structurally similar compound) in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Dialuminium chloride pentahydroxide is not genotoxic.

B. Acute Toxicity

No oral acute toxicity studies are available for dialuminium chloride pentahydroxide. The oral LD_{50} of aluminium hydroxychloride in rats is >2,000 mg/kg (ECHA) [Kl. score = 2].

The dermal LD_{50} of dialuminium chloride pentahydroxide in rats is >2,000 mg/kg (ECHA) [Kl. score = 2].

C. Irritation

No skin irritation studies are available for dialuminium chloride pentahydroxide. Application of 0.5 mL of aluminium hydroxychloride to the skin of rabbits for 4 hours under semi-occlusive conditions was not irritating. The mean of the 24, 48 and 72 hour scores were zero for both erythema and edema (ECHA). [Kl. score = 1]

Dialuminium chloride pentahydroxide 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. Sensitisation

Dialuminium chloride pentahydroxide was not a skin sensitiser in a guinea pig maximisation test (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

<u>Oral</u>

No studies are available on dialuminium chloride pentahydroxide.

Aluminium chloride, basic (aluminium hydroxychloride) 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 aluminium chloride, basic; 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 localised effects (site-of-contact) is 200 mg/kg-day (ECHA). [Kl. score = 2]

Inhalation

No adequate studies were located.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

Dialuminium chloride pentahydroxide was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537 and *E. coli* strain WP2*uvr*A in the absence or presence of metabolic activation (ECHA). [Kl. score = 1]

The *in vitro* genotoxicity studies on the structurally similar compound aluminium hydroxychloride is shown in Table 3.

Table 3 *In Vitro* Genotoxicity Studies on Aluminium Hydroxychloride

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (S. typhimurium and E. coli strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Micronucleus (peripheral human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

Male and female NMRI mice were given an oral gavage dose of 0 or 2,000 mg/kg dialuminium chloride pentahydroxide on two consecutive days. There were no increases in the frequency of micronucleated polychromatic erythrocytes in the bone marrow of the treated mice compared to the controls (ECHA). [Kl. score = 1]

G. Carcinogenicity

No studies are available.

H. Reproductive/Developmental Toxicity

No studies are available for dialuminium chloride pentahydroxide.

Aluminium chloride, basic (aluminium hydroxychloride) 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 aluminium chloride, basic; 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]

I. Derivation of Toxicological Reference and Drinking Water Guidance Values

Toxicological reference values were not derived for dialuminium chloride pentahydroxide.

The ADWG value 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 ADWG value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

J. Human Health Hazard Assessment of Physico-Chemical Properties

Dialuminium chloride pentahydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

In the aquatic environment, aluminium compound toxicity is intimately related to ambient pH; changes in ambient acidity may affect aluminium compound solubility, dissolved aluminium compound speciation and organism sensitivity to aluminium compounds. Toxicity testing on a similar aluminium salt compound identified a low toxicity concern for terrestrial invertebrates.

B. Aquatic Toxicity

<u>Acute Studies on Aluminium Polychlorohydrate</u>

Table 4 lists the results of acute aquatic toxicity studies conducted on aluminium salts.

Table 4 Acute Aquatic Toxicity Studies on Aluminium Salts

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Zebrafish *(Danio rerio)*	96-hour LC_{10}	142 nominal (as dissolved aluminum 0.58)	2	ECHA
Zebrafish	96-hour LC_{50}	186 nominal (as dissolved aluminum 1.39)	2	ECHA
Zebrafish	96-hour EC_{50}	>0.357* as Dis Al	1	ECHA
Water Flea *(Daphnia magna)*	48-hour EC_{50}	98 nominal (as dissolved aluminum <0.1)**	2	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Water Flea	48-hour EC_{50}	38*** nominal (as dissolved aluminum 1.26)	2	ECHA
Pseudokidrchneriella subcapitata	72-hour EC_{50} growth rate	14 nominal (as dissolved aluminum 0.24)	1	ECHA

*NOEC was >1,000 mg/L. pH of the test media was maintained at 7.5.
**Toxicity is driven by other causes than dissolved aluminium.
*** Value for dialuminium chloride pentahydroxide.

The pH significantly alters the speciation and therefore bioavailability of the aluminium such that acutely toxic concentrations occur below a pH of 6 but that above 6 the bioavailable concentration necessary to achieve immobilisation in an acute study cannot be achieved (ECHA).

Data used by ANZECC for Aluminium water quality guideline

In developing a water quality guideline for aluminium (ANZECC & ARMCANZ, 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_{50} 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[1] from seven species were 34-7,100 µg/L. The lowest measured chronic value was an 8-day LC_{50} for *Micropterus* species of 170 µg/L.

Amphibian

The 96-hour LC_{50} values for *Bufo americanus* were 860-1,660 µg/L. The chronic 8-day LC_{50} for *Bufo americanus* was 2,280 µg/L.

Crustacean

The 48-hour LC_{50} 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_{50} 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_{50} values for two species were 15-4,200 µg/L (the lowest value was for *Salmo trutta*). The 21- to 42-day LC_{50} values were 15-105 µg/L.

Amphibian

The 96- to 120-day LC_{50} 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.

[1]Chronic toxicity values were a mixture of LC/EC_{50} LOEC, MATC, and NOEC values; where stated, these were converted to NOEC equivalents.

C. Terrestrial Toxicity

A study equivalent to the earthworm acute toxicity (OECD TG 207) test was conducted on sulfuric acid, aluminium salt (3:2), octadecahydrate (CAS No. 7784-31-8). The 14-day LC_{50} to earthworm *Eisenia andre*i was 316 mg/kg soil dry weight (van Gestel and Hoogerwerf, 2001; ECHA). [Kl. score = 2]

D. Calculation of PNEC

PNEC water

The ANZECC water quality guideline (ANZECC & ARMCANZ, 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 dialuminium chloride pentahydroxide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of dialuminium chloride pentahydroxide 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 dialuminium chloride pentahydroxide is dominated by its water solubility. Sorption of dialuminium chloride pentahydroxide 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 dialuminium chloride pentahydroxide. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, dialuminium chloride pentahydroxide is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

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).

Dialuminium chloride pentahydroxide is an inorganic compound that dissociates in water to form chloride ions and various species of aluminium hydroxide hydrolysis. Biodegradation is not applicable to dialuminium chloride pentahydroxide. 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, dialuminium chloride pentahydroxide 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 dialuminium chloride pentahydroxide meets the screening criteria for toxicity.

The overall conclusion is that dialuminium chloride pentahydroxide is not a PBT substance.

B. Other Characteristics of Concern

Only tier 3 chemicals which trigger persistence and bioacummulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted in the prior section, dialuminium chloride pentahydroxide does not meet the criteria for persistence or bioaccumulation.

No other characteristics of concern were identified for dialuminium chloride pentahydroxide.

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]	
Dialuminium Chloride Pentahydroxide	12042-91-0	Not a PBT	No	No	NA	No	No	Yes	3	1	3

Footnotes:

1 - PBT Assessment based on PBT Framework.

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

3 - Tier 3 - Quantitative Risk Assessment: Complete PBT, qualitative and quantitative assessment of risk.

Notes:

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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, 64th Annual Water Industry Engineers and Operator's Conference. Available at: http://wioa.org.au/conference_papers/2001/pdf/paper6.pdf.

Gebbie, P. (2005). A Dummy's Guide to Coagulants. 68th Annual Water Industry Engineers and Operator's Conference. Available at: 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.

van Gestel, C.A.M., and Hoogerwerf, G. (2001). Influence of soil pH on the toxicity of aluminium for Eisenia Andrei (Oligochaeta: Lumbricidae) in an artificial soil substrate. Pedobiologia 45: 385-395).

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.

B. Abbreviations and Acronyms

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
AF	assessment factor
AICS	Australian Inventory of Chemical Substances
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BCF	bioconcentration factor
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/cm^3	grams per cubic centimetre
g/L	grams per litre
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
kPa	kilopascal
LC	lethal concentration
LD	lethal dose
LOEC	lowest observed effective concentration
MATC	maximum acceptable toxicant concentration
mg/kg	milligrams per kilogram

mg/L	milligrams per litre
mL	millilitre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NMRI	Naval Medical Research Institute
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
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
TG	Test Guideline
µg/L	micrograms per litre