Qualitative and Quantitative Tier 3 Assessment

Sodium Hypochlorite

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

Sodium hypochlorite is a component in a Water Management Facility (WMF) product (Sodium Hypochlorite Solution 12.5%) used as an oxidising agent/disinfectant 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)
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite Sodium Hydroxide	7681-52-9 1310-73-2	Oxidising agent/disinfectant	15000 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
Sodium hypochlorite (7681-52-9)	Chlorine	5 mg/L (health) and 0.6 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 presents the chemical, endpoint, no observed effect 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)
Sodium hypochlorite (7681-52-9)	-	-	-	0.003[a]

[a] $PNEC_{water}$ for sodium hypochlorite is the ANZECC Water Quality Guideline – Freshwater Trigger Value for chlorine.
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

Sodium hypochlorite is a yellow, limpid liquid with a chlorinated odour. The molecular structure of sodium hypochlorite is presented in **Figure 1**.

Figure 1 Molecular Structure of Sodium Hypochlorite[1]

In water, sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion. The hypochlorite ion (ClO^-) is in equilibrium with hydrochlorous acid (HClO) in water and chlorine gas (Cl_2), with the relative amounts determined by pH, temperature and ionic strength of the water. Free chlorine (Cl_2) reacts with ammonia and certain nitrogen compounds to form N-chlorinated compounds. These compounds are more persistent than the free chlorine. N-

[1] Source https://chem.nlm.nih.gov/chemidplus/rn/7681-52-9

chloramines are intentionally produced in water treatment to extend the effectiveness of chlorination.

Biodegradation is not applicable to sodium hypochlorite. Sunlight (ultraviolet light) will rapidly decompose sodium hypochlorite to sodium chloride (OxyChem, 2014). Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative.

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

Human Health Hazards

Sodium hypochlorite solutions have low acute toxicity by the oral and dermal routes. It is corrosive to the skin, eyes and the gastrointestinal tract. Based on human and animal data, sodium hypochlorite concentrations over 5% are irritating to the skin and eye, while concentrations over 10% are corrosive. Aerosolised sodium hypochlorite is a respiratory irritant. It is not a skin sensitiser (NICNAS, 2017).

No systemic, reproductive or developmental toxicity was seen in rats in repeated dose toxicity and reproductive/developmental toxicity studies. While sodium hypochlorite has been positive in some *in vitro* genotoxicity studies, the *in vivo* studies have been negative. Sodium hypochlorite was not carcinogenic to rats or mice in chronic drinking water studies.

Toxicological reference values were not derived for sodium hypochlorite. The ADWG values for chlorine are 5 mg/L (health) and 0.6 mg/L (aesthetics).

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 conceptual exposure model (CEM), 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**, sodium hypochlorite fully dissociates to sodium (Na) and chloride (Cl), with Na and Cl removed by the reverse osmosis (RO) system at 95% to the brine and 5% stays within permeate. Sodium concentrations are *de minimis* (< 10 mg/L) in the permeate and <80 mg/L in the brine, both of which are less than geogenic background. As a result, this chemical was not evaluated further 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 sodium hypochlorite 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

Sodium hypochlorite is very toxic to aquatic organisms. Sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion in aqueous media. As an inorganic salt, neither sodium hypochlorite nor its dissociated ions are expected to bioaccumulate. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.

In standard aquatic toxicity tests, sodium hypochlorite is highly toxic to aquatic organisms on both an acute and chronic basis. In the acute aquatic tests, algae were found to be the most sensitive species. Fish and *daphnia* were less susceptible. Acute terrestrial toxicity tests are available for earthworm, plants and soil microorganisms. Under typical environmental conditions, the chemical is

expected to degrade rapidly in soil and water and does not persist in the environment. The chemical also does not bioaccumulate.

The water quality guideline (ANZECC and ARMCANZ, 2000) used acute and chronic laboratory toxicity data for the derivation of a trigger value for chlorine. The guideline for freshwater is: "A freshwater moderate trigger value of 3 µg Cl/L measured as total residual chlorine was derived using the statistical distribution method with 95% protection. This figure was obtained from the application of the default ACR of 10 instead of the empirical ACR of 2.7 from the geometric mean of 8 figures. The smaller ACR would have resulted in a value not protective of some species under continuous exposure to chlorine for at least 48 hours".

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 sodium hypochlorite. Thus, the equilibrium partitioning method cannot be used to calculate PNECs for soil or sediment. Based on its properties, sodium hypochlorite 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 sodium hypochlorite. 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 sodium hypochlorite that may occur during water treatment activities. The risk characterisation evaluates the toxicity of sodium hypochlorite 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, sodium hypochlorite would not be present in permeate, brine or treated water above geogenic background levels. Therefore, EPCs were not developed for permeate accidental release scenarios or permeate beneficial use scenarios, and likewise, further quantitative analysis (i.e., calculation of hazards) for permeate beneficial reuse via direct contact by trespassers, workers and agricultural workers 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**), sodium hypochlorite 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 – Sodium Hypochlorite

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.

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

NICNAS. (2017) National assessment of chemicals associated with coal seam gas extraction in Australia, Technical report number 12- Human health hazards of chemicals associated with coal seam gas extraction in Australia: Attachment 5 – Hazard assessment sheets. Project report prepared by the Chemicals and Biotechnology Assessments Section (CBAS), in the Chemicals and Waste Branch of the Department of the Environment and Energy as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra.

OxyChem. (2014). Oxychem Sodium Hypochlorite Handbook. Available at: http://www.oxy.com/OurBusinesses/Chemicals/Products/Documents/sodiumhypochlorite/bleach.pdf.

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

Coogee Chemicals Sodium Hypochlorite

Coogee Chemicals Pty Ltd

Chemwatch Hazard Alert Code: **3**

Chemwatch: **63-4453**
Version No: **5.1.1.1**
Safety Data Sheet according to WHS and ADG requirements

Issue Date: **26/06/2018**
Print Date: **26/06/2018**
S.GHS.AUS.EN

SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

Product Identifier

Product name	Coogee Chemicals Sodium Hypochlorite
Synonyms	Product code: 3600
Proper shipping name	HYPOCHLORITE SOLUTION
Other means of identification	Not Available

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Bleaching Agent, Disinfectant, Oxidising agent.

Details of the supplier of the safety data sheet

Registered company name	**Coogee Chemicals Pty Ltd**
Address	Cnr of Patterson and Kwinana Beach Roads Kwinana WA Australia
Telephone	+61 8 9439 8200
Fax	+61 8 9439 8300
Website	www.coogee.com.au
Email	businessrelations@coogee.com.au

Emergency telephone number

Association / Organisation	**Coogee Chemicals**
Emergency telephone numbers	1800 800 655
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture

HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the WHS Regulations and the ADG Code.

Poisons Schedule	S5
Classification [1]	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1B, Serious Eye Damage Category 1, Acute Aquatic Hazard Category 1
Legend:	*1. Classified by Chemwatch; 2. Classification drawn from HSIS; 3. Classification drawn from Regulation (EU) No 1272/2008 - Annex VI*

Label elements

Hazard pictogram(s)	
SIGNAL WORD	**DANGER**

Continued...

Hazard statement(s)

H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.
H400	Very toxic to aquatic life.
AUH031	Contact with acid liberates toxic gas.

Supplementary statement(s)

Not Applicable

Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.
P234	Keep only in original container.
P273	Avoid release to the environment.

Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.

Precautionary statement(s) Storage

P405	Store locked up.

Precautionary statement(s) Disposal

P501	Dispose of contents/container in accordance with local regulations.

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
7681-52-9	10-30	sodium hypochlorite
1310-73-2	<1	sodium hydroxide
7732-18-5	>60	water

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye Contact	If this product comes in contact with the eyes: ▸ Immediately hold eyelids apart and flush the eye continuously with running water. ▸ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. ▸ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes. ▸ Transport to hospital or doctor without delay. ▸ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact	If skin or hair contact occurs: ▸ Immediately flush body and clothes with large amounts of water, using safety shower if available. ▸ Quickly remove all contaminated clothing, including footwear. ▸ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre. ▸ Transport to hospital, or doctor.

Continued...

Inhalation	▸ If fumes or combustion products are inhaled remove from contaminated area. ▸ Lay patient down. Keep warm and rested. ▸ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. ▸ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. ▸ Transport to hospital, or doctor. ▸ Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema. ▸ Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs). ▸ As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested. ▸ Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. **This must definitely be left to a doctor or person authorised by him/her.** (ICSC13719)
Ingestion	▸ For advice, contact a Poisons Information Centre or a doctor at once. ▸ Urgent hospital treatment is likely to be needed. ▸ If swallowed do **NOT** induce vomiting. ▸ If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. ▸ Observe the patient carefully. ▸ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. ▸ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. ▸ Transport to hospital or doctor without delay.

Indication of any immediate medical attention and special treatment needed

For acute or repeated exposures to hypochlorite solutions:

- Release of small amounts of hypochlorous acid and acid gases from the stomach following ingestion, is usually too low to cause damage but may be irritating to mucous membranes. Buffering with antacid may be helpful if discomfort is evident.
- Evaluate as potential caustic exposure.
- Decontaminate skin and eyes with copious saline irrigation. Check exposed eyes for corneal abrasions with fluorescein staining.
- Emesis or lavage and catharsis may be indicated for mild caustic exposure.
- Chlorine exposures require evaluation of acid/base and respiratory status.
- Inhalation of vapours or mists may result in pulmonary oedema.

ELLENHORN and BARCELOUX: Medical Toxicology.
Excellent warning properties force rapid escape of personnel from chlorine vapour thus most inhalations are mild to moderate. If escape is not possible, exposure to high concentrations for a very short time can result in dyspnea, haemophysis and cyanosis with later complications being tracheobronchopneumonitis and pulmonary oedema. Oxygen, intermittent positive pressure breathing apparatus and aerosolysed bronchodilators are of therapeutic value where chlorine inhalation has been light to moderate. Severe inhalation should result in hospitalisation and treatment for a respiratory emergency. Any chlorine inhalation in an individual with compromised pulmonary function (COPD) should be regarded as a severe inhalation and a respiratory emergency. [CCINFO, Dow 1988]
Effects from exposure to chlorine gas include pulmonary oedema which may be delayed. Observation in hospital for 48 hours is recommended
Diagnosed asthmatics and those people suffering from certain types of chronic bronchitis should receive medical approval before being employed in occupations involving chlorine exposure.
If burn is present, treat as any thermal burn, after decontamination.
for corrosives:

BASIC TREATMENT

- Establish a patent airway with suction where necessary.
- Watch for signs of respiratory insufficiency and assist ventilation as necessary.
- Administer oxygen by non-rebreather mask at 10 to 15 l/min.
- Monitor and treat, where necessary, for pulmonary oedema .
- Monitor and treat, where necessary, for shock.
- Anticipate seizures.
- Where eyes have been exposed, flush immediately with water and continue to irrigate with normal saline during transport to hospital.
- **DO NOT** use emetics. Where ingestion is suspected rinse mouth and give up to 200 ml water (5 ml/kg recommended) for dilution where patient is able to swallow, has a strong gag reflex and does not drool.
- Skin burns should be covered with dry, sterile bandages, following decontamination.
- **DO NOT** attempt neutralisation as exothermic reaction may occur.

ADVANCED TREATMENT

- Consider orotracheal or nasotracheal intubation for airway control in unconscious patient or where respiratory arrest has occurred.
- Positive-pressure ventilation using a bag-valve mask might be of use.
- Monitor and treat, where necessary, for arrhythmias.
- Start an IV D5W TKO. If signs of hypovolaemia are present use lactated Ringers solution. Fluid overload might create complications.
- Drug therapy should be considered for pulmonary oedema.
- Hypotension with signs of hypovolaemia requires the cautious administration of fluids. Fluid overload might create complications.
- Treat seizures with diazepam.
- Proparacaine hydrochloride should be used to assist eye irrigation.

Continued...

EMERGENCY DEPARTMENT

- Laboratory analysis of complete blood count, serum electrolytes, BUN, creatinine, glucose, urinalysis, baseline for serum aminotransferases (ALT and AST), calcium, phosphorus and magnesium, may assist in establishing a treatment regime.
- Positive end-expiratory pressure (PEEP)-assisted ventilation may be required for acute parenchymal injury or adult respiratory distress syndrome.
- Consider endoscopy to evaluate oral injury.
- Consult a toxicologist as necessary.

BRONSTEIN, A.C. and CURRANCE, P.L. EMERGENCY CARE FOR HAZARDOUS MATERIALS EXPOSURE: 2nd Ed. 1994

SECTION 5 FIREFIGHTING MEASURES

Extinguishing media

- Water spray or fog.
- Foam.
- Dry chemical powder.
- BCF (where regulations permit).

Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.

Advice for firefighters

Fire Fighting	▸ Alert Fire Brigade and tell them location and nature of hazard. ▸ Wear full body protective clothing with breathing apparatus. ▸ Prevent, by any means available, spillage from entering drains or water course. ▸ Use fire fighting procedures suitable for surrounding area.
Fire/Explosion Hazard	▸ Non combustible. ▸ Not considered a significant fire risk, however containers may burn. Decomposition may produce toxic fumes of: , hydrogen chloride May emit corrosive fumes. |May evolve toxic gases (chlorine) when heated to decomposition.
HAZCHEM	2X

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

See section 8

Environmental precautions

See section 12

Methods and material for containment and cleaning up

Minor Spills	▸ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material. ▸ Check regularly for spills and leaks. ▸ Clean up all spills immediately. ▸ Avoid breathing vapours and contact with skin and eyes. ▸ Control personal contact with the substance, by using protective equipment. ▸ Contain and absorb spill with sand, earth, inert material or vermiculite.
Major Spills	▸ Clear area of personnel and move upwind. ▸ Alert Fire Brigade and tell them location and nature of hazard. ▸ Wear full body protective clothing with breathing apparatus. ▸ Prevent, by any means available, spillage from entering drains or water course.

Personal Protective Equipment advice is contained in Section 8 of the SDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	▸ Avoid all personal contact, including inhalation. ▸ Wear protective clothing when risk of exposure occurs. ▸ Use in a well-ventilated area.

Continued...

	▸ Avoid contact with moisture.
Other information	▸ Store in original containers. ▸ Keep containers securely sealed. ▸ Store in a cool, dry, well-ventilated area. ▸ Store away from incompatible materials and foodstuff containers.

Conditions for safe storage, including any incompatibilities

Suitable container	▸ Lined metal can, lined metal pail/ can. ▸ Plastic pail. ▸ Polyliner drum. ▸ Packing as recommended by manufacturer. For low viscosity materials ▸ Drums and jerricans must be of the non-removable head type. ▸ Where a can is to be used as an inner package, the can must have a screwed enclosure. For materials with a viscosity of at least 2680 cSt. (23 deg. C) and solids (between 15 C deg. and 40 deg C.): ▸ Removable head packaging; ▸ Cans with friction closures and ▸ low pressure tubes and cartridges may be used.
Storage incompatibility	▸ Contact with acids produces toxic fumes Contact with acids produces toxic fumes of chlorine ▸ Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous |Contact with acids, organics, reducing agents (eg. amines), metallic powders and heat sources produces toxic fumes of chlorine. May be decomposed by hot water releasing chlorine fumes.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sodium hydroxide	Sodium hydroxide	Not Available	Not Available	2 mg/m3	Not Available

EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sodium hypochlorite	Sodium hypochlorite pentahydrate	13 mg/m3	140 mg/m3	290 mg/m3
sodium hypochlorite	Sodium hypochlorite	2 mg/m3	54 mg/m3	630 mg/m3
sodium hydroxide	Sodium hydroxide	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sodium hypochlorite	Not Available	Not Available
sodium hydroxide	10 mg/m3	Not Available
water	Not Available	Not Available

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The basic types of engineering controls are: Process controls which involve changing the way a job activity or process is done to reduce the risk. Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.
Personal protection	
Eye and face protection	▸ Chemical goggles. ▸ Full face shield may be required for supplementary but never for primary protection of eyes. ▸ Contact lenses may pose a special hazard; soft contact lenses may absorb and concentrate irritants. A written policy document, describing the wearing of lenses or restrictions on use, should be created for each workplace or task.

Continued...

Skin protection	See Hand protection below
Hands/feet protection	▸ Wear chemical protective gloves, e.g. PVC. ▸ Wear safety footwear or safety gumboots, e.g. Rubber ▸ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.
Body protection	See Other protection below
Other protection	▸ Overalls. ▸ PVC Apron. ▸ PVC protective suit may be required if exposure severe. ▸ Eyewash unit.

Recommended material(s)

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:
"Forsberg Clothing Performance Index".
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
Coogee Chemicals Sodium Hypochlorite

Material	CPI
NEOPRENE	A
BUTYL	C
NAT+NEOPR+NITRILE	C
NATURAL RUBBER	C
NATURAL+NEOPRENE	C
NEOPRENE/NATURAL	C
NITRILE	C
NITRILE+PVC	C
PE	C
PE/EVAL/PE	C
PVA	C
PVC	C
SARANEX-23	C
SARANEX-23 2-PLY	C
TEFLON	C
VITON	C
VITON/CHLOROBUTYL	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

Respiratory protection

Type B-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

- Respirators may be necessary when engineering and administrative controls do not adequately prevent exposures.
- The decision to use respiratory protection should be based on professional judgment that takes into account toxicity information, exposure measurement data, and frequency and likelihood of the worker's exposure - ensure users are not subject to high thermal loads which may result in heat stress or distress due to personal protective equipment (powered, positive flow, full face apparatus may be an option).
- Published occupational exposure limits, where they exist, will assist in determining the adequacy of the selected respiratory protection. These may be government mandated or vendor recommended.
- Certified respirators will be useful for protecting workers from inhalation of particulates when properly selected and fit tested as part of a complete respiratory protection program.
- Use approved positive flow mask if significant quantities of dust becomes airborne.
- Try to avoid creating dust conditions.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Clear yellow coloured alkaline liquid with chlorine odour; miscible with water.

Physical state	Liquid	**Relative density (Water = 1)**	1.17-1.22
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Available

Continued...

pH (as supplied)	>11.5	**Decomposition temperature**	Not Available
Melting point / freezing point (°C)	-25	**Viscosity (cSt)**	Not Available
Initial boiling point and boiling range (°C)	>100	**Molecular weight (g/mol)**	Not Applicable
Flash point (°C)	Not Applicable	**Taste**	Not Available
Evaporation rate	Not Available	**Explosive properties**	Not Available
Flammability	Not Applicable	**Oxidising properties**	Not Available
Upper Explosive Limit (%)	Not Applicable	**Surface Tension (dyn/cm or mN/m)**	Not Available
Lower Explosive Limit (%)	Not Applicable	**Volatile Component (%vol)**	80-95
Vapour pressure (kPa)	2.3	**Gas group**	Not Available
Solubility in water (g/L)	Miscible	**pH as a solution (1%)**	Not Available
Vapour density (Air = 1)	Not Available	**VOC g/L**	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▸ Unstable in the presence of incompatible materials. ▸ Product is considered stable. ▸ Hazardous polymerisation will not occur.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	Chlorine vapour is extremely irritating to the airways and lungs, causing coughing, choking, breathing difficulty, chest pain, headache, vomiting, fluid accumulation in the lungs, chest infection and loss of consciousness. Effects may be delayed. Long term exposure (at workplace) may lead to corrosion of the teeth, irritate the linings of the nose and may increase the likelihood of developing tuberculosis. Recent studies have not confirmed these findings.
Ingestion	The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion. Accidental ingestion of the material may be damaging to the health of the individual.
Skin Contact	The material can produce chemical burns following direct contact with the skin. Skin contact will result in rapid drying, bleaching, leading to chemical burns on prolonged contact |resulting in permanent injury.
Eye	The material can produce chemical burns to the eye following direct contact. Vapours or mists may be extremely irritating. If applied to the eyes, this material causes severe eye damage.
Chronic	Reduced breathing capacity may result from chronic low level exposure to chlorine gas. Chronic poisoning may result in cough, severe chest pains, sore throat and blood in the phlegm. Moderate to severe exposures over 3 years produced decreased lung capacity in a number of workers. Delayed effects can include shortness of breath, violent headaches, lung swelling and pneumonia.

Coogee Chemicals Sodium Hypochlorite	**TOXICITY**	**IRRITATION**
	Not Available	Not Available
sodium hypochlorite	**TOXICITY**	**IRRITATION**
	Oral (rat) LD50: >237 mg/kg[1]	Eye (rabbit): 10 mg - moderate
		Eye (rabbit): 100 mg - moderate
		Skin (rabbit): 500 mg/24h-moderate
sodium hydroxide	**TOXICITY**	**IRRITATION**

Continued...

	Not Available	Eye (rabbit): 0.05 mg/24h SEVERE
		Eye (rabbit):1 mg/24h SEVERE
		Eye (rabbit):1 mg/30s rinsed-SEVERE
		Skin (rabbit): 500 mg/24h SERVERE

water	TOXICITY	IRRITATION
	Not Available	Not Available

Legend:	*1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's SDS. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*

SODIUM HYPOCHLORITE	Hypochlorite salts are classified by IARC as Group 3: **NOT** classifiable as to its carcinogenicity to humans. Evidence of carcinogenicity may be inadequate or limited in animal testing. The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. Hypochlorite salts are extremely corrosive and can cause severe damage to the eyes and skin. A number of skin cancers have been observed in mice, when applied to their skin. as sodium hypochlorite pentahydrate
SODIUM HYDROXIDE	The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis. The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.
WATER	No significant acute toxicological data identified in literature search.
SODIUM HYPOCHLORITE & SODIUM HYDROXIDE	Asthma-like symptoms may continue for months or even years after exposure to the material ends. This may be due to a non-allergic condition known as reactive airways dysfunction syndrome (RADS) which can occur after exposure to high levels of highly irritating compound. Main criteria for diagnosing RADS include the absence of previous airways disease in a non-atopic individual, with sudden onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. Other criteria for diagnosis of RADS include a reversible airflow pattern on lung function tests, moderate to severe bronchial hyperreactivity on methacholine challenge testing, and the lack of minimal lymphocytic inflammation, without eosinophilia.

Acute Toxicity	⊘	**Carcinogenicity**	⊘
Skin Irritation/Corrosion	✔	**Reproductivity**	⊘
Serious Eye Damage/Irritation	✔	**STOT - Single Exposure**	⊘
Respiratory or Skin sensitisation	⊘	**STOT - Repeated Exposure**	⊘
Mutagenicity	⊘	**Aspiration Hazard**	⊘

Legend: ✘ *– Data available but does not fill the criteria for classification*
✔ *– Data available to make classification*
⊘ *– Data Not Available to make classification*

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

Coogee Chemicals Sodium Hypochlorite	ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
	Not Available	Not Available	Not Available	Not Available	Not Available

sodium hypochlorite	ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
	LC50	96	Fish	0.032mg/L	4
	EC50	48	Crustacea	0.026mg/L	2
	EC50	72	Algae or other aquatic plants	0.0183mg/L	2
	NOEC	72	Algae or other aquatic plants	0.0054mg/L	2

sodium hydroxide	ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
	LC50	96	Fish	125mg/L	4
	NOEC	96	Fish	56mg/L	4

Continued...

water	ENDPOINT	TEST DURATION (HR)	SPECIES	VALUE	SOURCE
	Not Available	Not Available	Not Available	Not Available	Not Available
Legend:	*Extracted from 1. IUCLID Toxicity Data 2. Europe ECHA Registered Substances - Ecotoxicological Information - Aquatic Toxicity 3. EPIWIN Suite V3.12 (QSAR) - Aquatic Toxicity Data (Estimated) 4. US EPA, Ecotox database - Aquatic Toxicity Data 5. ECETOC Aquatic Hazard Assessment Data 6. NITE (Japan) - Bioconcentration Data 7. METI (Japan) - Bioconcentration Data 8. Vendor Data*				

Prevent, by any means available, spillage from entering drains or water courses.
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
sodium hydroxide	LOW	LOW
water	LOW	LOW

Bioaccumulative potential

Ingredient	Bioaccumulation
sodium hydroxide	LOW (LogKOW = -3.8796)
water	LOW (LogKOW = -1.38)

Mobility in soil

Ingredient	Mobility
sodium hydroxide	LOW (KOC = 14.3)
water	LOW (KOC = 14.3)

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	▸ Containers may still present a chemical hazard/ danger when empty. ▸ Return to supplier for reuse/ recycling if possible. Otherwise: ▸ If container can not be cleaned sufficiently well to ensure that residuals do not remain or if the container cannot be used to store the same product, then puncture containers, to prevent re-use, and bury at an authorised landfill. ▸ Where possible retain label warnings and SDS and observe all notices pertaining to the product. ▸ Recycle wherever possible. ▸ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified. ▸ Treat and neutralise at an approved treatment plant. Treatment should involve: Neutralisation followed by: burial in a land-fill specifically licensed to accept chemical and / or pharmaceutical wastes or Incineration in a licensed apparatus (after admixture with suitable combustible material) ▸ Decontaminate empty containers.

SECTION 14 TRANSPORT INFORMATION

Labels Required

	
Marine Pollutant	
HAZCHEM	2X

Land transport (ADG)

Continued...

UN number	1791
UN proper shipping name	HYPOCHLORITE SOLUTION
Transport hazard class(es)	Class: 8 Subrisk: Not Applicable
Packing group	III
Environmental hazard	Environmentally hazardous
Special precautions for user	Special provisions: 223 Limited quantity: 5 L

Air transport (ICAO-IATA / DGR)

UN number	1791
UN proper shipping name	Hypochlorite solution
Transport hazard class(es)	ICAO/IATA Class: 8 ICAO / IATA Subrisk: Not Applicable ERG Code: 8L
Packing group	III
Environmental hazard	Environmentally hazardous
Special precautions for user	Special provisions: A3 A803 Cargo Only Packing Instructions: 856 Cargo Only Maximum Qty / Pack: 60 L Passenger and Cargo Packing Instructions: 852 Passenger and Cargo Maximum Qty / Pack: 5 L Passenger and Cargo Limited Quantity Packing Instructions: Y841 Passenger and Cargo Limited Maximum Qty / Pack: 1 L

Sea transport (IMDG-Code / GGVSee)

UN number	1791
UN proper shipping name	HYPOCHLORITE SOLUTION
Transport hazard class(es)	IMDG Class: 8 IMDG Subrisk: Not Applicable
Packing group	III
Environmental hazard	Marine Pollutant
Special precautions for user	EMS Number: F-A , S-B Special provisions: 223 Limited Quantities: 5 L

Transport in bulk according to Annex II of MARPOL and the IBC code

SOURCE	PRODUCT NAME	POLLUTION CATEGORY	SHIP TYPE
	Sodium hypochlorite solution (15% or less)	Y	2

SECTION 15 REGULATORY INFORMATION

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

SODIUM HYPOCHLORITE(7681-52-9) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Continued...

Australia Hazardous Chemical Information System (HCIS) - Hazardous Chemicals
Australia Inventory of Chemical Substances (AICS)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Appendix E (Part 2)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Appendix F (Part 3)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Schedule 5
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Schedule 6
International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs

SODIUM HYDROXIDE(1310-73-2) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards
Australia Hazardous Chemical Information System (HCIS) - Hazardous Chemicals
Australia Inventory of Chemical Substances (AICS)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Appendix E (Part 2)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Appendix F (Part 3)
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Schedule 5
Australia Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) - Schedule 6

WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)

National Inventory Status

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water; sodium hypochlorite; sodium hydroxide)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	Y
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	*Y = All ingredients are on the inventory* *N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)*

SECTION 16 OTHER INFORMATION

Revision Date	26/06/2018
Initial Date	17/06/2016

Other information

Ingredients with multiple cas numbers

Name	CAS No
sodium hypochlorite	7681-52-9, 10022-70-5
sodium hydroxide	1310-73-2, 12200-64-5

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

The SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Definitions and abbreviations

PC—TWA: Permissible Concentration-Time Weighted Average
PC—STEL: Permissible Concentration-Short Term Exposure Limit
IARC: International Agency for Research on Cancer
ACGIH: American Conference of Governmental Industrial Hygienists
STEL: Short Term Exposure Limit
TEEL: Temporary Emergency Exposure Limit。
IDLH: Immediately Dangerous to Life or Health Concentrations

Continued...

OSF: Odour Safety Factor
NOAEL :No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level
TLV: Threshold Limit Value
LOD: Limit Of Detection
OTV: Odour Threshold Value
BCF: BioConcentration Factors
BEI: Biological Exposure Index

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		On-site Storage		Operation		Annual Usage (ROP volumes based on peak rate of 10ML/d)	Purpose / Function
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration		
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite	7681-52-9	10-30%	Hypochlorite Solution	Coogee Chemicals	Reverse Osmosis Plant	10000L	12.50%	15000L	12.50%	18-35L/hour (25 AVG)	12.50%	220000L	oxidizing agent / disinfectant
	Sodium Hydroxide	1310-73-2	<10%											

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concentration
L = litres
L/hr = litre per hour
mg/kg = milligrams per kilogram
mg/L = milligrams per litre

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)
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite	7681-52-9	Converted to monochloramine and sodium metabisulphite dosing prior to RO membranes	NA	Fully dissociates to sodium (Na) and chloride (Cl) removed by the RO system (95%) goes to brine, 5% stays within permeate. Na concentrations are diminimis (< 10 mg/L), residual Na would be less than 4 mg/L. Na and Cl residual concentrations are consistent with or less than geogenic background.	NA	NA	NA
	Sodium Hydroxide	1310-73-2		NA	Fully dissociates to Na and hydroxyl ion (OH^-), with Na and OH^- removed by the RO system at 95% to the brine and 5% stays within permeate. Na concentrations are diminimis (< 10mg/L) and consistent with or less than geogenic background.	NA	NA	NA

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concentration
L = litres
L/hr = litre per hour
mg/kg = milligrams per kilogram
mg/L = milligrams per litre

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

Product Name	Chemical Name	CAS Number	Brine Notes
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite	7681-52-9	Fully dissociates with Na removed by the RO system (95%) will go to brine. Residual Na would be less than 80 mg/L in brine, which is consistent or less than geogenic background.
	Sodium Hydroxide	1310-73-2	Fully dissociates to Na and hydroxyl ion (OH-), with Na and OH- removed by the RO system at 95% to the brine dams. However, concentrations of Na consitient or less than geogenic background.

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concentration
L = litres
L/hr = litre per hour
mg/kg = milligrams per kilogram
mg/L = milligrams per litre

Attachment 3 Risk Assessment Dossier

SODIUM HYPOCHLORITE

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

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

1 BACKGROUND

Sodium hypochlorite is a yellow, limpid liquid with a chlorinated odour. In water, sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion. The hypochlorite ion (ClO^-) is in equilibrium with hydrochlorous acid (HClO) in water and chlorine gas (Cl_2) , with the relative amounts determined by pH, temperature and ionic strength of the water. Between pH 2 and 7, hydrochlorous acid (HClO) is the dominant form; at pH 7.4 and 20^oC, there is equimolar contribution of HClO and ClO-. Sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride. Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative. Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes and gastrointestinal tract, depending on the concentration. Inhalation of vapours for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitiser. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some in vitro genotoxicity studies, the in vivo studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant. Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Sodium hypochlorite

CAS RN: 7681-52-9

Molecular formula: NaClO

Molecular weight: 74.44

Synonyms: Sodium hypochlorite; hypochlorous acid, sodium salt; bleach; chlorine bleach

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 Sodium Hypochlorite

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Yellow, limpid liquid with a chlorinated odour	1	ECHA
Melting Point	-28.9°C	1	ECHA
Boiling Point	>60.4°C (decomposition)	1	ECHA
Density	1.3 @ 21.2°C*	1	-
Vapour Pressure	ca. 2.5 kPa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Very soluble	-	ECHA
Flash Point	>111°C @ 101.3 kPa	1	ECHA
Auto flammability	-	-	-
Oxidising properties	None	1	ECHA
pH (5% solution) pH (1% solution)	12.52 @ 19.1°C 10.30 @ 21.3°C	1	ECHA
Viscosity	1.4-1.6 mPa.s @ 20°C 1.4-1.6 mPa.s @ 40°C	1	ECHA

*Sodium hypochlorite with 24.3% available chlorine.

In water, sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion.

The hypochlorite ion (ClO^-) is in equilibrium with hydrochlorous acid (HClO) in water and chlorine gas (Cl_2), with the relative amounts determined by pH, temperature and ionic strength of the water. At very extremely low pH, chlorine gas (Cl_2) is essentially un-hydrolysed and is thus the dominant species of chlorine. Note that the term free chlorine refers to Cl_2. Between pH 2 and 7, hydrochlorous acid (HClO) is the dominant form; at pH 7.4 and 20°C, there is the equimolar contribution of HClO and ClO^-.

The chemical reactions are as follows:

$Cl_2 + H_2O \rightleftharpoons HClO + HCl$

$HClO \rightleftharpoons ClO^- + H^+$

Free chlorine reacts with ammonia and certain nitrogen compounds to form N-chlorinated compounds. With ammonia, chlorine forms chloramines (monochloramine, dichloramine, and nitrogen chloride or trichloramine. These compounds constitute what is termed combined chlorine. These compounds are more persistent than the free chlorine. Monochloramine contributes significantly to the combined available chlorine in the water. N-chloramines are intentionally produced in water treatment to extend the effectiveness of chlorination.

Free chlorine and combined chlorine may be present simultaneously in a water sample. The term total chlorine or total residual chlorine (TRC) refers to the sum of free chlorine and combined chlorine that is present in a water sample.

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 sodium hypochlorite.

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

Sodium hypochlorite (NaClO) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride (OxyChem, 2014). Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative.

6 HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes and gastrointestinal tract, depending on the concentration. Inhalation of vapours for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitiser. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some *in vitro* genotoxicity studies, the *in vivo* studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant.

B. Acute Toxicity

The oral LD_{50} of a sodium hypochlorite solution (12.2% active chlorine) in rats was 8,830 mg/kg, which was calculated to be 1,100 mg/kg based on average Cl_2 (ECHA) [Kl. score = 2]. The oral LD_{50} of

undiluted sodium hypochlorite in rats was 8,910 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} of sodium hypochlorite (given as a12.5% solution) was 5,230 mg/kg.

The dermal LD_{50} in rabbits is >20,000 mg/kg (ECHA). [Kl. score = 2]

The 1-hour LC_{50} in rats is >10.5 mg/L (ECHA). [Kl. score = 2]

C. Irritation

A 12.5% solution of sodium hypochloride was irritating to the skin of rabbits when 0.5 ml was applied for 24 hours under semi-occlusive conditions. The mean of the 24 and 72 hours scores were: 2.16 for erythema and 1.04 for edema (ECHA) [Kl. score = 2]. Application of 0.1 mL of sodium hypochlorite (5.25% solution) to the intact skin of rabbits for 24 hours under semi-occlusive conditions was slightly irritating but not sufficient for classification as an irritant. The 24 and 72-hour mean scores were: 1.17 for erythema and 0.13 for edema (ECHA) [Kl. score = 2]. In another study, application of sodium hypochlorite (5.25% solution) to the intact skin of rabbits and guinea pigs was slightly irritating (ECHA) [Kl. score = 2].

Instillation of 0.1 g of sodium hypochlorite into the eyes of rabbits was irritating without full recovery after 7 days (ECHA) [Kl. score = 2].

D. Sensitisation

Sodium hypochlorite was not a skin sensitiser in guinea pig maximisation tests (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

Oral

Male and female F344/N rats were given in their drinking water 0, 0.025%, 0.05%, 0.1%, 0.2%, and 0.4% sodium hypochlorite solution for 90 days. The concentrations correspond to daily intakes of: 0, 12.5, 25, 50, 100 and 200 mg/kg-day for males and 14.3, 28.6, 57.2, 114.4 and 228.8 mg/kg-day for females, assuming a daily water consumption of 25 mL and mean body weights of 0.5 kg for males and 0.35 kg for females. There were deaths during the study. Body weight gain was significantly reduced in the ≥0.2% males and 0.4% females. There were no treatment-related changes noted at necropsy, although several animals, particularly in the 0.4% group, appeared emaciated. Absolute weights of the lung, liver and spleen of males and the salivary gland, lung, heart and brain of females were significantly lower in the 0.4% groups compared to controls. Biochemical changes in the ≥0.2% groups indicated possible liver toxicity, but there were no corresponding histopathological changes in the liver; nor was there any other treatment-related histopathological changes. The NOAEL for this study is 0.1% in drinking water (50 and 57 mg/kg-day for males and females, respectively) (Hasewaga et al., 1986; ECHA). [Kl. score = 1]

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500 and 1000 ppm for males and 0, 1,000 and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25 and 50 mg/kg-day for males; and 0, 57 and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 mL). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups.

No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of treated females) were significantly decreased. The NOAELs are 50 and 114 mg/kg-day for males and females, respectively (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500 and 1000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day for females). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of treated females) were significantly decreased. The NOAELs are 167 and 200 mg/kg-day for males and females (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140 and 275 ppm (corresponding to 0, 3.5, 7 and 13.75 mg/kg-day for males and 0, 4, 8 and 15.7 mg/kg-day for females assuming a body weight of 0.5 and 0.35 g and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end of the studies. There were no treatment-related lesions in rats at the 14-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NO(A)EL > 275 ppm (13.75 mg/kg-day for males and 15.7 mg/kg-day for females) (NTP, 1992).

Male and female B6C3F_1 mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140 and 275 ppm (corresponding to 0, 11.7, 23.3 and 45.8 mg/kg-day for males and 0, 14, 28 and 55 mg/kg-day for females assuming a body weight of 300 kg and 250 kg and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and

their respective controls. There were no treatment-related lesions in mice at the 15-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NOAEL was >275 ppm (45.8 mg/kg-day for males and 55 mg/kg-day for females) (NTP, 1992).

Inhalation

No studies were located.

Dermal

No studies were located.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on sodium hypochlorite are summarised in Table 3.

Table 3 In Vitro Genotoxicity Studies on Sodium Hypochlorite

Test System	Results[a]		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* TA98, TA100)	-	+ (TA100 only)	2	ECHA
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA102)	-	NC	1	ECHA
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA1535, TA1537	-	+ (TA100 only)	1	ECHA
Chromosomal aberration (Chinese Hamster Lung cells)	[b]	+	2	ECHA
Chromosomal aberration (human HE2144 fibroblasts)	Ambiguous	NC	2	ECHA
E. coli PQ37 – SOS Chromotest [DNA repair]	-	-	2	ECHA
S. cerevisiae gene mutation assay	+	-	2	ECHA
Comet assay (human lymphocytes)	+	NC	2	ECHA

[a]+, positive; -, negative; NC, not conducted.
[b]No results since all concentrations were cytotoxic.
TA100 = Salmonella typhimurium strain TA100

In Vivo Studies

The *in vivo* studies on sodium hypochlorite are presented below in Table 4. Sodium hypochlorite was not mutagenic or genotoxic.

Table 4 *In Vivo* Genotoxicity Studies on Sodium Hypochlorite

Test System	Results*	Klimisch Score	Reference
Mouse bone marrow micronucleus (intraperitoneal, 1 or 4 consecutive days)	-	1	ECHA
Mouse bone marrow micronucleus (oral gavage, 1 or 5 consecutive days)	-	2	ECHA
Mouse bone marrow chromosomal aberration (oral gavage, 1 or 5 consecutive days	-	2	ECHA
Rat liver and kidney 8-hydroguanosine [DNA adduct] levels (oral, single dose)	-	2	ECHA
Mouse sperm head morphology	Ambiguous	2	ECHA

*+, positive; -, negative

G. Carcinogenicity

Oral

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500 and 1,000 ppm for males and 0, 1,000 and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25 and 50 mg/kg-day for males; and 0, 57 and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 mL). Survival was similar across all groups. Water consumption was comparable across all groups. There was no evidence of carcinogenicity in the treated animals (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500 and 1,000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day for females). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. There was no evidence of carcinogenicity in the treated mice (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140 and 275 ppm (corresponding to 0, 3.5, 7 and 13.75 mg/kg-day for males and 0, 4, 8 and 15.7 mg/kg-day for females assuming a body weight of 500 g for males and 350 g for females and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end

of the studies. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in F344/N rats receiving 70, 140 or 275 ppm (NTP, 1992).

Male and female B6C3F_1 mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140 and 275 ppm (corresponding to 0, 11.7, 23.3 and 45.8 mg/kg-day for males and 0, 14, 28 and 55 mg/kg-day for females assuming a body weight of 30 g for males and 25 g for females and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and their respective controls. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Sporadically renal neoplasms occurred in the low and high-dose males. This is an unusual finding in mice. Therefore, additional step sections of the kidney were prepared which revealed further incidences of renal hyperplasia in all groups including control and a carcinoma in the low dose group. Nearly all the additional neoplasms seen in the step sections were small (microscopic) adenomas believed to be the probable precursor of renal tubule carcinoma. Since no additional renal neoplasms were found in the mid and high-dose groups and since focal hyperplasia, a potential pre-neoplastic lesion, was found at similar incidences in the control and dosed groups, the small number of renal tubule cell neoplasms in male mice were not considered related to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in male or female B6C3F_1 mice receiving 70, 140 or 275 ppm (NTP, 1992).

H. Reproductive Toxicity

In a one-generation reproductive toxicity study, male and female Long-Evans rats were given in their drinking water 0, 1, 2 or 5 mg/kg-day dose of sodium hypochlorite. Males were dosed 56 days prior to and during mating. Females were dosed 14 days prior to mating, during mating, gestation and until lactation day 21. There were no adverse effects on reproduction or development, including histopathology of the reproductive organs in males and females, sperm parameters in males and histopathologic effects in the non-reproductive organs in females. The NOAEL for reproductive and developmental toxicity is 5 mg/kg-day (Carlton et al., 1986; ECHA). [Kl. score = 2]

I. Developmental Toxicity

Female SD rats were given in their drinking water 0, 1, 10 or 100 mg/L sodium hypochlorite for 2.5 months prior to mating and throughout gestation. Maternal toxicity was not examined. There were no treatment-related effects on viability, foetal weights, and external appearances of the foetuses in all dose groups. The foetuses of the $\geq$10 mg/L groups had a non-statistically significantly higher percentage of skeletal defects compared to controls. The 100 mg/L group also had a non-statistically

significantly higher rate of soft-tissue defects. These defects consisted of three cases of adrenal agenesis, one right-sided heart, one case of improper orientation of the apex of the heart, and one atrio-ventricular valve enlargement. The 100 mg/L group had a statistically significantly higher number of total defects; whereas the 1 mg/L dose had a lower percentage of defects compared to controls. In the absence of a clear dose-response and a relatively higher incidence of defects in the control animals, these findings were not considered to be of toxicological relevance. The NOAEL for developmental toxicity in this study was considered to be 100 mg/L, corresponding to 50 mg/kg-day (Abdel-Rahmen et al., 1982; ECHA). [Kl. score = 2]

J. Derivation of Toxicological Reference and Drinking Water Guidance Values

Non-Cancer

An oral toxicological reference value was not derived for sodium hypochlorite.

The Australian drinking water guideline values for chlorine are 5 mg/L (health) and 0.6 mg/L (aesthetics).

Cancer

Sodium hypochlorite was not carcinogenic to rats or mice in chronic drinking water studies; thus, a cancer reference value was not derived.

K. Human Health Hazard Assessment of Physico-Chemical Properties

Sodium hypochlorite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.

B. Aquatic Toxicity

A number of studies that have been conducted on the toxicity of sodium hypochlorite (or calcium hypochlorite) of aquatic organisms. A comprehensive summary of these studies is beyond the scope of this dossier.

In developing a water quality guideline for chlorine, ANZECC reviewed the literature on the effects of the following chemicals: chlorine gas (Cl_2) bubbled in water, sodium hypochlorite or hypochlorous acid; and ammonium sulfate or chloride and NaOCl at various combinations (molar ratios, pH values) to form monochloramine or dichloramine (ANZECC and ARMCANZ, 2000). The summary of the data measured as total residual chlorine (µg Cl/L) for freshwater fish and invertebrates is as follows:

Freshwater fish

The 24-96 hour LC_{50} values for seven species were 70- 840 µg/L. Two of the values for *O. mykiss* were 14 and 29 µg/L (Basch et al., 1971).

Freshwater crustaceans

The 24-48 LC_{50} values for three species of *cladocerans* were 12-16 µg/L. Two of the 48-hour LC_{50} values were 5 and 6 µg/L, measured under a continuous flow of test solution (Taylor, 1993).

The chronic NOEC from a 10-day *C. dubia* immobilisation study was 48 µg/L. In another chronic test, the NOEC of a 10-day *C. dubia* reproductive impairment test was 48 µg/L (Manning et al., 1996).

Freshwater Mollusc

The 24-48 hour LC_{50} values in one *Nitocris* species was 7,700 to 15,600 µg/L. The chronic 168-hour LC_{50} value for a periphyton was 32 µg/L.

Other species

The 24-48 LC_{50} values for the freshwater annelid *Aelosoma headleyi* were 1,680 to 3,200 µg/L. The 24-48 hour LC_{50} values for three species of insects were 710 to 1,350 µg/L. The 48-hour LC_{50} values for the freshwater rotifer *Philodina acuticornis* were 50 to 100 µg/L.

C. Terrestrial Toxicity

The acute oral LD_{50} value of sodium hypochlorite (12.5% solution) to bobwhite quail is >2,510 mg/kg (ECHA). [Kl. score = 2]

The 8-day oral LC_{50} value of sodium hypochlorite (12.5% solution) to bobwhite quail and mallard duck is >5,620 ppm (ECHA). [Kl. score = 2]

D. Calculation of PNEC

PNEC water

The ANZECC water quality guideline (ANZECC and ARMCANZ, 2000) used acute and chronic laboratory toxicity data for the derivation of a trigger value for chlorine. The guideline for freshwater is: “A freshwater moderate trigger value of 3 µg Cl/L measured as total residual chlorine was derived using the statistical distribution method with 95% protection. This figure was obtained from the application of the default ACR of 10 instead of the empirical ACR of 2.7 from the geometric mean of 8 figures. The smaller ACR would have resulted in a value not protective of some species under continuous exposure to chlorine for at least 48 hours”.

PNEC sediment

No experimental toxicity data on sediment organisms are available. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of sodium

hypochlorite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of sodium hypochlorite is dominated by its water solubility. Sorption of sodium hypochlorite should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium hypochlorite is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

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).

Sodium hypochlorite is an inorganic salt that dissociates completely in water to sodium (Na^+) and hypochlorite (ClO^-) ions. Biodegradation is not applicable to these inorganic ions; For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

As an inorganic salt, neither sodium hypochlorite nor its dissociated ions are expected to accumulate. Thus, sodium hypochlorite does not meet the criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies is <0.1 mg/L in invertebrates. Thus, sodium hypochlorite meets the criteria for toxicity.

The overall conclusion is that sodium hypochlorite is not a PBT substance.

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, sodium hypochlorite does not meet the criteria for persistence or bioaccumulation.

No other characteristics of concern were identified for sodium hypochlorite.

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]	
Sodium Hypochlorite	7681-52-9	Not a PBT	No	No	NA	No	No	Yes	3	3	3

Footnotes:

1 - PBT Assessment based on PBT Framework.

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

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

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

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B. Abbreviations and Acronyms

°C	degrees Celsius
ACR	Acute to chronic ratio
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
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
g	gram
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
kPa	kilopascal
LC	lethal concentration
LD	lethal dose
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mL	millilitre
mPa.s	millipascal second
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration

ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
TRC	total residual chlorine
UV	ultraviolet
µg/L	micrograms per litre