Rasp Mine, Broken Hill Screening Assessment of Health Risk Potentials due to Chemical Dust Suppression Agent Applications

Prepared for:
Broken Hill Operations Pty Ltd

On behalf of:
CBH Resources Ltd

Prepared by:
ENVIRON Australia Pty Ltd

Date:
11 June 2010

Project Number:
AS121150

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This document is issued in confidence to Broken Hill Operations Pty Ltd for the purposes informing the environmental impact assessment being undertaken for the Rasp Mine, Broken Hill, NSW. It should not be used for any other purpose.

VERSION CONTROL RECORD

Document File Name	Date Issued	Version	Authors	Reviewer
1150_BHOP Rasp Dust Suppressants_Final_15Jun10	15 June 2010	Final	Yvonne Scorgie Jackie Wright John Issa	Scott Fishwick

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1 Introduction

ENVIRON Australia Pty Ltd (ENVIRON) has been commissioned by Broken Hill Operations Pty Ltd (BHOP), a wholly owned subsidiary of CBH Resources Limited (CBH) to undertake a screening assessment of the potential for health risks arising due to the proposed application of chemical dust suppressants at the Rasp Mine. ENVIRON has enlisted the assistant of toxicologist John Issa of Cintox Australia Pty Ltd and Jackie Wright of Environmental Risk Sciences Pty Ltd to assist with the screening assessment.

The Rasp Mine is located on Consolidated Mining Lease 7 (CML7) in Broken Hill, NSW. BHOP are currently seeking approval for The Rasp Mine Project, hereafter termed “the Project”, under Part 3A of the *Environmental Planning and Assessment Act 1979 (*EP&A Act). The Project comprises the extension of underground mining to include the Western and Centenary Mineralisation and further mining development of the Main Lode Pillars, the expansion of mining production to 750,000 tpa and the recommencement of processing operations at the Rasp Mine in Broken Hill.

The Air Quality Assessment undertaken by ENVIRON for the Project highlighted the need for efficient dust control of emissions from existing exposed areas and future Project-related activities. BHOP propose to apply chemical dust suppression agents to control dust from various areas including: the tailings storage facility (TSF), unpaved roads and so-called “free areas” which comprise exposed areas which will not be traversed by personnel or vehicles other than in the normal course of land management. The locations of the TSF and free areas are illustrated in **Figure 1**. Chemical dust suppressants will be applied at the intensity required to achieve a dust control efficiency of at least 80%.

Concerns raised in regard to the use of chemical dust suppressants at the Project Site are two-fold:

(a) Achievability of dust control efficiencies of 80% in the field.

(b) Potential for health risks to occur as a result of the application of chemical dust suppressants at the Project Site.

General information on the control efficiencies achievable through the application of chemical dust suppressants agents from US-EPA documentation, and specific information on the control efficiencies of the agents being considered for use at the Project Site from wind tunnel testing studies are documented in the Air Quality Assessment undertaken by ENVIRON for the Rasp Mine Project(1). A summary of such information will be presented in this report and reference made to additional supporting information (**Section 2**).

Health risk concerns specifically relate to possible off-site community exposures to hazardous chemicals that may be present within the dust agents. The potential for off-site dispersal of chemicals due to such chemicals evaporating from application areas and sprays, or adhering to particles and subsequently wind entrained and deposited off-site have

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1 ENVIRON (2010). Rasp Mine, Broken Hill – Air Quality Assessment, Project number AS121150, 19 March 2010.

been raised. Furthermore, the potential existing for droplets containing chemicals to be wind entrained from application sprays and transported off-site.

Potentially hazardous chemicals present within dust suppressant agents being considered for application at the Project Site are discussed and conservative estimates of potential off-site transport of such chemicals presented in **Section 3**.

The toxicity of the chemicals identified is briefly discussed and the potential for health risks occurring as a result of the estimated off-site transport of such chemicals assessed in **Section 4**.

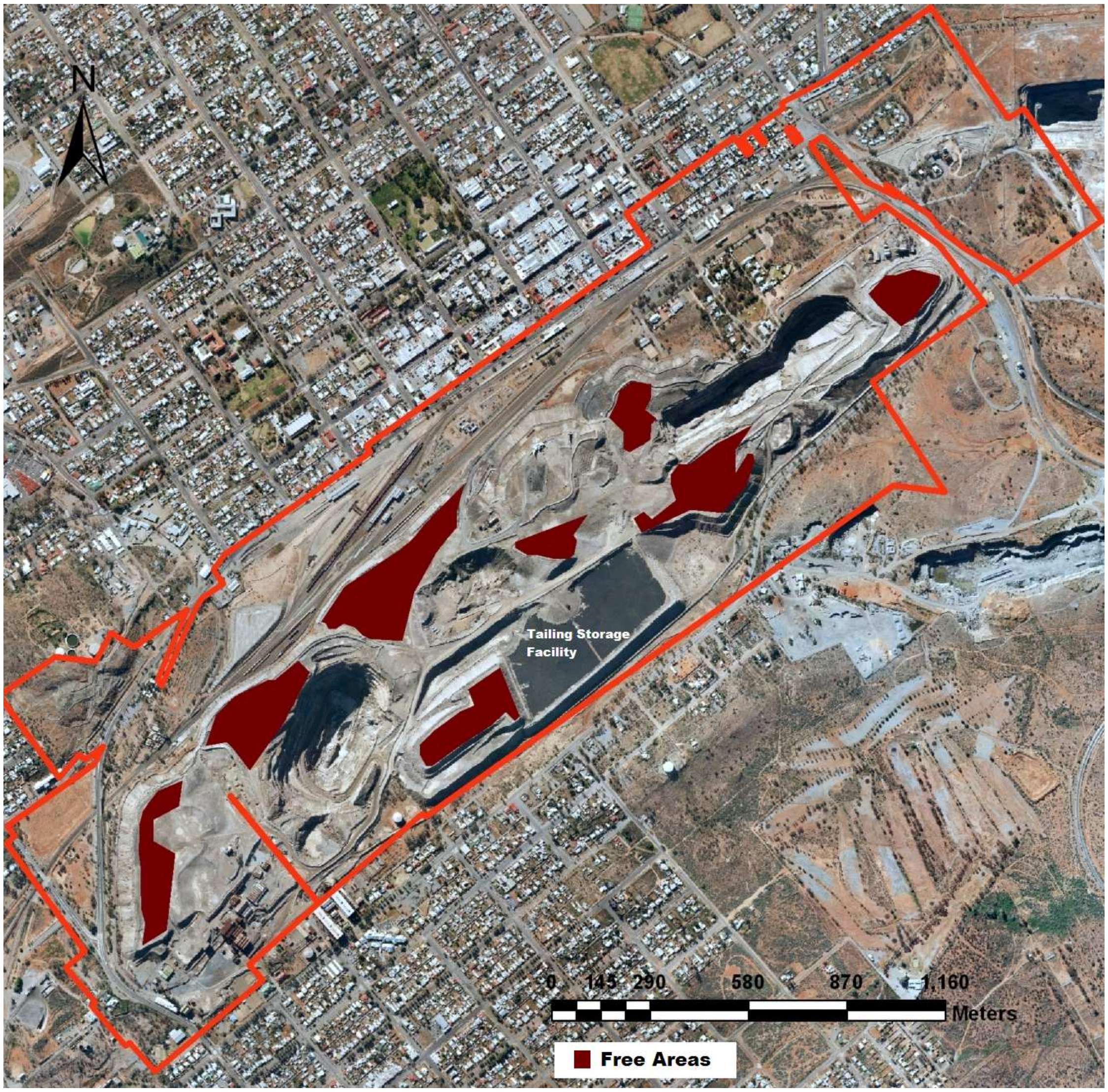

Figure 1: Rasp Mine Site with the location of the wind exposed 'free areas' and tailings storage facility indicated. Red lines delineate the Consolidated Mining Lease 7 (CML7) area.

1.1 Scope of Works

The scope of this study was restricted to the use of available and accessible information in regard to the chemical composition of the dust agents under consideration, and field trial evidence in regard to the dust control effectiveness of such agents.

Dust suppressant agents considered for implementation at the Project Site which are evaluated in the current study are as follows:

- Total Ground Control (TGC) supplied by Reynolds Soil Technologies Pty Ltd, and
- GLUON 500 supplied by Rainstorm Dust Control Pty Ltd.

In assessing field trial evidence of dust control efficiencies reference was made to available information for the TGC and GLUON 500 agents. Additionally, evidence is presented for agents approved under the US-EPA Environmental Technology Verification (ETV) Program where such agents are available for purchase locally (e.g. EK35 and PetroTac). EK35 is supplied locally by Chemcolour Industries Australia Pty Ltd. PetroTac is locally supplied by Chemical Dust Solutions Pty Ltd.

Information on the chemical composition of the above agents was restricted to the ingredients lists in the Material Safety Data Sheets (MSDS). These MSDS are provided in **Appendix A**. Given that the upper limits of chemicals are typically provided in MSDS, e.g. <0.1% styrene, such information could potentially result in a conservative (upper bound) estimation of risk due to chemicals listed. However trace constituents, that may include organic chemicals and metals, are not listed within MSDS.

2 Field Trial Evidence of Dust Control Achievable

An overview of the factors affecting the dust control effectiveness of chemical dust suppressants is given in Section 2.1, with reference made to documented control efficiencies in Section 2.2. Information on the control efficiencies of the dust suppressants being considered for use at the Rasp Mine is presented in Section 2.3.

2.1 Factors affecting Dust Control Efficiencies

The control effectiveness of chemical dust suppressants is depending on a range of factors including (a) dilution rate used in the mixture; (b) application rates, i.e. volume of solution per unit area; (c) time between applications; (d) the frequency and magnitude of surface disturbances, including traffic on roadways or open areas; and (e) meteorological conditions, specifically rainfall. Other factors that affect the performance of products include the characteristics of the area (slope; material character) and deposition of material onto the treated surface through track-on by vehicles or wind entrainment from untreated areas. The variability of these factors, and differences between individual dust control products, make the control efficiencies of chemical dust suppressants difficult to estimate.

Due to the periodic reapplication of most chemicals, the use of a time-averaged control efficiency is appropriate[2]. The estimation of the average control efficiency of a chemical involves the calculation of the ‘ground inventory’ and the estimation of the control efficiency arising from such a ground inventory. The ground inventory is a measure of the residual effects of earlier applications, and is calculated by adding together the total volume of concentrate (undiluted) per unit area applied since the start of the dust control season, expressed in litres per square metre. Following the calculation of the ground inventory, the control efficiency as a percentage arising from such an inventory may be estimated based either on information from the chemical supplier or on chemical dust suppressant control efficiency models.

2.2 Documented Dust Control Efficiencies

Due to the extent of the disturbances experienced on unpaved roads, by way of frequent traffic passes and track-on from unsealed shoulders, unpaved roads represent potentially the most challenging area to achieve high dust control efficiencies using dust suppression products.

The US-EPA reference to the control efficiencies achievable through chemical dust suppression in its AP42 Emission Factor Database chapter on Unpaved Roads, represents the most widely referenced source in this regard [3]. Referencing field studies conducted in the 1980s, the US-EPA concludes that chemical dust suppressants can provide a PM_{10} control efficiency of about 80 percent when a sufficient ground inventory has been established.

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[2] C. Cowherd, Jr. *et al., Control Of Open Fugitive Dust Sources*, EPA-450/3-88-008, , U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1988.

[3] US-EPA (2006). *AP42 Emission Factor Database*, Chapter 13.2.2 Unpaved Roads, United States Environmental Protection Agency, November 2006.

Control efficiency models may be generated for specific chemical stabilizers, based on a range of assumptions. An example of a chemical dust suppressant PM10 control efficiency model is illustrated in **Figure 2**. The model assumes 300 vehicle passes per day. The PM_{10} control efficiency for three averaging periods, viz. one week, two weeks, and a month, is given. Although only chemical treatments within the current control season are taken into account up to 20 percent of the final ground inventory value may be due to treatments within the previous season. The value of chemicals stabilizers applied in previous seasons is, however, dependent on whether the same chemical was used, and whether regrading of the road has been undertaken.

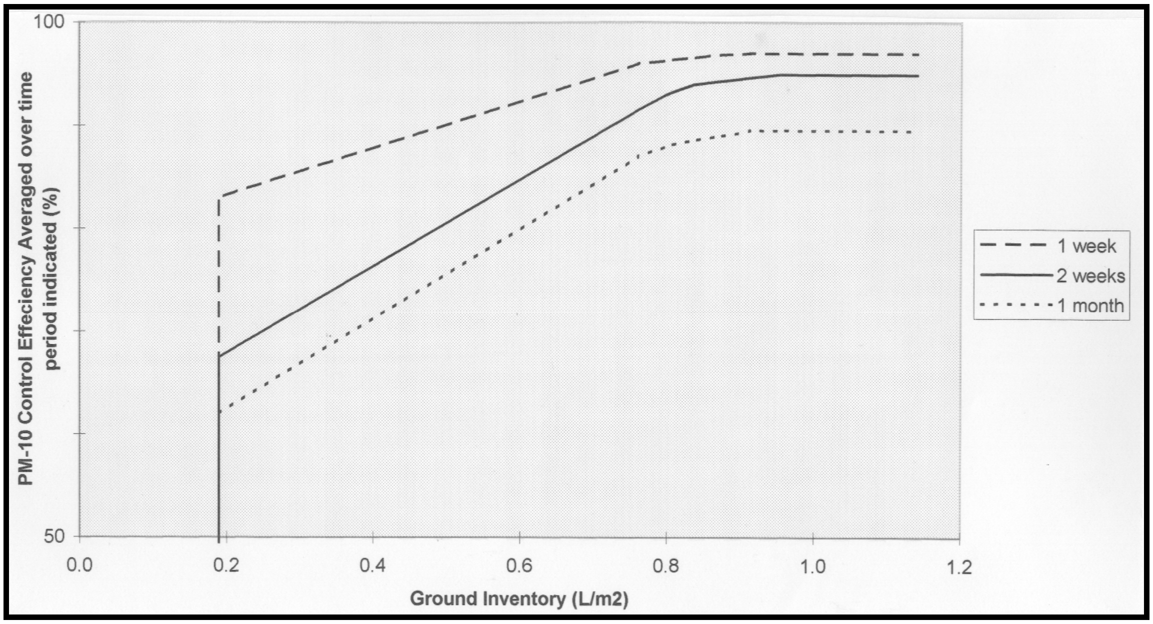

Figure 2. Chemical dust suppressant control efficiency model (after Cowherd *et al*., 1988).

More recently the US-EPA has verified the dust control efficiency of several chemical dust suppressants through field trials as part of its Environmental Technology Verification (ETV) Program[4]. The range of dust control efficiencies measured for each of the products currently approved under this Program are summarised in **Table 1**.

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[4] http://www.epa.gov/etv/vt-apc.html#dsssp

Table 1: Dust control efficiencies of chemical dust suppressants approved by the US-EPA under its ETV Program

	Dust Control Efficiency (%)		
Product	**Total Particulate Matter (TPM)**	**PM10**	**PM2.5**
EK35	63 - 87	84 - 90	56 - 94+
EnviroKleen	78 - 99+	87 - 91+	20 - 87+
DustGard	75 - 86	88 - 90+	58 - 59
PetroTac	74 - 94	73 - 98	>90
Techsuppress	62 - 84	43 - 76	>90

Certain of these products are available for purchase within Australia including EK35 and PetroTac. (EK35 is supplied locally by Chemcolour Industries Australia Pty Ltd. PetroTac is locally supplied by Chemical Dust Solutions Pty Ltd.) Detailed chemical testing was undertaken for EK35 during the course of the product verification, as documented in the ETV Report EPA/600/R-05/128 dated January 2006(5). Such testing included analysis for trace analytes including metals, semi-volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), herbicides, pesticides, and polynuclear aromatic hydrocarbons (PAHs).

The above mentioned products are generally suitable for applications on unpaved roadways. The US-EPA ETV Program has focused on products for roads due to vehicle-entrained road dust being a significant source of airborne particles, and since achieving high dust control efficiencies on roads is complicated by frequent traffic movements. It is accepted that higher dust control efficiencies are achievable for undisturbed exposed areas.

2.3 Effectiveness of GLUON and Total Ground Control (TGC) Products

2.3.1 Wind Tunnel Trials

The chemical dust suppressants being considered for application for the Project are reported to have a dust abatement efficiency of above 95% (Tundra Bulk Solids Handling Research Associates, July 2009; Introspec Consulting, November 2009). This dust control efficiency is based on wind tunnel testing of various tailings materials, including lead tailings, under wind speeds of 10 m/s. A summary of the wind tunnel test findings is presented in **Table 2**.

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[5] http://www.epa.gov/etv/pubs/600r05128.pdf

Table 2: Dust control efficiencies measured for GLUON and TGC within wind tunnel tests

Chemical Dust Suppressant	Source Controlled	Application Scenario	Wind Speed	Dust lift off (g/m²)	Dust lift off (grams)	Dust Control Efficiency (%)
GLUON[6](a)	Iron ore piles	no control	10 m/s		70.6	
		water	10 m/s		7.2	89.8
		Gluon240 (3%)	10 m/s		12.7	82.0
		Gluon240SP (3%)	10 m/s		1.03	98.5
		Gluon240SP (5%)	10 m/s		0	100.0
TGC[7]	Bauxite tailings	no control	10 m/s	663.7	26.4	
		water	10 m/s	248.9	8.4	68.2
		TGC (3%)	10 m/s	0	0	100.0
		TGC (2%)	10 m/s	20.7	0.7	97.3
TGC7	Gold, Silver, Lead tailings	no control	10 m/s	641.5	21.7	
		water	10 m/s	221.8	7.5	65.4
		TGC (3%)	10 m/s	0	0	100.0
		TGC (2%)	10 m/s	16.3	0.6	97.2

(a)GLUON500 represents a more recently developed product introduced by Rainstorm Dust Control.

Both GLUON and TGC are design for use as broad acre and stockpile stabilizers, with TGC also being marketed with specific application to tailings storage facilities. Both are long term crusting agents, requiring generally very infrequent application (e.g. up to 18 months between applications for TGC for free area applications),

Despite the high dust control efficiencies achieved by the chemical dust suppressants under wind tunnel testing in laboratory conditions, questions have been raised in regard to the performance of these products in the field under wind speeds greater than 10 m/s.

2.3.2 Field Trials

Field trial information was requested from the suppliers of TGC and GLUON. Information and testimonials were primarily received for TGC, a summary of which is given in **Table 3**. Although primarily applied at mining operations, these products have also been implemented at other sites, e.g. Brisbane Airport, construction works (e.g. Leschenault Leisure Centre upgrade, Australind, WA), agricultural operations and applied in road side embankment stabilization.

TGC is reported to have performed well in a range of environments, including areas experiencing high UV levels, strong winds (~30 m/s) and seasonal rainstorms. Under harsher meteorological conditions greater solution strengths and more frequent applications are implemented.

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[6] Introspec Consulting (2006). Wind Tunnel Test for the Evaluation of Selected Solution Strengths of GLUON Veneer to Reduce Dust Lift-off from the Surface of Iron Ore Stockpiles, Project Conducted at Tunra Bulk Solids Handling Research Associates, University of Newcastle, November 2006.

[7] Tunra Bulk Solids Handling Research Associates (2009). Analysis for Tailings Dam Application using Reynolds Soil Technologies Total Ground Control (TGC) Treatment, July 2009.

Table 3: Information from Field trials of TGC

Location Applied	**Source Controlled**	Performance
Barrick Gold Corporation – Osborne Mine, Townsville, QLD	Tailings storage facilities (gold)	“the product has performed as stated by RST and made a huge difference to the amount of windblown dust emissions, even on the windiest of days” (Glen Pryce, Environmental Team Leader, Osborne Mine, 20 April 2009)
Rio Tinto Alcan – Weipa Operations, QLD	Tailings Storage Facility (bauxite)	Weipa, located in far north Queensland, is a windy environment with an extended dry season. The TSF is situated immediately adjacent to the residential suburb of Nanum. Easterly winds blow persistently throughout much of the year, with Nanum being situated to the west (and hence downwind) of the TSF. Wind blown dust incidences in 2008 resulted in the QLD EPA requiring that efficient dust controls be identified and applied to ensure no further incidents occur. TGC was applied at 3% solution strength at the East Weipa TSF. It was noted to result in significant reductions in airborne dust levels and eliminated the need for constant re-watering of the entire area to prevent dust. The QLD EPA is reported to be satisfied with progress being made in regard to dust mitigation to the surrounding neighborhoods.
Glencore International AG - Compañía Minera Aguilar SA (Aguilar), zinc and lead mine, in the north of Argentina, Jujuy Province	Tailings storage facility (lead, zinc mine)	Successfully trialled for 10 hectares of tailings dams. The treated area was reported to show no visible dust lift off.
Tarong Energy Corporation Ltd – Tarong Power Station, QLD	Ash disposal facility	Testimonial from Clint Inwards (Ash Plant Facilities Officer at Tarong Power Station): “Recently we used TGC at our ash disposal facility, on an area that was a major source of dust. Green dye was added with the TGC, to identify the area of application. The TGC formed a crust over the dust source and it has been successful in containing the dust. We applied the TGC concentration for a life expectancy of 12 – 18 months. Although it is early in that life expectancy, I am confident that we should achieve this target. We have experienced weather conditions of all extremes in this area recently, including a down pour of rain which lasted for over 3 days. After the rainfall I was surprised to see the TGC crust without any deterioration and the dust source is still contained.”

3 Off-site Transfer of Potential Contaminants

This section documents the contaminants of potential concern identified for review in the current study (Section 3.1), potential mechanisms whereby such chemicals may be transferred off-site (Section 3.2), and conservative upper bound estimates of the maximum off-site levels of such chemicals (Section 3.3).

3.1 Identification of Contaminants of Potential Concern

GLUON 500 comprises a liquid polymer emulsion which is given as being made up primarily of non hazardous vinyl acetate/acrylic copolymer (54% to 56%) and water (44-46%). Trace chemicals listed on the MSDS are: acetaldehyde (0-0.1%) and vinyl acetate (0-0.09%).

The composition of Total Ground Control (TGC) is indicated on the MSDS as being comprised of non-hazardous proprietary ingredients (~100%), with no further detail on such ingredients provided. Trace chemicals are given as including ammonia (0-<1%) and styrene (0-<0.1%).

3.2 Mechanisms for Off-site Transfer of Chemicals

Chemical dust suppressants, diluted in water, are to be applied to free areas using a water cart. Roadway applications of dust suppressants may be achieved through the application of water carts or roadside sprays.

A detailed description of the dust suppression system to be implemented at the TSF is given in the Golder Associates (February 2010) report(8) and the Air Quality Assessment for the Project(9). The system involves primarily the application of the chemical dust agent using a set of sprinklers located on the perimeter of the two TSF cells.

Based on the locations of dust suppressant applications, and the nature of such applications, the following potential mechanisms for off-site transfer of chemicals were identified:

- Volatilisation of chemicals from sprays and from the ground, and dispersion of such chemicals in the air to off-site locations. (Inhalation represents the main inhalation pathway for off-site ambient air concentrations of such chemicals.)
- Chemicals adhering to soil particles on the ground, with subsequent wind entrainment and dispersal and deposition off-site. (Potential pathways of exposure to off-site deposited chemicals include ingestion and dermal contact.)
- Wind entrainment of droplets containing chemicals from application sprays and transfer of such droplets off-site. (Exposure pathways to droplet drift may include inhalation, ingestion and dermal contact.)

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8 Golder Associates (2010). Rasp Mine, Broken Hill, NSW – Tailings Storage Facility Feasibility Design, Report Number 08761101 012 R Rev3, February 2010.

9 ENVIRON (2010). Rasp Mine, Broken Hill – Air Quality Assessment, Project number AS121150, 19 March 2010.

3.3 Upper Bound Estimates of Chemicals Leaving the Mine Site

3.3.1 Off-site Concentrations and Deposition Rates

RST recommends that TGC be applied at a solution strength or 2% to 3%, with reapplication typically required after 12 to 18 months. To ensure that a dust control efficiency of 80% will be achieved at the Project site, a solution strength of 5% (i.e. 1 part TGC for every 20 litres of water) with annual applications was assumed. Given the extent of the free areas (22.3 ha), it was estimated that 1 675 litres of TCG would need to be applied per year.

Based on the highly conservative assumption that all of the ammonia and styrene in the TGC would be emitted during the application, emission rates of approximately 138 grams/annum and 15 grams/annum were estimated for ammonia and styrene respectively based on the upper bound proportions of these chemicals in the agent.

GLUON 500 is designed for application on non-trafficked areas. The heaviest application rates of this agent (over 100 ml/m²) is reported to result in the soil becoming a rock hard surface, with efficiencies retained for months to years depending on whether the site is disturbed. The supplier recommends an application rate (water and agent) of 1 L/m². A solution strength of 10% would be required to achieve a chemical application rate of 100 ml/m². Given the extent of the free areas, it was estimated that about 22,300 litres of the agent would be required.

Conservatively assuming that all of the acetaldehyde and vinyl acetate in the GLUON 500 agent would be emitted during the application, emission rates of 17.4 kg/annum and 18.1 kg/annum were estimated respectively based on the upper bound portions of these chemicals in the agent.

In the estimation of maximum possible off-site deposition of chemicals sorbed onto particles, the conservative assumption was made that 20% of the chemicals applied (by mass) would adhere to and be deposited with the uncontrolled dust being entrained from the free areas.

Off-site dispersion of the emissions estimated was simulated using the air dispersion model developed and populated for the Rasp Mine Site for the Air Quality Assessment(10). Maximum off-site ambient air pollutant concentrations and deposition rates predicted to occur as a result of the upper bound emission estimates are documented in **Table 4**.

Table 4: Predicted maximum off-site air concentrations and deposition rates

Product	Chemical	Maximum Off-site Air Concentrations(µg/m³)			Deposition (mg/m²/annum)
		1 hr max	24 hr max	Annual	Annual
Total Ground Control	Ammonia	1.1E-03	9.3E-05	8.1E-09	2.9E-03
Total Ground Control	Styrene	1.2E-04	1.0E-05	8.9E-10	3.1E-04
GLUON 500	Acetaldehyde	1.4E-01	1.2E-02	1.0E-06	3.6E-01
GLUON 500	Vinyl acetate	1.5E-01	1.2E-02	1.1E-06	3.8E-01

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10 ENVIRON (2010). Rasp Mine, Broken Hill – Air Quality Assessment, Project number AS121150, 19 March 2010.

3.3.2 Spray Droplet Drift

The application of dust suppressant agents to the TSF carries the greatest risk of droplet entrainment and drift off-site. This is due to the proximity of the TSF to the site boundary, the use of sprinklers with relatively longer throw distances (95 m given as maximum throw distance) compared to water truck sprays, and the likelihood of such sprinklers being operated during periods of high wind.

Six sprinklers are proposed around the perimeter of each of the two TSF cells. Each sprinkler has a maximum throw distance of 95 m and a maximum spacing of 75 m is proposed between sprinkler units. The operating pressure of each unit is given as 800 kPa. It is proposed that 6000 litres of a crusting agent will be added to water at a solution strength of 3% and applied across the inactive TSF cell over a two week period. The two sprinklers (per cell) to be located along the eastern perimeter of the TSF are estimated to be at least 150 m away from the adjacent public road and adjacent residences.

The potential for spray droplet drift due to the application of dust suppressant agents on TSF cells was assessed through the application of the AgDRIFT® (Version 2.0.05) and DRIFTSIM (Version 3.1) models.

AgDRIFT® comprises the US-EPA regulatory screening methodologies for assessing off-target drift due to ground and orchard airblast spraying and aerial spraying(11). The Tier I ground sprayer assessment method was used, assuming an elevated (“high boom”) sprayer due to the height of the TSF and “very fine to fine” droplet size distributions, to provide a conservative estimate of downwind spray droplet drift.

Maximum downwind spray deposition, given as a factor of the application rate, estimated for the sprinklers on the perimeter of the TSF is depicted in **Figure 3**. It is evident that the majority of the deposition is expected to occur within 50 m of the sprinklers with no substantial deposition likely to occur over 100 m. At 150 m, maximum downwind deposition rates are estimated to comprise a fraction of 0.004 of the initial application rate.

Taking into account the sprinkler application rates, agent solution strengths and chemical content within the agent, the maximum quantities of chemicals estimated to be carried off-site within droplets and available for deposited at distances greater than 150 m (given conducive meteorological conditions) are as follows:

- TCG application – ammonia (2.4 grams/day); styrene (0.3 grams/day)
- GLUON 500 application – acetaldehyde (0.2 grams/day); vinyl acetate (0.2 grams/day)

To determine the likelihood of spray drift occurring beyond 100 m downwind of the sprinklers, use was made of the DRIFTSIM model. DRIFTSIM was developed by the US Department of Agriculture, Agricultural Research Service (USDA-ARS) in collaboration with

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11 Teske ME, Bird AL, Esterly DM, Ray SL and Perry SG. (2002). A User’s Guide for AgDRIFT® 2.0.05: A Tiered Approach for the Assessment of Spray Drift of Pesticides, Prepared for Spray Drift Task Force, C.D.I. Report No. 01-02, January 2002.

the Food Agricultural and Biological Engineering Dept. at The Ohio State University(12). Model inputs used within DRIFTSIM are documented in **Table 5**.

Table 5: DRIFTSIM model inputs

Variable	Model Range	Value Used	Notes
Droplet diameter (µm)	10 - 2000	10	Provided most conservative estimate of downwind drift distance
Discharge height (m)	0.5	0.5	Site specific
Wind velocity (m/s)	0 - 10	10	Maximum wind speed in model range used to provide upper bound estimate
Relative humidity (%)	10 - 100	15 - 95	Based on hourly meteorological data from the Bureau of Meteorology's Broken Hill automatic weather station, the relative humidity was noted to vary between 15% and 95%, with average humidity in the range of 50%. A range of values was modeled to determine upper bound drift distances.
Temperature (℃)	10 - 30	10 - 30	A range of values was modeled to determine upper bound drift distances.
Droplet velocity (m/s)	34.1	34.1	Model calculated from site specific spray pressure (800 kPa)

Spray drift distances were only calculated by the model to extend beyond 100 m for very small droplet sizes (~10 µm) and very high relative humidity conditions (95%). Such high relative humidity conditions are only measured to occur about 0.1% of the time (based on data from the Bureau of Meteorology's Broken Hill automatic weather station).

Based on the spray drift modelling undertaken it is concluded that the meteorological conditions conducive to spray drift occurring beyond 100 m occur infrequently (<0.1% of the time). Furthermore, only a small fraction (0.004) of the chemicals applied reach distances of 150 m.

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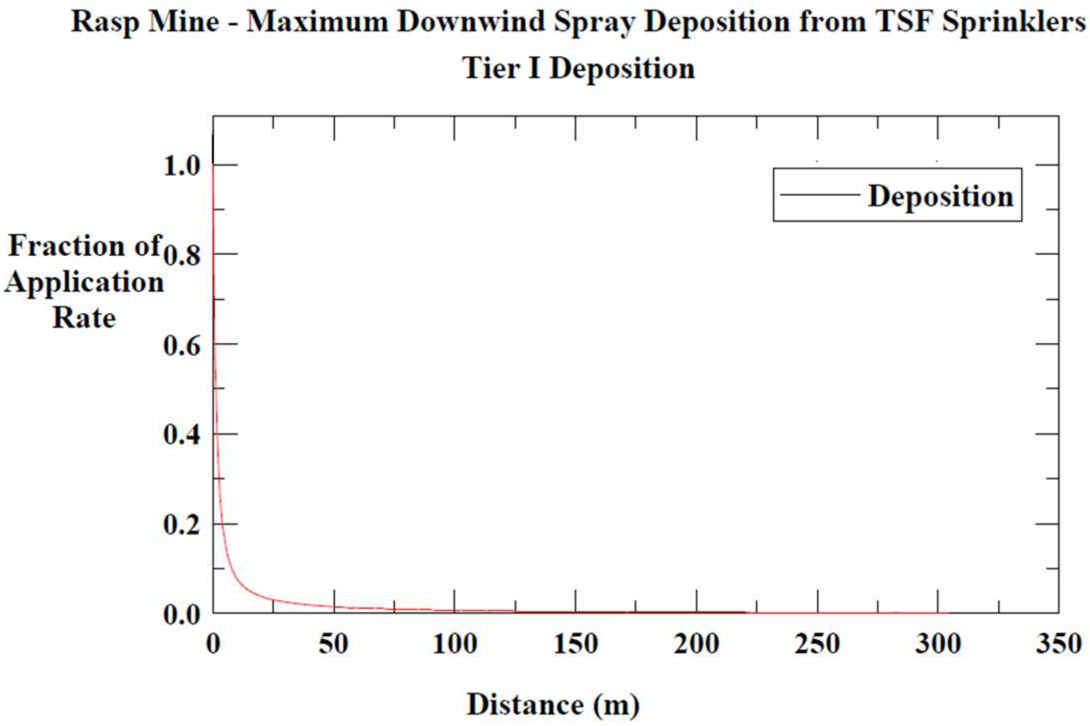
12 Zhu, H., D.L. Reichard, R.D. Fox, H.E. Ozkan and R.D. Brazee. 1995. DRIFTSIM, a program to estimate drift distances of spray droplets. Applied Engineering in Agriculture 11 (3): 365-369.



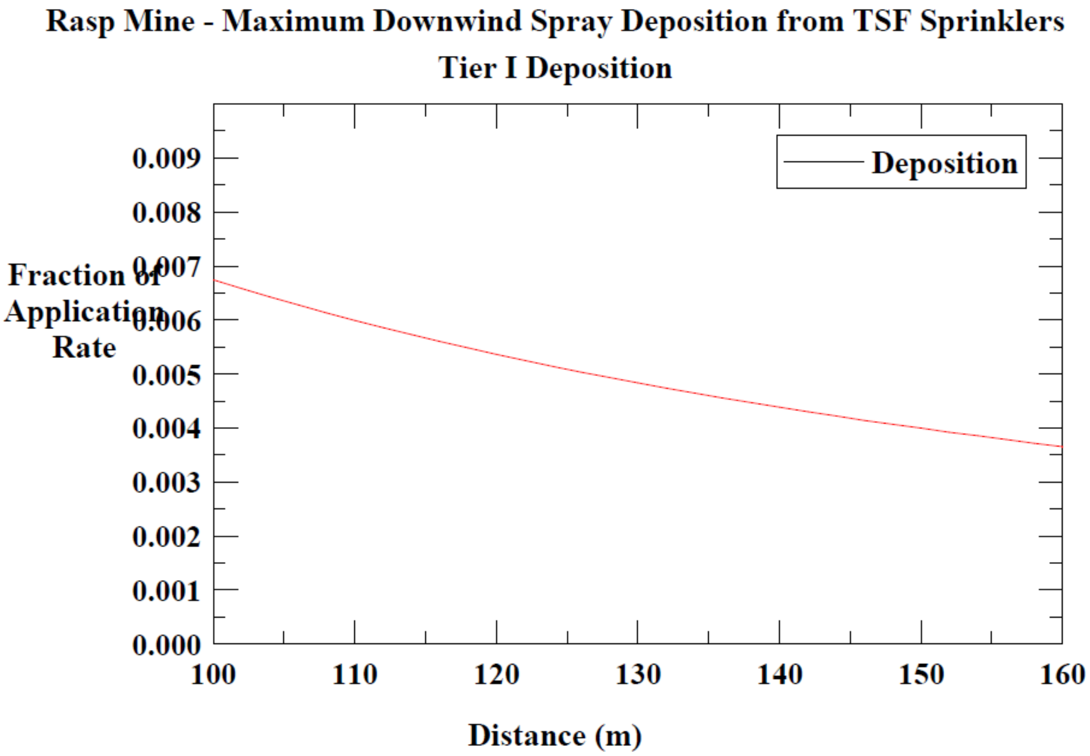


Figure 3: **Maximum downwind spray deposition, given as a factor of the application rate, estimated for the sprinklers on the perimeter of the TSF.**

4 Health Risk Potentials to Dust Agent Applications

This section provides toxicity profiles for the contaminants of potential concern identified and details the exposure and risk assessment methodology implemented and the result of this assessment.

4.1 Chemical and Toxicity Profile for Contaminates of Concern

4.1.1 Ammonia

Ammonia (NH_3) is a gas which exists in solution as ammonium hydroxide (NH_4OH). Therefore ammonia is a highly volatile and relatively mobile chemical in air. It has a vapour pressure of 7510 mmHg at 25^{o}C, 1.6 x 10^{-5} atm.m^3/mol vapour density of 0.59, and an air diffusion coefficient of 0.28 cm^2/s. It has a characteristic and pungent odour with an odour threshold of 18 - 38 mg/m^3 in air.

The half-life of ammonia in air is in the order of a few days. Ammonia is a key compound in the nitrogen cycle and as such is continually recycled in the environment. Therefore it is expected to have low persistence.

The following summary of key health effects has been derived from Health Effects Summary presented in ATSDR 2004[13] and WHO 1996[14].

Following acute exposure, ammonia and ammonia solutions are irritating and corrosive and may and can cause burns to the skin, eyes, mouth and lungs. Acute oral exposure rapidly results in pain, excessive salivation and burns to the mouth, throat and oesophagus. Acute inhalation may cause upper respiratory tract irritation. Substantial exposures can result in burns as well as airway obstruction, respiratory disease and bronchiolar and alveolar oedema. Ammonia and ammonia solutions are corrosive via direct contact with tissues and splashes to the eye may result in serious injury. However, these local effects are concentration dependent and unlikely to be observed at low concentration such as those below the occupational exposure standard (25 ppm or 18 mg/m^3 as 8-hr time weighted average (TWA), and 35 ppm or 25 mg/m^3 as a short term exposure limit (STEL)).

Effects following chronic oral exposure have not been identified in humans, however data from animals suggest osteoporosis, occurring secondary to chronic metabolic acidosis and the key endpoints. Chronic inhalation exposure has been associated with increase cough, phlegm, wheeze and asthma.

Human data are inconclusive with regard to the genotoxicity of ammonia. However the available animal data indicate that ammonia and ammonium ion may have some clastogenic and mutagenic properties. The database of information is limited and significance of these finding is not clear, particularly to mammals (WHO 1986) and further tests that are more relevant to mammals is recommended by the ATSDR.

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[13] http://www.atsdr.cdc.gov/toxprofiles/tp126.html

[14] http://www.inchem.org/documents/ehc/ehc/ehc54.htm

Limited information is available on the carcinogenic potential of ammonia to humans. There is some evidence of carcinogenicity in animal studies however the significance of the findings is unclear.

The Australian Drinking Water Guidelines (2004) has established a guideline value of 0.5 mg/L based on aesthetic considerations. There are no guidelines based on health.

The US EPA Integrated Risk Information System (IRIS) contains an Inhalation Reference Concentration (RfC) of 0.1 mg/m^3 based on decreased pulmonary function or changes in subjective syptomatology (critical organ: lung) in an occupational study. The RfC has been derived on the basis of a ‘no observed adverse effect level (NOAEL) of 2.3 mg/m^3 (HEC) and uncertainty factor of 30.

4.1.2 Styrene

Styrene (C8H8) is a liquid which is commonly used as a solvent or as a monomer in polymer production. It has a vapour pressure of 6.4 mmHg at 20℃ (1/3 of the vapour pressure of water), Henry’s Law Constant of 2.61x10^{-3} atm.m^3/mol (@25^{o}C), and an air diffusion coefficient of 0.0711 cm^2/s. These properties indicate that styrene is volatile and relatively mobile in air. It has an aromatic, sweet, penetrating odour with an odour threshold of 400-640 µg/m^3 (recognition in air).

If released to air styrene will exist as a vapour which will be degraded by reaction with photochemically-produced hydroxyl radicals and ozone. The half-life is approx 7 to 16 hours.

Biodegradation by aerobic microorganisms may lead to extensive or complete destruction in soil.

Styrene may irritate the eyes and mucous membranes and result in effects to the central nervous system (CNS). Most sensitive endpoint associated with acute exposure is eye and throat irritation.

Most widely examined and sensitive endpoint for styrene exposure is neurotoxicity (CNS effects). Synergistic action is noted between styrene and other volatile solvents.

Available studies on carcinogenicity and genotoxicity show mixed and inconsistent results. Styrene induced mutations in human lymphocytes and caused DNA strand breaks and chromosome aberrations. However it did not induce DNA adducts in humans and was negative in other DNA repair tests and the micronucleus test. Its carcinogenic potential is related to the metabolite styrene oxide. In humans the concentration of this metabolite is low due to rapid biotransformation to styrene glycol. Occupational studies are typically affected by exposure to other solvents. In addition studies in mice that show the development of lung tumours associated with formation of styrene oxide resulting in cytotoxicity and increased cell proliferation may not be relevant in humans. On the basis of the available data genotoxic effects are not considered critical endpoints for the development of a guideline based on the equivocal evidence of carcinogenicity.

An acceptable daily intake (ADI) of 0.0077 mg/kg/day was used for Styrene in the Australian Drinking Water Guidelines[15]. The WHO[16] has set a tolerable daily intake (TDI) of 0.0077 mg/kg/day for styrene. This was based on reduced body weight in a 2-year drinking water study using rats and 1000 fold uncertainty factor (includes additional 10 fold safety for carcinogenicity and genotoxicity of metabolite. The WHO Ambient Air Quality Guidelines[17] contain a level of 0.26 mg/m^3 (1 week).

4.1.3 Acetaldehyde

Acetaldehyde is a colourless liquid or colorless gas at around room temperature having a boiling point of 21℃ and a high vapour pressure of 99 kPa at 20℃. It is highly soluble in water and expected to be mobile in soil.

Acetaldehyde induces moderate irritation in human eyes and respiratory tract including the throat and nose. In experimental animals, acetaldehyde showed moderate irritation in the eyes and skin of rabbits.

Oral administration of acetaldehyde to rats for 4 weeks caused slight hyperkeratosis of the forestomach at a dose of 675 mg/kg/day. The NOAEL is 125 mg/kg/day. Inhalation exposure caused damage of epithelium of the respiratory tract in rats and hamsters. The NOAEL values are 150 ppm (270 mg/m^3) for rats exposed for 4 weeks and 390 ppm (700 mg/m^3) for hamsters exposed for 13 weeks based on the effects of upper respiratory tract.

There are no reliable epidemiological data for carcinogenicity of acetaldehyde to humans. In rats, 27-month inhalation exposure of acetaldehyde at doses of 750 ppm (1,350 mg/m^3) and above caused dose-dependent increases in nasal adenocarcinoma and squamous cell carcinoma. Also, in hamsters, 52-week inhalation exposure of acetaldehyde at doses of 2,500 ppm (4,500 mg/m^3) and above exhibited significant increases in laryngeal and nasal tumours. Therefore, acetaldehyde is considered to be carcinogenic in experimental animals. Some data suggest the promoter activity of acetaldehyde to respiratory tumorigenesis, but the data are limited to make a definitive conclusion. Acetaldehyde is categorized as Group 2B (the agent is possibly carcinogenic to humans) by the IARC.

In genotoxicity studies of acetaldehyde, there are many positive results in *in vitro* studies including gene mutation, chromosomal aberration, sister chromatid exchanges. Also in *in vivo* studies, the frequency of sister chromatid exchange was increased in intraperitoneal studies using hamsters and mice, and positive results were observed in a micronucleus assay. From the overall evaluation of these data, acetaldehyde is considered to be genotoxic.

A TDI of 0.1 mg/kg b.w. has been established in the EU Scientific Committee on Food[18] . This was based on the toxicity profile of acetaldehyde being similar to metaldehyde. A 2-

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[15] http://www.nhmrc.gov.au/publications/synopses/eh19syn.htm

[16] WHO, 2003. Styrene in Drinking-water. Background document for the development of WHO Guidelines for Drinking-water quality.

[17] http://www.who.int/phe/health_topics/outdoorair_aqg/en/

[18] Opinion of the Scientific Committee on Food on an additional list of monomers and additives for food contact materials (adopted the 18 September 1998)

year oral rat study and a 3-generation oral rat study including teratogenicity with metaldehyde were used. The reports on nasal carcinogenicity after inhalation were considered without relevance for effects from oral intake of smaller doses.

The US EPA IRIS contains Inhalation RfC of 0.009 mg/m^3 for non-neoplastic effects and and Unit Risk of 2.2 x 10^{-6} per (µg/m^3) based on the incidence of nasal squamous cell carcinoma or adenocarcinoma in rats.

4.1.4 Vinyl Acetate

Vinyl acetate is commonly used as a monomer in the production of polyvinyl acetate polymers and copolymers which are the main components of some dust suppressant products.

Vinyl acetate is highly volatile and expected to have a high rate of volatilisation from moist soil surfaces based on an estimated Henry's Law constant of 5.1X10-4 atm-m^3/mole, vapour pressure of 90.2 mm Hg, and high water solubility of 20,000 mg/L. However, a hydrolysis half-life of 7.3 days indicates that hydrolysis is also likely to occur in moist soils. Similarly, biodegradation of vinyl acetate occurred rapidly (within 26 hours under both anaerobic and aerobic conditions). In the atmosphere vinyl acetate is degraded by reaction with photochemically-produced hydroxyl radicals with the half-life for this reaction in air is estimated to be 14 hours.

Acute inhalation tests with rats demonstrated severe irritation in the respiratory tract of the animals. Similar there is evidence to show that this compound has potential for irritation of skin and eyes.

In a resent European draft risk assessment[19] of vinyl acetate has it has been concluded that there is clear evidence for the carcinogenicity of vinyl acetate in two animal species and in both sexes. The carcinogenic potential was demonstrated for the inhalation and oral route of administration. Vinyl acetate was carcinogenic at the surface epithelium of multiple sites along the exposure routes. However, The data from human experience are inadequate for the evaluation of the carcinogenicity of vinyl acetate in humans. The report recommendation is for vinyl acetate to be classified in Europe as a Category 2 Carcinogen.

Vinyl acetate is negative was bacterial mutagenicity tests. Clastogenicity was demonstrated in a number of in vitro assays. Some weak potential for producing micronuclei was observed in in vivo assays. Vinyl acetate is hydrolyzed by carboxylesterases to acetic acid and acetaldehyde which is subsequently oxidized to acetic acid by aldehydedehydrogenases. Vinyl acetate is thought to exhibits its genotoxicity via

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http://ec.europa.eu/food/fs/sc/scf/outcome_en.html

[19] http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/DRAFT/R059_0807_env_hh.pdf

acetaldehyde. However, there is no clear evidence for vinyl acetate being a genotoxic carcinogen,

The US EPA IRIS contains Inhalation RfC of 0.2 mg/m^3 for non-neoplastic effects.

4.2 Exposure and Risk Assessment

4.2.1 Approach to the Assessment of Health Risks

The assessment of potential health risks associated with use of the nominated dust suppressants on the site has been conducted in accordance with the protocols/ guidelines recommended by enHealth ("Health Impact Assessment Guidelines" (2001) and "Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards", June 2002 [reprinted 2004]) and NEPM (Schedule B(4), "Guideline on Health Risk Assessment Methodology", 1999). Where relevant (and as referenced), guidance has also been used from international, published, peer reviewed sources.

Based on the information available in relation to the composition of the products to be used and the air modelling presented in the previous section the following presents a discussion on exposure pathways considered to be potentially complete that may or may not warrant further consideration:

- The key compounds of concern identified in the dust suppressants are volatile, hence the inhalation of vapour phase concentrations emitted to air and carried off-site into adjacent residential areas during the spray application of these products was investigated.

- For organic compounds to be of concern with respect to sorption to dust and soil and subsequent exposures due to inhalation, ingestion or dermal contact with soil, the organic compounds need to be sufficiently persistent and have the ability to absorb at high enough levels onto dust and soil to be of concern. The key compounds indentified are highly volatile and are not persistent in the environment. In addition soil materials in Broken Hill are organic carbon poor limiting the potential for any of these volatile compounds to adsorb onto soil or dust particles. While the potential for exposures associated with these pathways are likely to be negligible, a screening level calculation relevant to these pathways has been conducted.

- During the application of the product there is the potential for aerosol droplets to be released and spray drift may extend beyond the site boundaries and deposit onto soil surfaces where exposures via inhalation, ingestion and dermal contact may occur. While the assessment of the likelihood of this occurring indicated it was very low, (0.1% of the time, and only in high humidity conditions), a screening level calculation relevant to these pathways has been conducted.

Assessment of Inhalation Exposures

During application, maximum 1 hour and 24-hour average off-site ground level concentrations have been estimated. These concentrations are expected to be higher than those that may be associated with volatilisation from any spray drift or dust that may have deposited off-site. Hence the assessment of inhalation exposures during application is considered adequately conservative for the assessment of any other inhalation exposures.

The assessment of potential health issues associated with inhalation exposures during application has been undertaken on the basis of short-term effects (considering the maximum 1 hour average concentrations) and longer-term effects (based on the 24 hour average concentration). It is overly conservative to assume that the 24-hour average concentration is representative of long-term health effects as spraying operations only occur infrequently, and even if some spray drift settled on the soil surface the compounds of concern would not persist for longer than a few hours or at most a few days. The potential for exposure during applications is dependent on the wind direction and other atmospheric conditions.

The assessment of potential exposure and risk differs for chemicals assessed on the basis of a non-threshold or threshold approach as follows:

Non-Threshold Approach

For potential exposures to acetaldehyde, identified as non threshold chemicals any exposure increases the risk of an adverse health effect, generally cancer. This is calculated by multiplying the modelled concentration in air (usually an annual average, however in this case the 24-hour average concentration) by the published inhalation unit risk factor for these chemicals. The calculation has not been presented for shorter duration exposures; however a threshold assessment has been conducted for acute exposures to acetaldehyde.

$$\text{Risk} = \text{Concentration in air} \bullet \text{Inhalation Unit Risk (UR)}$$

This simple approach assumes that an individual is exposed to the non-threshold chemicals in the air at the concentration estimated all day, every day for 70 years (i.e. a lifetime). Hence, it provides a conservative estimate of potential risk, particularly for exposures that may only occur on one day per year.

An acceptable criteria for the assessment of non-threshold carcinogenic risk is less than 1 in a million to 1 in 100,000 ($1\text{x}10^{-6}$ to $1\text{x}10^{-5}$) which is generally adopted as indicative of acceptable incremental lifetime cancer risks.

Threshold Approach

For potential exposure to styrene, ammonia and vinyl acetate the assessment of risk is based on a comparison of the air concentration for short or longer duration exposures with a threshold guideline. The threshold is a concentration or dose below which no adverse health effects are anticipated. In these cases, published threshold concentrations can be compared directly with the modelled concentrations to provide a Hazard Index as follows:

$$\text{HazardIndex} = \frac{\text{Concentration in air}}{\text{Threshold Concentration}}$$

The 1 hour average concentration has been compared against available acute inhalation guidelines (based on peak short-duration exposures) and the 24 hour average concentration has been compared against the available chronic inhalation guideline. This approach for the assessment of chronic exposures is conservative as the chronic guideline assumes that an individual is exposed to the chemicals in the air at the concentration estimated all day, every day for a lifetime. Hence, it provides a conservative estimate of potential risk, particularly for exposures that may only occur on one day per year.

If the Hazard Index is less than one, exposure to the chemical is judged unlikely to result in an adverse health effect. If the index is greater than one, a more detailed and critical evaluation of the risks (including consideration of specific target organs affected and mechanisms of toxic action of the chemicals of concern) would be required to ascertain if the cumulative exposure would in fact be likely to harm exposed individuals.

Inhalation Exposures due to Volatilisation of Potential Contaminants

Table 6 presents an assessment of potential risks to all members of the population associated with exposure to the maximum predicted off-site concentrations in air during the application of the proposed products.

Table 6: Review of Inhalation Exposures and Risk

Key Compound and Exposure	Maximum Air Concentration off-site (µg/m^3)	Guideline Air Concentration or Unit Risk	Risk (non-threshold or threshold HI)
Non-Threshold Carcinogenic Effects			
Acetaldehyde			
- chronic exposure	0.012 (24-hour)	UR = 2.2x10^{-6} (µg/m^3)$^{-1}$ (I)	2.6x10^{-8}
Threshold Effects			
Acetaldehyde			
- acute exposure	0.14 (1-hour)	TC = 470 µg/m^3 (O)	HI = 0.0003
Ammonia			
- Acute exposure	0.0011 (1-hour)	TC = 3200 µg/m^3 (O)	HI = 0.0000003
- Chronic exposure	0.000093 (24-hour)	TC = 100 µg/m^3 (I)	HI = 0.0000009
Styrene			
- Acute exposure	0.00012 (1-hour)	TC = 8700 µg/m^3 (A)	HI = 0.00000001
- Chronic exposure	0.00001 (24-hour)	TC = 870 µg/m^3 (A)	HI = 0.00000001
Vinyl Acetate			
- Acute exposure	0.15 (1-hour)	NA	NA
- Chronic exposure	0.012 (24-hour)	TC = 200 µg/m^3 (I)	HI = 0.00006

Notes:
Guideline values adopted from:
I = IRIS
O = OEHHA
A = ATSDR

On the basis of the conservative assessment, potential non-threshold risks and threshold HI associated with acute and chronic exposures are orders of magnitude below the target risk levels. On this basis potential inhalation exposures during application are essentially negligible.

Assessment of Dust and Spray Drift Exposures

While unlikely to be of significance, the potential for soil concentrations to be impacted by the deposition of dust and spray drift during the application of the proposed products and been assessed.

The potential accumulation of volatile compounds (assuming no losses due to volatilisation) in soil, which may be the result of deposition of dust or spray drift, can be estimated using a soil accumulation model (Stevens 1991)20.

The concentration in soil, which may be the result of deposition, can be calculated using the following equation.

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000 \qquad \text{(mg/kg)}$$

where:

DR = Particle deposition rate – maximum estimated (mg/m^2/year)

k = Chemical-specific soil-loss constant (1/year) = ln(2)/$T^{0.5}$

$T^{0.5}$ = Chemical half-life in soil (years)

t = Accumulation time (years)

d = Soil mixing depth (m)

ρ = Soil bulk-density (g/m^3)

and 1000 = Conversion from g to kg

With respect to the assessment of deposition from dust and spray drift the following has been assumed:

- Accumulation time has been assumed to be 1 year as the compounds of concern are volatile and do not reside in dust or shallow soil for any longer than 1 year (conservative) and hence accumulation over time will be negligible.
- The chemical half-life in soil has been obtained from the Hazardous Substances Data Bank (HSDB) database for each compound.
- It is assumed that the mixing depth for deposited dust and spray drift is 1cm.

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20 Stevens B. 2,3,7,8-Tetrachlorobenzo-p-Dioxin in the Agricultural Food Chain: Potential Impact of MSW Incineration on Human Health. Presented In: Health Effects of Municipal Waste Incineration, Edited by Holly A. Hattemer-Frey and Curtis Travis, CRC Press 1991.

- Dust deposition rates have been estimated using modelling for emissions that may be generated during the application of the products.
- With respect to the assessment of spray drift, it has been conservatively assumed that all of the predicted spray drift beyond the site boundary is deposited onto an individual backyard that is 250 m^2 (half an average low density block). This is a highly conservative assumption.

Review of Significance of Estimated Concentrations in Soils

The calculated soil concentrations have been directly compared against USEPA Regional Screening Levels (RSLs) for residential soil (most current version dated May 2010). The RSLs are risk based soil concentrations that are based on the protection of human health (chronic exposures). In the case of residential soil RSLs the levels are derived to be protective of exposures by all residents (adults and children) why may be exposed to chemicals in soil (and dust) via ingestion, dermal contact and inhalation of volatiles released from the soil surface (outdoors). These pathways of exposure are consistent with those that may be present should the chemicals be present in dust and spray drift that migrates and is deposited off-site during application of the products. In addition, the levels are derived on the basis of a target non-threshold risk level of 1×10^{-6} and a target HI of 1, consistent with the target risk levels considered in this review.

Table 7 presents the calculated concentrations in soil that may be derived from deposition of dust and spray drift off-site during application of the proposed products on-site, with comparison against the residential soil RSL.

Table 7: Review of Dust/Soil Concentrations

Key Compound	Maximum Soil Concentration off-site – Dust deposition (mg/kg)	Maximum Soil Concentration off-site – Spray drift (mg/kg)	Residential Soil RSL (mg/kg)
Acetaldehyde	0.00032	0.00074	10
Ammonia	0.0000026	0.0087	NA
Styrene	0.0000022	0.0087	6300
Vinyl Acetate	0.00034	0.00074	970

Notes:

NA – no RSL has been derived for ammonia in soil as no toxicity data is available to address the oral or dermal exposure pathways and ammonia is expected to rapidly degrade (more so than the other chemicals) once released to air as dust or aerosol.

Regardless of the overly conservative approach adopted for the above evaluation, the concentrations of acetaldehyde, styrene and vinyl acetate in soil (and dust) are many orders of magnitude below the residential soil RSL and are therefore considered negligible. On this basis the potential risks to human health associated with exposures to chemicals that may be deposited to soil (or dust) in off-site areas as a result of the application of the proposed products as dust suppressant are considered negligible.

5 Conclusions

5.1 Health Risk Potential of Dust Suppressants

The chemical components of the dust suppressants which have been identified as being of concern are generally of high volatility and environmental fate properties indicate that these chemicals will be relatively short lived, both in the soil as a result of degradation processes, and in the atmosphere. Adsorption to soil particles is also unlikely due to the low organic matter content of the sandy soils typically found in vicinity of the mining site. Nevertheless, the migration of contaminants off-site via vapour, dust and spray drift was modelled.

The exposure of the nearest residents was estimated using estimated using worst case scenarios. Maximum concentrations were compared with toxicity values according to enHealth guidelines. The risk and hazard index were calculated and these indicated that the potential for human health impacts from the use of dust suppressants on the mining site were negligible.

5.2 Dust Control Efficiencies

Documented field trials by independent third parties, including the US-EPA, demonstrates that dust control efficiencies in excess of 80% (and even 90%) can be achieved through the successful implementation of chemical dust suppressants. Although most of the field trials documented have been undertaken for unpaved road applications, it is evident that higher dust control efficiencies could be achieved through applications on undisturbed areas not subject to vehicle movements.

Based on wind tunnel testing under laboratory conditions, the chemical dust suppressants being considered for application on free areas and the TSF at the Rasp Mine are shown to have a dust abatement efficiency of above 95%. This dust control efficiency was achieved for various tailings and other materials under wind speeds of 10 m/s.

Field trial information was requested from the suppliers of TGC and GLUON. The information obtained was primarily qualitative, without dust control efficiencies (%) having been measured or estimated. Furthermore, most of the information is noted to be documented by product suppliers rather than independent third parties, with the exception of the testimonials received from mine and ash disposal facility personnel.

The good performance of chemical dust suppressants under controlled conditions and their reported success in the field serve to support the application of such products at the Rasp Mine. Field trials are proposed to be undertaken prior to commencement of the operation to establish the optimum concentration of chemical dust suppressant required to ensure there is no significant dust generation given prevailing meteorological conditions.

Appendix A
Material Data Safety Sheets for Total Ground Control and GLUON 500

MATERIAL SAFETY DATA SHEET

Product Name: 'Total Ground Control'
Issued By: Reynolds Soil Technologies Pty Ltd
Item No: TGC
Review Date: 18/02/2010
Issue Date: 18/02/2010
Version Number: 1.0

RST
DUST · EARTH · WATER
SOLUTIONS

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

COMPANY NAME: Reynolds Soil Technologies Pty Ltd (ABN 31 068 825 696)
ADDRESS: 14, Greg Chappell Drive,
Burleigh Heads, Queensland, Australia, 4220
EMERGENCY PHONE: 0417 770567
PHONE: 07 5522 0244
FAX: 07 5522 0799
EMAIL: rst@rsth2o.com.au

PRODUCT NAME: Total Ground Control
SYNONYMS: TGC, TGC Dust Suppressant, TGC Crusting Agent, TGC Veneer Coat

USE:

- Soil Binder for Erosion Control
- Broad Acre Dust Suppressant
- Stockpile Binder
- Revegetation Binder
- Hydromulching Binder
- Hydroseeding Binder

2. HAZARD IDENTIFICATION

Based on available information, not classified as hazardous according to the criteria of NOHSC.

RISK PHRASES	None Allocated
SAFETY PHRASES	S24 Avoid Contact with Eyes S25 Avoid contact with Skin

3. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL ENTITY	CAS NO	PROPORTION
Ammonia, aqueous solutions	1336-21-6	0-<1%
Styrene	100-42-5	0-<0.1%
Ingredients determined not to be hazardous including Water	Proprietary	To 100%
Acrylic Monomers	Proprietary	0-0.1%

4. FIRST AID MEASURES

SWALLOWED	Do not induce vomiting. Rinse mouth thoroughly with water. Seek medical attention.
EYES	If in eyes, hold eyelids apart and flush the eyes continuously with running water. Continue flushing for several minutes until all contaminants are washed off completely. Seek immediate medical attention.

SKIN	If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. If irritation develops seek medical attention.
INHALED	Keep patient calm and remove to fresh air.
FIRST AID FACILITIES	Ensure eye wash bath and safety shower is readily accessible.
ADVICE TO DOCTOR	Treat according to symptoms.

5. FIRE-FIGHTING MEASURES

SUITABLE EXTINGUISHING MEDIA	In case of fire use water, carbon dioxide (CO2), foam or dry extinguishing media.
HAZARDS FROM COMBUSTION PRODUCTS	No explosion hazard.
PRECAUTIONS FOR FIRE FIGHTERS & SPECIAL PROTECTIVE EQUIPMENT	Not available.

6. ACCIDENTAL RELEASE MEASURES

EMERGENCY PROCEDURES	Product is very slippery in concentrate form.
METHODS AND MATERIALS FOR CONTAINMENT AND CLEAN UP	Contain large spills and pump out into containers; soak up remainder with absorbent material. Small spills can be flushed away with copious amounts of water for effluent treatment only. Dispose of wastewater correctly. Clean up personnel should wear protective overalls with goggles and gloves. Place waste in labelled containers for disposal. Must be disposed to approved landfill or incineration in accordance with local regulations.

7. HANDLING AND STORAGE

PRECAUTIONS FOR SAFE HANDLING	Product is very slippery in concentrate form. Hands and face should be washed before breaks and at the end of the shift.
CONDITIONS FOR SAFE STORAGE	Handle in accordance with good industrial hygiene and safety practice.
INCOMPATIBILITIES	Not available.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

NATIONAL EXPOSURE STANDARDS	No exposure standard allocated.
BIOLOGICAL LIMIT VALUES	No biological limit allocated.
ENGINEERING CONTROLS	Ensure workplace is well ventilated.
PERSONAL PROTECTION	Protective Goggles, Protective Gloves, Protective Overalls

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Varies

ODOUR:	None
pH:	6.5-7.0 (at 200g/L, 20^{o}C)
VAPOUR PRESSURE:	No Data
VAPOUR DENSITY:	No Data
BOILING POINT/RANGE:	No Data
FREEZING/MELTING POINT:	No Data
SOLUBILITY:	Soluble
SPECIFIC GRAVITY OR DENSITY	ca. 1.01 (23^{o}C)
FLAMMABILITY:	Not Flammable
OTHER PROPERTIES	
SOLIDIFICATION TEMPERATURE:	ca. -5°C
VISCOSITY(23°C):	ca. 1000 mPa.s [Brookfield]

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY	Stable under normal conditions of use.
CONDITIONS TO AVOID	None expected.
INCOMPATIBLE MATERIALS	Strong oxidising agents (may degrade polymer).
HAZARDOUS DECOMPOSITION PRODUCTS	No decomposition expected under normal storage conditions.
HAZARDOUS REACTIONS	Will not occur.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA FOR SIMILAR PRODUCT:

Acute Oral Toxicity	> 5000 - LD50 . mg/kg (rat)

ACUTE & CHRONIC HEALTH EFFECTS

SWALLOWED	Adverse effects are not expected.
EYE	Eye contact with product is not expected to cause irritation.
SKIN	Skin contact with product is not expected to cause irritation.
INHALED	Inhalation overexposure is not expected at ambient temperatures.
CHRONIC EFFECTS	Chronic effects are not known.

12. ECOLOGICAL INFORMATION

ECOTOXICITY	
Oral Toxicity LD50 (Rat):	Undetectable
Fish Toxicity LC50 (Golden Orfes):	Undetectable

Bacteria Toxicity EC50:	Undetectable
Daphnia Toxicity EC50:	Undetectable
Algae Toxicity:	Undetectable
PERSISTANCE & DEGRADABILITY	Not Available
MOBILITY	Not Available

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHODS	Refer to appropriate authority in your State. Dispose of material through a licensed waste contractor. Advise of combustible nature.
SPECIAL REQUIREMENTS FOR LANDFILL OR INCINERATION	Normally disposable through a licensed waste contractor.

14. TRANSPORT INFORMATION

UN No: None Allocated	**D.G. Class:** None Allocated	**CAS No.:** None Allocated
Hazchem: None Allocated	**Sub. Risk:** None Allocated	**Susdp.:** None Allocated
G.T.EPG: None Allocated	**Spec.EPG:** None Allocated	**Pack.Grp:** None Allocated

Not classified as a dangerous good for transport.
No special transport requirements necessary.

15. REGULATORY INFORMATION

POISONS SCHEDULE	No Poisons schedule number allocated
OTHER	None

16. OTHER INFORMATION

PREPARATIONS AND REVISIONS	This MSDS was last revised 16/02/2010 to bring up to date with the National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC:2011(2003)] **Version 1.0 supersedes all other versions.**

This MSDS summarises our best knowledge of the health and safety hazard information of the product and how to safely handle and use the product in the workplace. It should be read taking into account how the product is handled in your particular situation and how it is used in conjunction with other products.

This is the last page of the MSDS.

Material Safety Data Sheet

GLUON 500

Infosafe no.	**PT076**	**Issue Date**	**Oct 2008**	**Status**	**ISSUED by Rainstorm Dust Control Pty Ltd**

Not classified as hazardous according to criteria of NOHSC

COMPANY DETAILS

Company Name	RAINSTORM DUST CONTROL P/L (ABN 52 003 646 160) or SUNHAWK P/L (ABN 74 090 432 974)
Address	P O BOX 1278 CANNING VALE WA 6970
Emergency Tel.	24HR- 0417 988 604
Tel/Fax	Tel: 61 8 9459 2785 Fax: 61 8 9459 2786 (WEST) 61 3 5229 7717 (EAST)
Other Information	

IDENTIFICATION

Product Code	74504
Product Name	GLUON 500
Proper Shipping Name	None Allocated
Other Names	None Listed
UN Number	None Allocated
DG Class	None Allocated
Packing Group	None Allocated
Hazchem Code	None Allocated
Poisons Schedule	Not Scheduled

Physical Data

Appearance	Milky white liquid; acrylic odour.
Melting Point	0°C/32°F Water
Boiling Point	100°C/212°F Water
Vapour Pressure	17 mm Hg @ 20°C/68°F
Specific Gravity	(Water = 1) ~1.08

Flash Point	Non-combustible
Flamm. Limit	Not applicable

Other Properties

Volatile Component	44 to 46% Water
Auto ignition Temp.	Not applicable
Vapour Density	(Air = 1) < 1 Water
pH Value	4.5 to 5.0
Other Information	Viscosity: 300 to 1500 CPS Solubility in Water: Dilutable Evaporation Rate (BAc = 1): < 1 Water See FIRE/EXPLOSION HAZARDS in the SAFE HANDLING INFORMATION Section.

Ingredients

Ingredients	**Name**	**CAS**	**Proportion**
	Vinyl acetate/acrylic copolymer	Not Hazard	54-56 %
	Water	7732-18-5	44-46 %
	Acetaldehyde	75-07-0	0-0.1 %
	Individual residual monomers	Not required	0-0.1 %
	Vinyl acetate	108-05-4	0-0.09 %

See EXPOSURE STANDARDS/PERSONAL PROTECTION

in the PRECAUTIONS FOR USE INFORMATION Section.

HEALTH HAZARD INFORMATION

Health Effects

Acute – Eye	Direct contact with material can cause the following: - slight irritation.
Acute – Skin	Prolonged or repeated skin contact can cause the following: - slight skin irritation.
Acute – Inhaled	Inhalation of vapour or mist can cause the following: - headache - nausea - irritation of nose, throat, and lungs.
Other	PRIMARY ROUTES OF EXPOSURE: Inhalation

Information Skin Contact
Eye Contact

First Aid

Swallowed If swallowed, give 2 glasses of water to drink. Consult a physician. Never give anything by mouth to an unconscious person.

Eye Flush eyes with a large amount of water for at least 15 minutes. Consult a physician if irritation persists.

Skin Wash affected skin areas thoroughly with soap and water. Consult a physician if irritation persists.

Inhaled Move subject to fresh air.

First Aid Facilities Facilities storing or utilizing this material should be equipped with an eyewash facility.

Advice to Doctor

Other Health Hazard Information

PRECAUTIONS FOR USE

Exposure Limits

COMPONENT		RAINSTORM		NOHSC		ACGIH	
No.	Units	TWA	STEL	TWA	STEL	TLV	STEL
1		None	None	None	None	None	None
2	ppm	5	10	10	20	10	20
3	ppm	10	30	100	150	100	150
4		a	a	a	a	a	a
5		None	None	None	None	None	None

a Not Required
1 Vinyl acetate/acrylic copolymer
2 Vinyl acetate
3 Acetaldehyde
4 Individual residual monomers
5 Water

Eng. Controls Use local exhaust ventilation with a minimum capture velocity of 100 ft/min. (0.5 m/sec.) at the point of vapour evolution. Refer to Australian Standards AS1668.

Personal Protection

Protective Equip.

RESPIRATORY PROTECTION: A respiratory protection program meeting AS1716 and AS1715 requirements must be followed whenever workplace conditions warrant a respirator's use. None required if airborne concentrations are maintained below the exposure limit listed in the EXPOSURE STANDARDS INFORMATION Section. Up to 10 times the exposure limit: Wear an Australian Standards approved (or equivalent) half-mask, air-purifying respirator. Up to 100 times the exposure limit: Wear an Australian Standards approved (or equivalent) full-face piece, air-purifying respirator, OR full-face piece, airline respirator in the demand mode. Above 100 times the exposure limit or Unknown: Wear an Australian Standards approved (or equivalent) self-contained breathing apparatus in the pressure demand mode, OR Australian Standards approved (or equivalent) full-face piece, airline respirator in the pressure demand mode with emergency escape provision. Air-purifying respirators should be equipped with organic vapour cartridges and dust and mist filters.
EYE PROTECTION: Use chemical splash goggles (AS1337 or approved equivalent).
HAND PROTECTION: The glove(s) listed below may provide protection against permeation. Gloves of other chemically resistant materials may not provide adequate protection: - Neoprene

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Flammability

Fire Hazards Non-combustible.

SAFE HANDLING INFORMATION

Storage and Transport

Storage and Transport

STORAGE CONDITIONS: Keep from freezing; material may coagulate. The minimum recommended storage temperature for this material is 1°C/34°F. The maximum recommended storage temperature for this material is 49°C/120°F.

HANDLING PROCEDURES: Monomer vapours can be evolved when material is heated during processing operations. See EXPOSURE STANDARDS/PERSONAL PROTECTION in the PRECAUTIONS FOR USE INFORMATION Section for types of ventilation required.
This material contains residual levels of vinyl acetate monomer and acetaldehyde. Lack of adequate ventilation may result in airborne levels of vinyl acetate monomer and/or acetaldehyde above established exposure limits in the workplace. Monitoring the workplace to determine actual vinyl acetate/acetaldehyde levels is recommended.

Proper Shipping Name None Allocated

Spills and Disposal

Spills & Disposal

ACCIDENTAL RELEASE MEASURES: Personal Protection: Appropriate protective equipment must be worn when handling a spill of this material. See EXPOSURE STANDARDS/PERSONAL PROTECTION in the PRECAUTIONS FOR USE INFORMATION Section for recommendations. If exposed to material during clean-up operations, see FIRST AID MEASURES for actions to follow.

Procedures: Keep spectators away. Floor may be slippery; use care to avoid falling. Contain spills immediately with inert materials (e.g. sand, earth). Transfer liquids and solid diking material to separate suitable containers for recovery or disposal.

CAUTION: Keep spills and cleaning runoff out of municipal sewers and open bodies of water.

DISPOSAL CONSIDERATIONS: Procedure: Coagulate the emulsion by the stepwise addition of ferric chloride and lime. Remove the clear supernatant and flush to a chemical sewer. Incinerate liquid and contaminated solids in accordance with local, state, and federal regulations.

Fire/Explosion Hazard

Fire/Explosion. Hazard

UNUSUAL HAZARDS: Material can splatter above 100°C/212°F. Dried product can burn.

EXTINGUISHING AGENTS: Use extinguishing media appropriate for surrounding fire.

PERSONAL PROTECTIVE EQUIPMENT: Wear self-contained breathing apparatus (pressure-demand, AS1716 approved or equivalent) and full protective gear.

Hazardous Reaction

INSTABILITY: This material is considered stable. However, avoid temperatures above 177°C/350°F, the onset of polymer decomposition. Thermal decomposition is dependent on time and temperature.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition may yield the following: - acrylic monomers - vinyl acetate monomer.

HAZARDOUS POLYMERIZATION: Product will not undergo polymerization.

INCOMPATIBILITY: There are no known materials which are incompatible with this product.

Hazchem Code None Allocated

OTHER INFORMATION

Toxicology

ACUTE DATA

No toxicity data are available for this material.

The information shown in the HEALTH HAZARDS INFORMATION Section is based on toxicity profiles of similar materials or on the components present in this material.

Oral LD50 - rat: >5000 mg/kg
Dermal LD50 - rabbit: >5000 mg/kg
Skin Irritation - rabbit: slight to moderate
Eye Irritation - rabbit: slight to moderate

CARCINOGENICITY DATA

The International Agency for Research on Cancer has determined that vinyl acetate is not classifiable as to its carcinogenicity to humans. There are no human studies on the carcinogenicity of vinyl acetate. Animal studies have shown mixed results; one study showed an increase in tumours of the noses of rats who breathed vinyl acetate, while another study did not show an increase in tumours in rats who drank water containing the chemical.*****

****Agency for Toxic Substances and Disease Registry (ATSDR), an agency of the***

U.S. Department of Health and Human Services

Other Information	GLUON 500 IS A TRADEMARK OF SUNHAWK PTY LTD OR ONE OF ITS SUBSIDIARIES OR AFFILIATES.

CONTACT POINT

Contact	TECHNICAL ENQUIRIES: Phone: 08 9459 2785 GENERAL ENQUIRIES: Phone: 08 9459 2785 This information contained herein relates only to the specific material identified. Sunhawk Pty Ltd believes that such information is accurate and reliable as of the date of this material safety data sheet, but no representation, guarantee or warranty, expressed or implied, is made to the accuracy, reliability, or completeness of the information. Sunhawk Pty Ltd urges persons receiving this information to make their own determination as to the information's suitability and completeness for their particular application.

END OF MSDS