PROJECT DONE ON BEHALF OF
ZITHOLELE CONSULTING (PTY) LTD

RISK ASSESSMENT FOR THE PROPOSED RAILWAY LINE TO THE KUSILE POWER STATION

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Mike Oberholzer is a Professional Engineer and holds a BSc (Chemical Engineering). He is an approved signatory for MHI risk assessments, thus meeting the competency requirements of SANAS for assessments of hazardous materials covering, fire, explosions and toxic releases.

GOVERNMENT APPROVED INSPECTION AUTHORITY No MHI 005

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This report is not a MHI or SANAS accredited report

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1 INTRODUCTION

The Kusile Power Station, and its infrastructure, including a rail and road transport network, received an Environmental Authorisation in March 2008. However, during the design phase of the infrastructure, the authorised rail route was deemed not feasible due to technical challenges.

Eskom is now required to carry out an Environmental Impact Assessment (EIA) for the revised rail route alternatives.

The proposed rail transport would be used for the transportation of a sorbent used in Flue Gas Desulphurisation (FGD) technology for the reduction of sulphur dioxide.

The purpose of this report is to convey the essential details, including a short description of the hazards, the receiving environment, the design, the risk and consequences of an accidental release or sorbent.

1.1 Legislation

Concern about public health and safety has led to the regulation of the handling, storage and use of industrial chemicals. On 16 January 1998, the Major Hazard Installation (MHI) Regulations were promulgated under the Occupational Health and Safety Act 1993 (Act No 85 of 1993; hereafter referred to as the OSH Act), with a further amendment on 30 July 2001. The provisions of the regulations apply to installations which have on their premises a quantity of a substance which can pose a significant risk to the health and safety of employees and the public.

Rolling stock has specific mention in the regulation and the risk assessment does not need to comply with risk assessment elements of regulation. In other words a railway line does not require a MHI risk assessment.

1.2 Terms of Reference

The main aim of the investigation was to quantify the risks to employees and neighbours with regard to the proposed railway line transporting a sorbent to the Kusile Power Station. This study assumes the sorbent to be lime or limestone.

2 PROJECT DESCRIPTION

2.1 General Background

The proposed Kusile railway line project entails the construction of a railway line and associated infrastructure, for the transportation of a sorbent from the existing railway line two kilometres north of the N4 highway to the power station, situated west of Witbank to the Kusile Power Station.

Three alternative routes for the railway line have been proposed as shown in Figure 2-1.

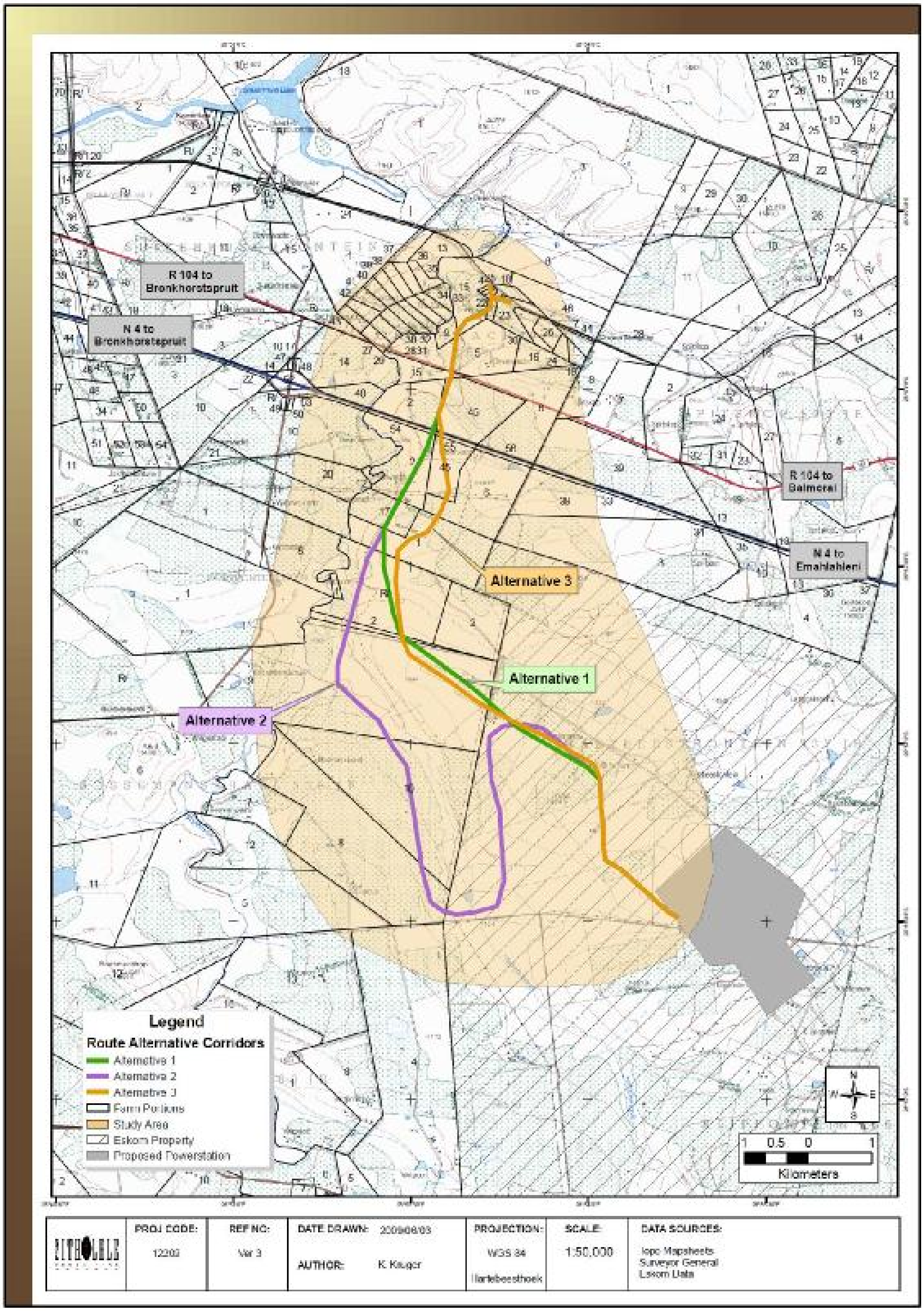

Figure 2-1 Proposed railway routing for the transportation of sorbent to Kusile Power Station

3 HAZARD IDENTIFICATION

The first step in any risk assessment is to identify all hazards. The merits of including the hazard for further investigation are subsequently determined by its significance, normally using a cut-off or threshold quantity. The evaluation methodology assumes that the plant will perform as designed in the absence of unintended events such as component and material failures, human errors, external events and process unknowns.

Once a hazard has been identified, it is necessary to evaluate it in terms of the risk it presents to the employees and the neighbouring community. In principle, both probability and consequence should be considered, but there are occasions where if either the probability or the consequence can be shown to be sufficiently low or sufficiently high, decisions can be made on just one factor.

During the hazard identification component, the following considerations are taken into account:

- Chemical identities;
- Location of facilities that use, produce, process, transport or store hazardous materials;
- The type and design of containers, vessels or pipelines;
- The quantity of material that could be involved in an airborne release; and,
- The nature of the hazard (e.g. airborne toxic vapours or mists, fire, explosion, large quantities stored or processed handling conditions) most likely to accompany hazardous materials spills or releases.

3.1 Notifiable Substances

The General Machinery Regulation 8 and its Schedule A, on notifiable substances, requires any employer who has a substance equal or exceeding the quantity as listed in the regulation to notify the divisional director. A site is classified as a Major Hazardous Installation if it contains one or more notifiable substances or if the offsite risks are sufficiently high. The latter can only be determined from a quantitative risk assessment.

Neither calcium carbonate nor calcium oxide is a notifiable product.

3.2 Substance Hazards

All components on the plant were assessed for potential hazards according to the criteria discussed below.

3.2.1 Chemical Properties

3.2.1.1 Limestone/Lime/ Calcium Carbonate

Limestone is calcareous sedimentary rock containing calcium carbonate ($CaCO_3$; mineral name: calcite). It is composed of calcite ($CaCO_3$). Calcium carbonate is an odourless, tasteless powder or crystals that are neither toxic nor flammable.

3.2.1.2 Lime /Calcium Oxide

Calcium oxide (CaO), commonly known as burnt lime, lime or quicklime, is a widely used chemical compound. It is a white, caustic and alkaline crystalline solid at room temperature that is neither flammable nor toxic.

Calcium oxide is hydroscopic and reacts with water generating sufficient to ignite combustible materials. With water it forms a medium strong base. Calcium oxide may react violently with acids, halogens and metals.

Calcium oxide is usually made by the thermal decomposition of materials such as limestone, that contain calcium carbonate ($CaCO_3$; mineral name: calcite) in a lime kiln. This is accomplished by heating the material to above 825°C,a process called calcination or lime-burning, to liberate a molecule of carbon dioxide (CO2); leaving CaO. This process is reversible, since once the quicklime product has cooled, it immediately begins to absorb carbon dioxide from the air, until, after enough time, it is completely converted back to calcium carbonate.

3.2.2 Corrosive Liquids

Corrosive liquids considered under this section are those chemicals that have a low or high pH that may burn if they come into contact with people or they may attack and cause failure of equipment.

Calcium oxide is a base and can be corrosive to eyes. It is however not considered hazardous.

3.2.3 Reactive Chemicals

Reactive chemicals are chemicals that when mixed or exposed to one another react in a way that may cause a fire, explosion or release a toxic component.

Calcium oxide reacts with water but is not considered extremely hazardous.

3.2.4 Flammable materials

Flammable materials are those that can ignite to give a number of possible hazardous effects, depending on the actual material and conditions. These are flash fires, explosion, fireball, jet fire or pool fire.

Neither limestone nor lime are considered flammable or combustible.

3.2.5 Toxic materials

Toxic materials of interest to this study are those that could give dispersing vapour clouds upon release into the atmosphere. These could subsequently cause harm through inhalation or absorption through the skin. Typically the hazard posed by a toxic material will depend both on concentration of the material in the air and the exposure duration.

Neither limestone nor lime are considered toxic.

4 PHYSICAL AND CONSEQUENCE MODELLING

In order to establish the impact following an accident, it is necessary to first estimate the physical process of the spill (i.e. rate and size), spreading of the spill, the evaporation from the spill, and the subsequent atmospheric dispersion of the airborne cloud, or in the case of ignition, the burning rate, the resulting thermal radiation or the overpressures from an explosion.

The second step is then to estimate the consequences of a spill on humans, fauna, flora and structures. This merely illustrates the significance and the extent of the impact in the event of a release. The consequences would be due to the toxicity, thermal radiation and/or explosion overpressures. The consequences may be described in various formats. The simplest methodology follows a comparison of predicted concentrations (or thermal radiation, or overpressures) to short-term concentration (or radiation or pressure) guideline values. In a different, but more realistic fashion, the consequences may be determined by using a dose-response analysis. Dose-response analysis aims to relate the intensity of the phenomenon that constitutes the hazard to the degree of injury or damage, which it can cause. *Probit Analysis* is possibly the method mostly used to estimate probability of death, hospitalisation or structural damage. The *probit* is a lognormal distribution and represents a measure of the percentage of the vulnerable resource that sustains injury or damage. The probability of injury or death (i.e. *risk level*) is in turn estimated from this *probit* (risk characterisation).

4.1 Toxic Vapour Clouds

No toxic vapour clouds would be expected as neither limestone nor lime are considered toxic.

4.2 Fires

Combustible materials within their flammable limits may ignite and burn if exposed to an ignition source of sufficient energy. On process plants this normally occurs as a result of a leakage or spillage. Depending on the physical properties of the material and the operating parameters, the combustion of material in a plant may take on a number of forms i.e. pool fires, jet fires and flash fires.

Neither limestone nor lime are not considered flammable or combustible and thus fires would not be expected

4.3 Vapour Cloud Explosion Consequences

A release of combustible gases into the atmosphere could result in the formation of a vapour cloud. The concentration of the combustible component decreases from the point of release to the lower explosive limits (LEL), where the concentration of the component can no longer ignite. The material contained in the vapour cloud between the higher explosive limits (HEL) and the lower explosive limit (LEL), if it ignites will form a flash fire or a fireball. The sudden detonation of the explosive mass of material causes an overpressure that can result in injury or damage to property.

Neither limestone nor lime are considered flammable or combustible and thus explosions would not be expected.

5 CONCLUSIONS

The proposed Kusile rail transport would be used for the transportation of a sorbent used in Flue Gas Desulphurisation (FGD) technology for the reduction of sulphur dioxide. **As neither lime nor limestone is flammable or toxic, there would be no acute health effects from an accidental release during transportation.**

This risk assessment is valid for the transportation of **limestone and lime only**. The risk assessment would require a review if hazardous materials were transported on the railway line.

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7 APPENDIX A – MSDS

CALCIUM CARBONATE	ICSC: 1193 October 1999

CAS No: 471-34-1 RTECS No: FF9335000	$CaCO_3$ Molecular mass: 100.1

TYPES OF HAZARD / EXPOSURE	ACUTE HAZARDS / SYMPTOMS	PREVENTION	FIRST AID / FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE			
Inhalation		Local exhaust.	Fresh air, rest.
Skin		Protective gloves.	Rinse skin with plenty of water or shower.
Eyes		Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion		Do not eat, drink, or smoke during work.	Rinse mouth.

SPILLAGE DISPOSAL	PACKAGING & LABELLING
Sweep spilled substance into containers. (Extra personal protection: P1 filter respirator for inert particles).	

EMERGENCY RESPONSE	STORAGE
	Separated from acids, aluminium and ammonium salts.

IMPORTANT DATA	
Physical State; Appearance ODOURLESS, TASTELESS POWDER OR CRYSTALS **Chemical dangers**	**Routes of exposure** The substance can be absorbed into the body by inhalation.

The substance decomposes on heating 825 °C producing corrosive fumes of calcium oxide. Reacts with acids, aluminium and ammonium salts. **Occupational exposure limits** TLV: 10 mg/m³ (as TWA) (total dust, containing no asbestos and 1% crystalline silica) (ACGIH 1998).	

PHYSICAL PROPERTIES	ENVIRONMENTAL DATA
Melting point (decomposes): 825°C Density: 2.8 g/cm³ Solubility in water: none	

NOTES
Health effects of exposure to the substance have been investigated, but none has been found. Calcium carbonate exists in nature as mineral aragonite and calcite (as in limestone, chalk and marble).

CALCIUM OXIDE	ICSC: 0409 April 1997

Lime
Burnt lime
Quicklime

CAS No: 1305-78-8 RTECS No: EW3100000 UN No: 1910	CaO Molecular mass: 56.1

TYPES OF HAZARD / EXPOSURE	ACUTE HAZARDS / SYMPTOMS	PREVENTION	FIRST AID / FIRE FIGHTING
FIRE	Not combustible.		In case of fire in the surroundings: all extinguishing agents allowed except water.
EXPLOSION			
EXPOSURE		**PREVENT DISPERSION OF DUST! STRICT HYGIENE!**	
Inhalation	Burning sensation. Cough. Shortness of breath. Sore throat.	Local exhaust or breathing protection.	Fresh air, rest. Refer for medical attention.
Skin	Dry skin. Redness. Skin burns. Burning sensation. Pain.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
Eyes	Redness. Pain. Blurred vision. Severe deep burns.	Safety goggles or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
Ingestion	Burning sensation. Abdominal pain. Abdominal cramps. Vomiting. Diarrhoea.	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Give nothing to drink. Refer for medical attention.

SPILLAGE DISPOSAL	PACKAGING & LABELLING	
Sweep spilled substance into dry containers. Personal protection: P2 filter respirator for harmful particles.	UN Hazard Class: 8 UN Pack Group: III	Do not transport with food and feedstuffs.

EMERGENCY RESPONSE	SAFE STORAGE

	Separated from strong acids, organics water food and feedstuffs. Dry.

IMPORTANT DATA	
Physical State; Appearance HYGROSCOPIC WHITE CRYSTALLINE POWDER. **Chemical dangers** The solution in water is a medium strong base. Reacts with water generating sufficient heat to ignite combustible materials. Reacts violently with acids, halogens, metals. **Occupational exposure limits** TLV: 2 mg/m³ as TWA; (ACGIH 2004). MAK: IIb (not established but data is available); (DFG 2004).	**Routes of exposure** The substance can be absorbed into the body by inhalation of its aerosol and by ingestion. **Inhalation risk** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly when dispersed. **Effects of short-term exposure** The substance is corrosive to the eyes, the skin and the respiratory tract. The effects may be delayed. Medical observation is indicated. **Effects of long-term or repeated exposure** Repeated or prolonged contact with skin may cause dermatitis. Lungs may be affected by repeated or prolonged exposure to dust particles. The substance may cause ulceration and perforation of the nasal septum.

PHYSICAL PROPERTIES	ENVIRONMENTAL DATA
Boiling point: 2850°C Melting point: 2570°C Relative density (water = 1): 3.3-3.4 Solubility in water: reaction	

NOTES
Reacts violently with fire extinguishing agents such as water. Clumps of calcium oxide formed by reaction with moisture and proteins in the eye are difficult to remove by irrigation. Manual removal by a physician is necessary. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water. Card has been partly updated in October 2005. See sections Occupational Exposure Limits, Emergency Response.

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