ATMOSPHERIC IMPACT REPORT

In support of South African Road Binders' application for an Atmospheric Emission Licence (AEL) for a proposed emulsion plant located in Harrismith, Free State

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Report Details

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EXECUTIVE SUMMARY

South African Road Binders (Pty) Ltd propose to develop and operate an emulsion plant on a site located on Erf 1559, Hardustria, in Harrismith, Free State. Macadam Production is a Listed Activity in terms of the National Environmental Management: Air Quality Act (Act No. 39 of 2004) (NEM: AQA) defined in Sub-Category 5.10 of the regulations for Listed Activities and Minimum Emission Standards. Sub-category 5.10 specifies minimum emission standards for permanent facilities using mixtures of aggregate and tar or bitumen to produce road surfacing materials. In addition, the storage of petroleum products exceeding 1 000 m^3 constitutes a Sub-category 2.4 Listed Activity. The Environmental Authorisation process requires that an atmospheric impact assessment must be conducted for Listed Activities and it must satisfy the requirements of the Atmospheric Impact Report (AIR). uMoya-NILU Consulting (Pty) Ltd. was appointed to prepare the AIR for the proposed South African Road Binders – Emulsion plant.

Particulate and gaseous emissions generated during the production of bitumen emulsion mainly originate from diesel burners that are used to keep the bitumen warm in the hot storage tanks. VOCs are released from the hot storage tanks through "breathing losses". Gaseous pollutant emissions are SO_2, NO_x, CO, and VOCs. Of the VOCs, only benzene, toluene, ethylbenzene and toluene (BTEX) is considered in this assessment.

USEPA AP42 emission factors are used to estimate emissions from the proposed South African Road Binders – Emulsion plant, and the DEA recommended and USEPA-approved SCREEN3 dispersion model is used to assess the effects and potential consequences of emissions from the proposed plant in the surrounding environment. The impact of modelled ambient concentrations of PM_{10}, NO_2, SO_2, CO and BTEX are well below the respective national health-based ambient air quality standards and guidelines. No exceedance of the respective standards or guidelines are predicted within the site or in sensitive receptor areas around the site. The predicted ambient concentrations therefore comply with the national health-based ambient air quality standards in the ambient environment.

From an air quality perspective, it is therefore recommended that the proposed project application is approved.

GLOSSARY OF TERMS AND ACRONYMS

AEL	Atmospheric Emission Licence
AIR	Atmospheric Impact Report
BTEX	Benzene, toluene, ethylbenzene and xylene
DEA	Department of Environmental Affairs
g/s	Grams per second
kPa	Kilo Pascal
MES	Minimum Emission Standards
mg/hr	Milligrams per hour refers to emission rate, i.e. mass per time
mg/Nm^3	Milligrams per normal cubic meter refers to emission concentration, i.e. mass per volume at normal temperature and pressure, defined as air at 20^{o}C (293.15 K) and 1 atm (101.325 kPa)
NAAQS	National Ambient Air Quality Standards
NEM-AQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
USEPA	United States Environmental Protection Agency
µm	1 µm = micrometer 1 µm = 10^{-6} m
VOC	Volatile Organic Compounds
WHO	World Health Organization

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1. ENTERPRISE DETAILS

1.1 Enterprise Details

The enterprise details relating to South African Road Binders (Pty) Ltd are listed in Table 1.

Table 1: Enterprise details

Entity Name:	South African Road Binders (Pty) Ltd
Trading as:	
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	Company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):	2012/102841/07
Registered Address:	25 Bloemendal Road, Rayton, Bloemfontein, 9301
Postal Address:	P.O. Box 13125, Noordstad, Bloemfontein, 9302
Telephone Number (General):	051 436 4891
Fax Number (General):	086 482 6319
Company Website:	
Industry Type/Nature of Trade:	Construction
Land Use Zoning as per Town Planning Scheme:	General Industrial
Land Use Rights if outside Town Planning Scheme:	
Responsible Person:	Mr. Marius Prinsloo
Emissions Control Officer:	
Telephone Number:	051 436 4891
Cell Phone Number:	082 450 8957
Fax Number:	086 482 6319
Email Address:	mprinsloo@taupele.co.za
After Hours Contact Details:	082 450 8957

1.2 Location and Extent of the Plant

The site information relating to South African Road Binders (Pty) Ltd are listed in Table 2.

Table 2: Site information

Physical Address of the Licensed Premises:	Erf 1559, Hardustria, Harrismith, Free State.
Description of Site:	Undeveloped industrial stand
Property Registration Number (Surveyor-General Code):	
Coordinates (latitude, longitude) of Approximate Centre of Operations (Decimal Degrees):	Latitude*: 28°17'46.80"S Longitude*:29° 8'15.25"E
Extent (km^2):	0.74 ha (0.0074 km^2)
Elevation Above Mean Sea Level (m):	1651 m
Province:	Free State
District/Metropolitan Municipality:	Thabo Mofutsanyana District Municipality
Local Municipality:	Maluti-A-Phofung Local Municipality
Designated Priority Area (if applicable):	n/a

Description of surrounding landuse (within 5 km radius)

The proposed South African Road Binders – Emulsion plant site is located on Erf 1559, Hardustria, Harrismith, in the Maluti-A-Phofung Local Municipality, within the Thabo Mofutsanyana District Municipality, in Free State. The relative location of the proposed site is shown in Figure 1.

The surrounding land use within a 5 km radius from the center of the proposed South African Road Binders – Emulsion plant is generally rural and includes vacant land, agricultural land and residential areas. The proposed site is located within the industrial area, Hardustria. Residential areas of Harrismith and Wilge Park are located in the northwestern quadrant. The N3 toll road is adjacent to the eastern boundary of the proposed site.

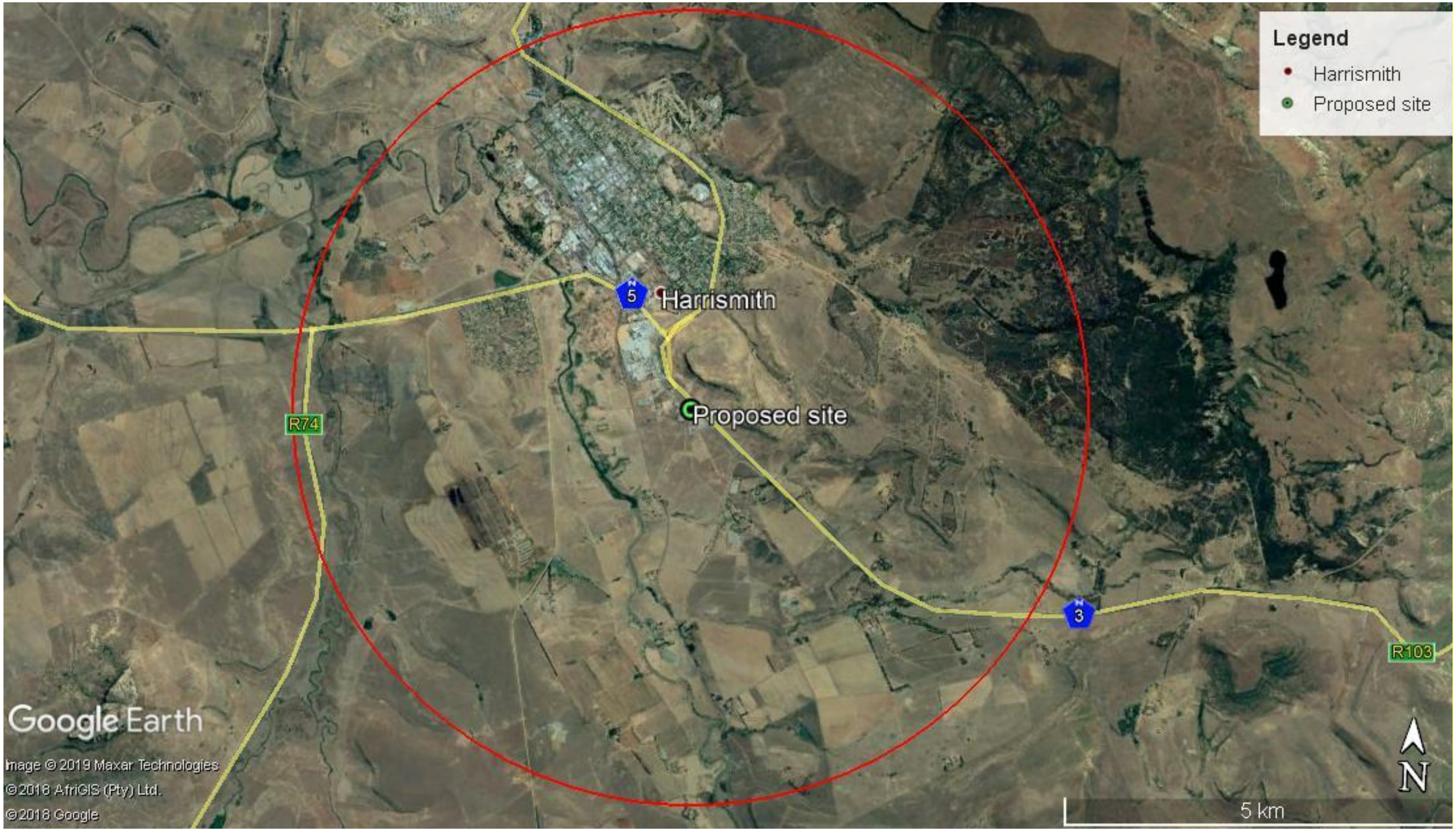


Figure 1: Relative location of the proposed South African Road Binders – Emulsion plant to the surrounding residential, commercial and industrial areas, within a 5 km radius around the proposed plant (Google Earth, 2019)

1.3 Atmospheric Emission Licence (AEL) and Other Authorisations

The South African Road Binders – Emulsion plant is a proposed facility and is therefore not in possession of an Atmospheric Emissions Licence (AEL) or any other authorisations related to air quality (Table 3).

Table 3: Current authorisations related to air quality

Atmospheric Emission License	Date of Registration Certificate	Listed Activity Subcategory	Category of Listed Activity	Listed Activity Process Description
No Record				

2. NATURE OF THE PROCESS

2.1 Listed Activity or Activities

As a measure to reduce emissions from industrial sources and to improve ambient air quality, Listed Activities and associated Minimum Emission Standards (MES) were published in 2010 in Government Notice 248 (DEA, 2010) and revised in Government Notice 893 (DEA, 2013a), and again in Government Notice 1207 of 31 October 2018 (DEA, 2018).

The processes at proposed South African Road Binders – Emulsion plant includes two Listed Activities. These are the storage and handling of petroleum products (Category 2, Subcategory 2.4) and Macadam Production (Category 5, Subcategory 5.10). Details of these Listed Activities are shown in Table 4.

According to the Minimum Emission Standards, existing industrial facilities must comply with the MES for 'New Plants' by 1 April 2020. New facilities must immediately comply with the MES for new plants. The proposed South African Road Binders – Emulsion plant is a new facility and should comply with the MES for new plants. The MES for the Listed Activities for the proposed plant is shown in Tables 5 - 7.

Table 4: Details of the Listed Activities carried out at the proposed South African Road Binders – Emulsion plant according to GN 248 (DEA, 2013a)

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
Category 2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass	Subcategory 2.4: Storage and Handling of Petroleum Products	Petroleum product storage tanks and product transfer facilities

Category 5: Mineral processing, Storage and Handling	Sub-category 5.10: Macadam Preparation	Macadam preparation: Permanent facilities used for mixtures of aggregate; tar or bitumen to produce road-surfacing materials

Table 5: Special arrangements for control of TVOCs from storage of raw materials, intermediate and final products with a vapour pressure of up to 14 kPa at operating temperature for Subcategory 2.4: Storage and Handling of Petroleum Products according to GN 1207 (DEA, 2018)

Listed Activity	**Application**	**All permanent immobile liquid Storage facilities at a single site with a combined storage capacity of greater than 1 000 m^3**
Subcategory 2.4: Storage and Handling of Petroleum Products	**True vapour pressure of contents at product storage temperature**	**Type of tank or vessel**
	Type 1: Up to 14 kPa	Fixed-roof tank vented to atmosphere, or as per Type 2 and 3
	Type 2: Above 14 kPa and up to 91 kPa with a throughput of less than 50 000 m^3 per annum	Fixed-roof tank with Pressure Vacuum Vents fitted as a minimum, to prevent "breathing" losses, or as per Type 3
	Type 3: Above 14 kPa and up to 91 kPa with a throughput greater than 50 000 m^3 per annum	a) External floating-roof tank with primary rim seal and secondary rim seal for tank with a diameter greater than 20 m, or b) fixed-roof tank with internal floating deck / roof fitted with primary seal, or c) fixed-roof tank with vapour recovery system.
	Type 4: Above 91 kPa	Pressure vessel

Table 6: Special arrangements for control of TVOCs from the loading and unloading (excluding ships) of raw materials, intermediate and final products with a vapour pressure of greater than 14 kPa at handling temperature for Subcategory 2.4: Storage and Handling of Petroleum Products according to GN 1207 (DEA, 2018)

Listed Activity	Description:		Vapour Recovery Units	
Subcategory 2.4: Storage and Handling of Petroleum Products	**Application:**		**All loading/ offloading facilities with a throughput greater than 50 000 m³**	
	Substance or mixture of substances		**Plant status**	**mg/Nm³ under normal conditions of 273 Kelvin and 101.3 kPa**
	Common Name	**Chemical Symbol**		
	Total volatile organic compounds from vapour recovery/ destruction units using thermal treatment	N/A	New	150
			Existing	150
	Total volatile organic compounds from vapour recovery/ destruction units using non-thermal treatment	N/A	New	40 000
			Existing	40 000

Table 7: Minimum Emission Standards for Subcategory 5.10 Listed Activities according to GN 248 (DEA, 2013a)

Substance or mixture of substances		Plant Status	Minimum Emission Standards (mg/Nm³) under normal conditions of 273 Kelvin and 101.3 kPa.
Common name	**Chemical symbol**		
Particulate matter	N/A	New	50
Sulphur dioxide	SO_2	New	1000
TVOC	N/A	New	150

2.2 Process Description

Emulsion Production (Emulsion Plant)

The basic operation includes raw bitumen being pumped into a Polymer Modifier Plant where polymer is added to the bitumen. The addition of polymers improves the paving properties of bitumen, making it more suitable to handle high stress. The finished product gets pumped into hot storage tanks. In chemical mixing tanks water, emulsifiers, chemicals and additives are mixed. The hot bitumen (at 140°C) and the prepared "soap" are both pumped into the emulsion plant or colloid mill where it gets mixed. The finished bitumen emulsion is pumped into either anionic storage tanks (in which the bitumen particles are charged negatively) or into cationic storage tanks (in which the bitumen particles are charged positively).

The emulsion plant will operate approximately 12 hours a day, 300 days per year. Raw materials that will be used to produce the emulsion mix include raw bitumen, Vinex powder (emulsifier), caustic soda flakes, EM44 (emulsifier), 33.3% hydrochloric acid, paraffin, E11(emulsifier), Indulin Latex, Alvaloy Polymer and water. The products resulting from this process are different bitumen emulsions that include SS60, CAT65, MC30, PRECOAT, S-E1 and A-E2. Specific processes for these products:

SS60 @ 10 ton/h
Bitumen goes from hot storage (@140°C) to the mill inside the plant (@5900 litre/h) Inside the mill, it gets mixed with water (4100 litre/h) and 1% Vinex and Caustic Soda dilution 320 kg/h. Bitumen gets shredded and emulsified and then stored in cold storage ready to send to site.

CAT65 @ 6 ton/h
Bitumen goes from hot storage (@140°C) to the mill inside the plant (@ 3870 litre/h) Inside the mill, it gets mixed with water (2130 litre/h) and EM44 (@18kg/h) and hydrochloric acid (@18kg/h). Bitumen gets shredded and emulsified and then stored in cold storage ready to send to site.

S-E1
Mix contain bitumen (28 tons) and 500kg of Alvaloy polymer.

A-E2
Mix contain bitumen (29 tons) and 725kg Alvaloy polymer.

PRECOAT
Mix contains bitumen 15.636 tons and paraffin 11.250 tons, diesel 3.003 tons and EM44 165kg

MC30
Mix contains bitumen 21.150 tons, paraffin 8.856 tons

Some other products also get made on demand and these include CAT70, PRIME and ACE2. The Emulsion Plant will have the capacity to store approximately a total of 1 102 000 L of dangerous substances. This will include 816 000 L Raw Bitumen, 9000 L

Diesel, 23 000 L Paraffin and 254 000 L Bitumen Emulsion. Approximately 5 tons of Caustic Soda and 5000 L of Hydrochloric Acid will also be stored on site.

Some emissions are generated during the production of bitumen emulsion. These emissions mainly originate from the burners that are used to keep the bitumen warm in the hot storage silos and from "breathing losses" from the hot storage silos themselves. Key emissions from the emulsion plant include NO_x, SO_2, CO_2, CO and Volatile Organic Compounds (VOCs). However, these emissions are very low and were well below the limits set for the listed activity 5.10: Macadam Preparation for the previous emission monitoring conducted on the plant when it was located at a different site. An air emission monitoring program will be implemented to verify compliance to the air emission standards in terms of the NEM:AQA.

The manufacturing process for the emulsion plant is graphically presented in Figure 2.

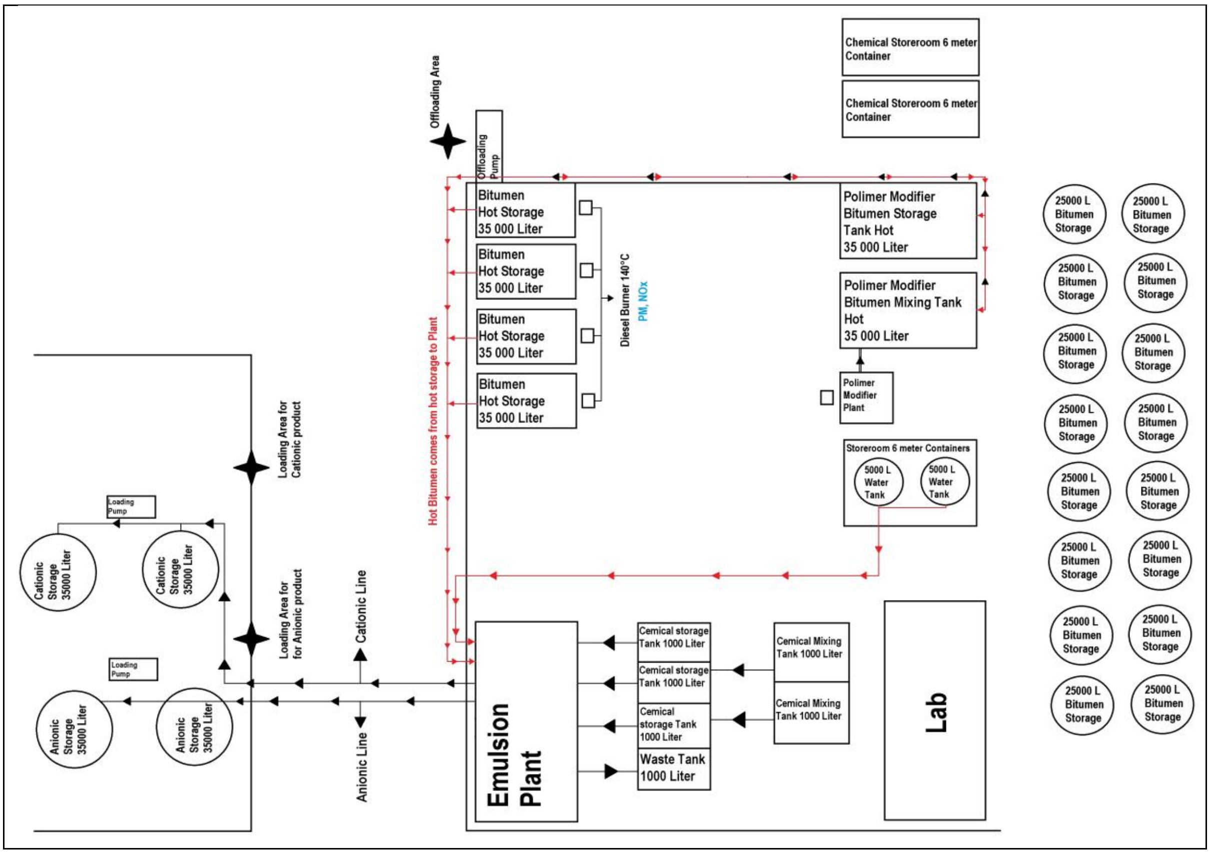


Figure 2: Process flow diagram for the proposed emulsion plant

2.3 Unit Processes

The unit processes at the proposed South African Road Binders – Emulsion plant are listed in Table 8.

Table 8: Unit processes at South African Road Binders – Emulsion plant

Name of the Unit Process	Unit Process Function	Batch or Continuous
Bitumen Hot Storage Tanks	Stores and heats bitumen	Batch

Name of the Unit Process	Unit Process Function	Batch or Continuous
Chemical Mixing Tanks	Mixes "soap"	Batch
Chemical Storage Tanks	Stores "soap"	Batch
Colloid Mill	Mixes hot bitumen and "soap"	Batch
Emulsion Storage Tanks	Stores Emulsion	Batch

3. TECHNICAL INFORMATION

3.1 Raw Materials Used

The raw materials type and design consumption rate at the proposed South African Road Binders – Emulsion plant are listed in Table 9.

Table 9: Raw material type and design consumption rate

Raw Material Type	Design Consumption Rate (quantity)	Units (quantity/period
Bitumen (in emulsion plant)	3-6	tons/hour
Emulsifiers	1	tons/hour
Water	2-4	tons/hour

3.2 Appliances and Abatement Equipment Control Technology

No air pollution control and abatement technology at proposed South African Road Binders – Emulsion plant is listed in Table 10.

Table 10: Appliances and abatement equipment and control technology

Appliance Name	Appliance Type/Description	Appliance Function/Purpose
n/a		

4. ATMOSPHERIC EMISSIONS

4.1 Point Source Parameters

No point sources are provided in Table 11.

Table 11: Location of stack and stack parameters

Point source number	Point source name	Point source coordinates	Height of release above ground (m)	Height above nearby building (m)	Diameter at stack tip/vent exit (m)	Actual gas exit temperature (°C)	Actual gas volumetric flow (m^3/hr)	Actual gas exit velocity (m/s)	Type of emission (continuous/ batch)
n/a									

No point source emission rates are provided in Table 12.

Table 12: Point source emission rates

Point source number (as above)	Point source name (as above)	Pollutant name	Average emission rate		Duration of emissions
			(mg/Nm³)	Averaging period	
n/a					

4.2 Point Source Maximum Emission Rates (Normal Operating Conditions)

As per Section 21 of the National Environmental Management: Air Quality Act (NEMAQA), the maximum permitted emission rates for the point sources at the proposed South African Road Binders – Emulsion plant are presented in Table 13.

Table 13: Point source maximum emission rates

Point source number (as above)	Point source name (as above)	Pollutant name	Average emission rate		Duration of emissions
			(mg/Nm³)	Averaging period	
n/a					

4.3 Point Source Maximum Emission Rates (Start Up, Shut-Down, Upset and Maintenance Conditions)

As the proposed South African Road Binders – Emulsion plant is a new plant, assumptions were made around emissions during start up, shut down, upset and maintenance that may occur at the plant, based on previous studies. During these abnormal conditions, ambient air quality concentrations may increase by the following percentages:

Particular Matter - During Start-Up, Shut-Down, Upset and Maintenance Conditions the values may increase by 25 - 50% for a short period in time, depending on the operating conditions.

Sulphur Dioxide - During Start-Up, Shut-Down, Upset and Maintenance Conditions the values may increase by 50 - 100% for a short period in time, depending on the operating conditions.

Total volatile organic compounds – During Start-Up, Shut-Down, Upset and Maintenance Conditions the values may increase by 100 - 150% for a short period in time, depending on the operating conditions.

4.4 Fugitive Emissions

The primary fugitive emission sources identified at the proposed South African Road Binders – Emulsion plant for the plant operations are the bitumen storage tanks, diesel storage tanks, and burners.

The primary fugitive emission sources for the emulsion plant operations include storage tanks containing hot bitumen, diesel storage tanks, paraffin storage tanks and diesel burners.

Storage tanks are sources of fugitive emissions from standing losses and working losses from evaporation. The USEPA TANKS model (USEPA, 2005) is used to estimate emissions from all storage tanks on site. TANKS accounts for the input on storage tanks (e.g. tank type, dimensions, construction, paint condition), liquid fuel contents, handling protocols (e.g. type of fuel, annual product throughput, number of turnovers per year) and monthly average site-specific meteorology. Speciation of the emission into its resultant components is based on the composition of the components in their liquid phases.

The compounds selected for reporting are TVOCs as these are required when reporting for Subcategory 2.4: Storage and Handling of Petroleum Products. Emission rates for all tanks are presented in Table 15 for total organic compounds (TOC), as well as the BTEX group of organic compounds. Due to the low volatility and low vapour pressure of cold bitumen, fugitive emissions from storage tanks containing cold bitumen is expected to be very low. Emissions from these storage tanks are therefore not considered in this assessment.

Emissions inventory for point and area sources

Stack emission testing is generally considered to be the most accurate method for estimating emissions, as it entails the direct measurement of pollutant concentrations. In the absence of emission testing data, the alternate method is to apply appropriate emission factors to estimate emissions. This section describes the methodology used to estimate emissions of PM_{10}, NO_2, SO_2, CO and BTEX resulting from the proposed South African Road Binders – Emulsion plant.

An emissions factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kg of particulate emitted per ton of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category.

The general equation for emissions estimation is:

$E = A \times EF \times (1 - ER/100)$, where:
E = emissions;
A = activity rate;
EF = emission factor; and
ER = overall emission reduction efficiency (%)

The emission factors used for the calculation of PM_{10}, NO_X, SO_2, CO and VOCs for the proposed South African Road Binders – Emulsion plant are the most recent factors published in the United States Environmental Protection Agency (US EPA), AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. The chapters of interest include Chapter 1: External Combustion Sources, and Chapter 13: Miscellaneous Sources (USEPA, 1995a). The emission factors listed in Table 14 is used to develop the emission inventory for the proposed South African Road Binders – Emulsion plant in Table 15. Emission factors for TOC and BTEX for the storage tanks are embedded within the TANKS Model and are therefore not presented here.

Table 14: Emissions factors for the proposed South African Road Binders – Emulsion plant

Emission Source	Pollutant	Emission Factor	Unit
Diesel Burner	PM_{10}	0.24	kg/1000 litres
	CO	0.6	kg/1000 litres
	NO_X	2.4	kg/1000 litres
	SO_2	17.03	kg/1000 litres

Table 15: Emissions inventory for the proposed South African Road Binders – Emulsion plant

Pollutant Concentration (tons/year)								
Operation	**PM_{10}**	**SO_2**	**NO_X**	**CO**	**Benzene**	Toluene	Ethyl-benzene	Xylene
Diesel Burners	0.10	0.00	1.04	0.26				
Emulsion Plant Storage Tanks					0.00001	0.00015	0.00002	0.00038
Total plant emissions	0.10	0.00	1.04	0.26	0.00001	0.00015	0.00002	0.00038

4.5 Emergency Incidents

The South African Road Binders – Emulsion plant is a proposed facility. Emergency incidents relating to uncontrolled emissions have there not been reported.

5. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

In order to assess the atmospheric impact of the facility on human health, a dispersion modelling study was undertaken in accordance with the regulations regarding air dispersion modelling specified for regulatory purposes – developed in terms of section 53 of AQA. The impact assessment only takes the emissions of the facility under consideration into account during this assessment.

A compliance assessment was undertaken using the National Ambient Air Quality Standards (NAAQS), specifically in residential areas and other areas where human exposure could occur.

This section first provides a background on the prevailing climatic conditions of Harrismith in terms of temperature, rainfall and wind; NAAQS; and the current status of ambient air quality in the vicinity of the proposed South African Road Binders – Emulsion plant. This is then followed by the dispersion modelling procedure, results of the dispersion modelling and an air quality impact assessment.

5.1.1 Prevailing Climatic Conditions

The climate of a location is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents. Climates can be classified according to the average and typical ranges of different variables, most commonly temperature and precipitation. The proposed South African Road Binders – Emulsion plant is located at approximately 28°17'46.80"S and 29° 8'15.25"E, and approximately 1651 m above sea level. It experiences a Dry-winter subtropical highland climate according to the Köppen Climate Classification system.

The wind and climate data at Harrismith, using Bethlehem as a nearby observation proxy, are therefore obtained from Meteoblue (www.meteoblue.com). Meteoblue has been archiving weather model data since 2007 and in 2014 started to calculate weather models with historical data from 1985 onwards and generated a continuous 30-year global history with hourly weather data. The climate diagrams are the first simulated climate data-set made public on the Internet. The Meteoblue weather history covers any place on earth at any given time regardless of availability of weather stations.

Temperature and Rainfall

Winters are mild with average maximum temperatures dropping below 20 ºC between May and August, but are cold at night dropping below 0°C (Figure 3). Summers are hot and the average maximums exceed 25°C from October to March.

Harrismith receives an average of 500 mm of rainfall annually, with majority of the rainfall occurring in the summer months from October to April (Figure 3). Rainfall seldom occurs in winter between May and September.

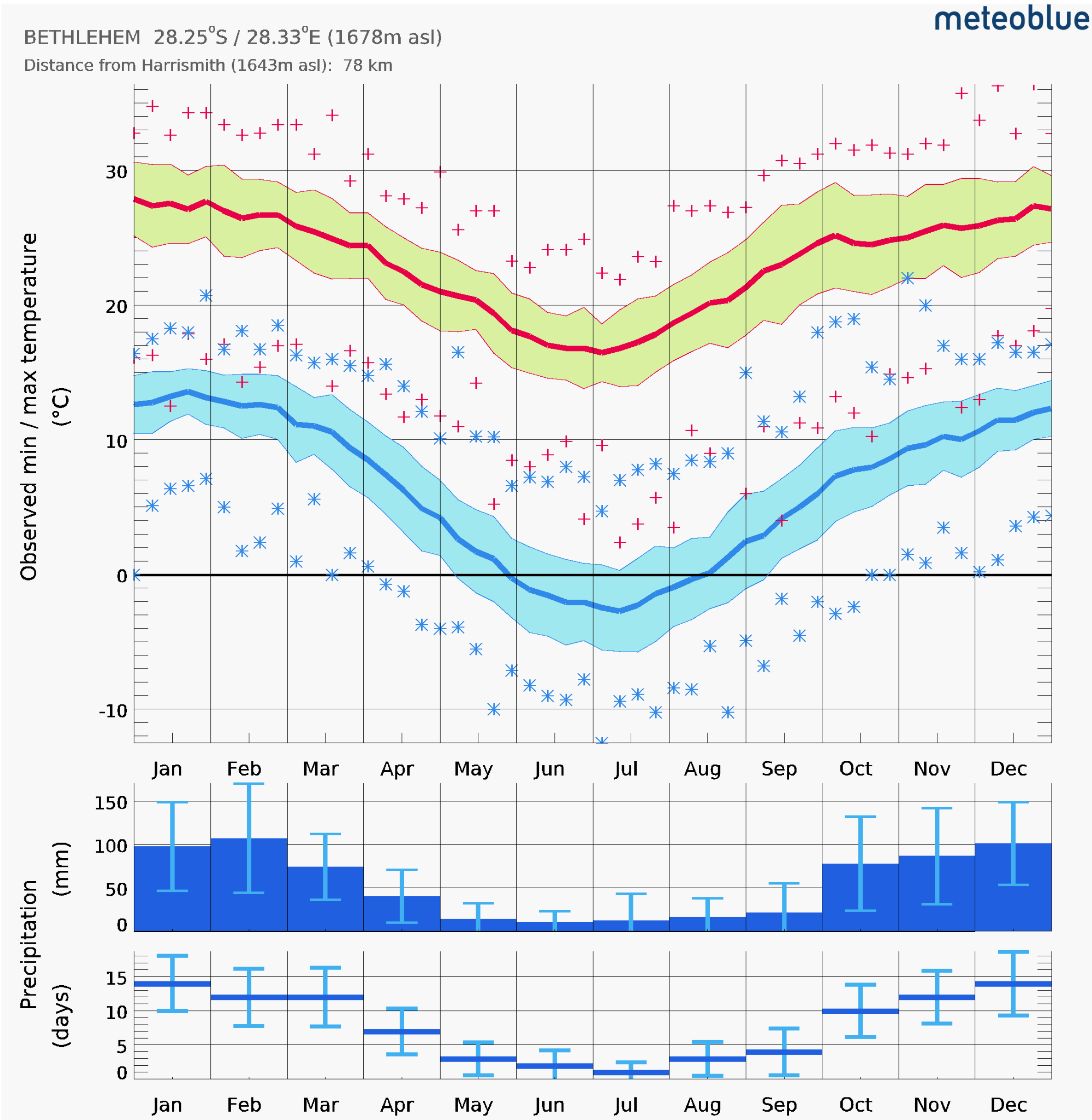


Figure 3: Average monthly maximum and minimum temperature. The average monthly rainfall is in mm (www.meteoblue.com)

Wind

The winds at Harrismsith are described by means of an annual windrose obtained from Meteoblue (www.meteoblue.com) (Figure 4). Windroses simultaneously depicts the frequency of occurrence of wind from the 16 cardinal wind directions and wind speed classes. Wind direction is given as the direction from which the wind blows, i.e., south-westerly winds blow from the southwest. Wind speed is given in m/s, and each arc represents a frequency of occurrence of 500 hours. There are 8 760 hours in a year.

The winds at Harrismith are generally light and seldom exceed 12 m/s. The predominant wind direction is from the broad sectors west to west-northwest and east to east-southeast. The strongest winds are from the broad sector west to west-northwest, but these are infrequent.

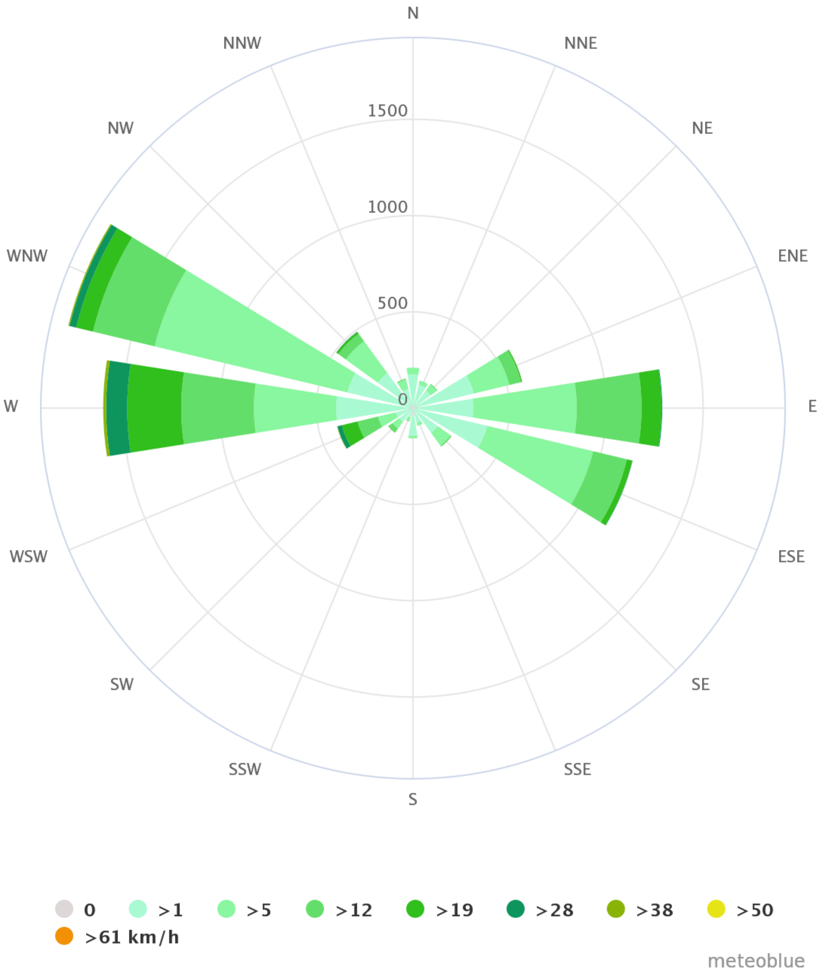


Figure 4: Annual windrose (www.meteoblue.com)

5.1.2 National Ambient Air Quality Standards and Guidelines

The effects of air pollutants on human health occur in a number of ways with short-term, or acute effects, and chronic, or long-term, effects. Different groups of people are affected differently, depending on their level of sensitivity, with the elderly and young children being more susceptible. Factors that link the concentration of an air pollutant to an observed health effect are the concentration and the duration of the exposure to that air pollutant.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented (e.g. WHO, 1999; 2003; 2005). South Africa has established national ambient air quality standards for the criteria pollutants, i.e. SO_2, NO_2, CO, inhalable particulate matter with a diameter of equal or less than 10 µm in diameter (PM_{10}), ozone (O_3), lead (Pb) and benzene (C_6H_6) (DEA, 2009) and respirable particulate matter with a diameter of equal to or less than 2.5 µm in diameter $PM_{2.5}$ (DEA, 2012). The National Ambient Air Quality Standards for SO_2, NO_2, PM_{10}, and benzene are listed in Table 16.

There are no NAAQS for toluene, ethylbenzene and xylene. WHO (2000) and the Alberta (Government of Alberta, 2013) ambient air quality guidelines are used for these compounds (Table 16).

The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99th percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance. Being a health-based standard, ambient concentrations below the standard imply that air quality poses an acceptable risk to human health, while exposure to ambient concentrations above the standard implies that there is an unacceptable risk to human health.

Table 16: Ambient air quality standards and guidelines

Pollutant	Averaging Period	Guideline Value (µg/m^3)	Source
PM_{10}	24 hour	75	DEA, 2009
	1 year	40	DEA, 2009
NO_2	1 hour	200	DEA, 2009
	1 year	40	DEA, 2009
SO_2	1 hour	350	DEA, 2009
	24 hour	125	DEA, 2009
	1 year	50	DEA, 2009
CO	1 hour	30 000	DEA, 2009
	8 hour	10 000	DEA, 2009
Benzene	Calendar year	5	DEA, 2009
Toluene	30-minute	1 000 (odour)	WHO (2000)
	24-hour	7 500 (CNS Effect)	WHO (2000)
Ethylbenzene	1-hour	2 000	Government of Alberta (2013)
Xylene	1-hour	2 300	Government of Alberta (2013)
	24-hour	700	Government of Alberta (2013)

The sections below provide a literature review of particulates (PM_{10}), NO_X, SO_2, CO and BTEX from an air quality and human health perspective.

Particulate Matter

Particulate Matter (PM) is a broad term used to describe the fine particles found in the atmosphere, including soil dust, dirt, soot, smoke, pollen, ash, aerosols and liquid droplets. With PM, it is not just the chemical composition that is important but also the particle size. Particle size has the greatest influence on the behaviour of PM in the atmosphere with smaller particles tending to have longer residence times than larger ones. PM is categorised, according to particle size.

PM_{10} describes all particulate matter in the atmosphere with a diameter equal to or less than 10 µm. Sometimes referred to simply as coarse particles, they are generally emitted from motor vehicles, factory and utility smokestacks, construction sites, tilled fields, unpaved site roads, stone crushing, and burning of wood. Natural sources include sea spray, windblown dust and volcanoes. Coarse particles tend to have relatively short residence times as they settle out rapidly and PM_{10} is generally found relatively close to the source except in strong winds.

Particulate matter may contain both organic and inorganic pollutants. The extent to which particulates are considered harmful depends on their chemical composition and size, e.g. particulates emitted from diesel vehicle exhausts mainly contain unburned fuel oil and hydrocarbons that are known to be carcinogenic. Very fine particulates pose the greatest health risk as they can penetrate deep into the lung, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

In normal nasal breathing, particles larger than 10 µm are typically removed from the air stream as it passes through the nose and upper respiratory airways, and particles between 3 µm and 10 µm are deposited on the mucociliary escalator in the upper airways. Only particles in the range of 1 µm to 2 µm penetrate deeper where deposition in the alveoli of the lung can occur (WHO, 2003). Coarse particles (PM_{10} to $PM_{2.5}$) can accumulate in the respiratory system and aggravate health problems such as asthma. $PM_{2.5}$, which can penetrate deeply into the lungs, are more likely to contribute to the health effects (e.g. premature mortality and hospital admissions) than coarse particles (WHO, 2003).

The WHO has reviewed many studies since 2005 to update information on health effects on PM (WHO, 2013). Studies have once again confirmed that PM (not only PM_{10} but fine and ultra-fine PM as well), has short and long-term (both immediate and delayed) adverse health effects such as cardiovascular effects, but new associations with diseases such as atherosclerosis (thickening of artery walls), birth defects and respiratory illness in children have also been found (WHO, 2013). In addition, some studies have suggested a possible link between PM and diabetes and effects on the central nervous system (WHO, 2013). The increase in daily mortality (between 0.4% and 1%) from exposure to PM_{10} was also confirmed in several studies since 2005 (WHO, 2013).

Nitrogen dioxide (NO_2)

Nitrogen dioxide (NO_2) and nitric oxide (NO) are formed simultaneously in combustion processes and other high temperature operations such as metallurgical furnaces, blast furnaces, plasma furnaces, and kilns. NO_X is a term commonly used to refer to the combination of NO and NO_2. NO_X can also be released from nitric acid plants and other types of industrial processes involving the generation and/or use of nitric acid. NO_X also forms naturally through de-nitrification by anaerobic bacteria in soils and plants. Lightning is also a source of NO_X.

The route of exposure to NO_2 is inhalation and the seriousness of the effects depend more on the concentration than on the length of exposure. The site of deposition for NO_2 is the distal lung where NO_2 reacts with moisture in the fluids of the respiratory tract to form nitrous and nitric acids. About 80 to 90% of inhaled nitrogen dioxide is absorbed through the lungs (CCINFO, 1998). Nitrogen dioxide (present in the blood as the nitrite ion) oxidises unsaturated membrane lipids and proteins, which then results in the loss of control of cell permeability. Nitrogen dioxide causes decrements in lung function, particularly increased airway resistance. Inflammatory reactions were observed at NO_2 concentrations between 200 and 1000 ppb (380 to 1880 µg/m^3) when individuals were exposed under controlled conditions for periods that varied between 15 minutes and six hours (WHO, 2013). However, the results had been inconsistent below 1000 ppb but were much more evident at concentrations higher than 1000 ppb (1880 µg/m^3) (WHO, 2013). Below 1000 ppb healthy individuals did not show inflammatory reactions and for those with respiratory diseases (asthma and chronic obstructive pulmonary disease), inflammation was not induced below 600 ppb, except for one study that reported individuals responded at 260 ppb (500 µg/m^3) (Hesterberg et al., 2009). A review study (on 50 publications) published in 2009 by Hesterberg et al. focussed on short-term exposure to NO_2 and adverse health effects on humans. The authors came to the conclusion that a short-term exposure standard of not more than 200 ppb would protect all individuals, including sensitive individuals. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure.

Chronic exposure to NO_2 increases susceptibility to respiratory infections (WHO, 1997). However, a review study of 50 publications found no consistent evidence that short-term exposure below 200 ppb increased susceptibility to viral infections (Hesterberg et al., 2009).

The WHO has reviewed hundreds of studies published between 2004 and 2011 on adverse health effects after short-term and long-term exposure to NO_2 (WHO, 2013). The health effects from short-term exposure are more evident than those from long-term (chronic) exposure, because in many studies a high correlation was found between NO_2 and other pollutants (WHO, 2013). However, some epidemiology studies suggested an association between NO_2 and respiratory mortality and an association with respiratory effects in children, including effects on children's lung function (WHO, 2013).

Sulphur dioxide (SO_2)

Dominant sources of SO_2 include fossil fuel combustion from industry and power plants. SO_2 is emitted when coal is burnt for energy. The combustion of fuel oil also results in high SO_2 emissions. Domestic coal or kerosene burning can thus also result in the release of SO_2. Motor vehicles also emit SO_2, in particular diesel vehicles due to the higher sulphur content of diesel fuel. Smelting of mineral ores can also result in the production of SO_2, because metals usually exist as sulphides within the ore.

On inhalation, most SO_2 only penetrates as far as the nose and throat, with minimal amounts reaching the lungs, unless the person is breathing heavily, breathing only through the mouth, or if the concentration of SO_2 is high (CCINFO, 1998). The acute response to SO_2 is rapid, within 10 minutes in people suffering from asthma (WHO, 2005). Effects such as a reduction in lung function, an increase in airway resistance, wheezing and shortness of breath, are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract (WHO, 1999). SO_2 reacts with cell moisture in the respiratory system to form sulphuric acid. This can lead to impaired cell function and effects such as coughing, broncho-constriction, exacerbation of asthma and reduced lung function. For example, an exposure of 5 to 10 min to 200 to 300 ppb (520 to 780 µg/m^3) may reduce lung function (measured as Forced Expiratory Volume in the first second (FEV_1)) by more than 15% (US-EPA, 2009). There is however, uncertainty about exposure-response effects below concentrations of 200 ppb (520 µg/m^3). For SO_2 exposure short-term peak concentrations are therefore important (US-EPA, 2009). Re-analysis of the effects of SO_2 done post-2005 has found evidence to suggest that the point of departure for setting the 10-minute guideline needs an additional uncertainty factor, which indicates that the guideline may have to be lowered when it is re-evaluated (WHO, 2013).

Carbon monoxide

CO is an odourless, colourless and toxic gas. People with pre-existing heart and respiratory conditions, blood disorders and anaemia are sensitive to the effects of CO. Health effects of CO are mainly experienced in the neurological system and the cardiovascular system (WHO, 1999). The binding of CO with haemoglobin reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen from haemoglobin to extravascular tissues. These are the main causes of tissue hypoxia produced by CO at low exposure levels. The toxic effects of CO become evident in organs and tissues with high oxygen consumption such as the brain, the heart, exercising skeletal muscle and the developing fetus.

Benzene

Benzene (C_6H_6) is a natural component of crude oil, petrol, diesel and other liquid fuels and is emitted when these fuels are combusted. Diesel exhaust emissions therefore contain benzene. After exposure to benzene, several factors determine whether harmful health effects will occur, as well as the type and severity of such health effects. These factors include the amount of benzene to which an individual is exposed and the length of time of the exposure. For example, brief exposure (5–10 minutes) to very high levels of benzene (14000 – 28000 µg/m^3) can result in death (ATSDR, 2007). Lower levels (980 – 4200 µg/m^3) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion and unconsciousness. In most cases, people will stop feeling these effects when they are no longer exposed and begin to breathe fresh air. Inhalation of benzene for long periods may result in harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. Excessive exposure to benzene can be harmful to the immune system, increasing the chance for infection. Both the International Agency for Cancer Research and the US-EPA have determined that benzene is carcinogenic to humans as long-term exposure to benzene can cause leukaemia, a cancer of the blood-forming organs. The National Ambient Air Quality Standard for benzene is µg/m^3 (DEA, 2009).

Toluene

Toluene is a colourless, flammable liquid with an odour threshold of 2.5 ppm (ACGIH, 2001). The major use of toluene is as a mixture added to gasoline to improve the octane ratings. It can be emitted into the air by motor vehicles, industries using or producing toluene, during storage or when using products that contain toluene. The main route of exposure to toluene is inhalation. About half of the inhaled toluene is absorbed by the human body and is deposited in fatty tissue and tissue rich in blood supply, such as the brain, liver, kidney and fat, but a large percentage of the deposited toluene is removed from the body within 12 hours (ATSDR, 1997).

There are no South African ambient air guidelines or standards for toluene. The South African occupational exposure limit for toluene is 50 ppm (188 mg/m^3). The WHO non-cancer 30-minute guideline of 1000 µg/m^3 is based on odour annoyance (WHO, 2000). The WHO 24-hour guideline of 7 500 µg/m^3 is based on negative effects on the central nervous system (CNS) effects in workers (WHO, 2000).

Ethylbenzene

Ethylbenzene is a colourless flammable liquid with an aromatic odour (odour threshold 2.3 ppm or 10 000 µg/m^3) (ACGIH, 2001). It is primarily used in the manufacture of styrene (used in polystyrene products) and is the starting product for a wide variety of plastics, synthetic rubber and latex products based on styrene. Ethylbenzene is used as a solvent for resins and is a minor component of gasoline. Ethylbenzene may be emitted to the atmosphere from industries using or producing ethylbenzene, from motor vehicle exhausts, tobacco smoking and evaporation from contaminated soil and water. The main route of exposure to ethylbenzene is inhalation when it is rapidly and efficiently absorbed. Hereafter, it is distributed to adipose tissue where approximately 2% is retained. Ethylbenzene has a low acute and chronic toxicity for animals and humans. Prolonged skin contact with the liquid may cause dermatitis due to the de-fatting action of ethylbenzene.

There are no South African ambient air guidelines or standards for ethylbenzene. The WHO guideline for ethylbenzene is 22 000 µg/m^3 as an annual average. The Government of Alberta health-based ambient air quality guideline for ethylbenzene is a 1-hour guideline of 2 000 µg/m^3 (Government of Alberta, 2013).

Xylene

Xylene is a colourless flammable liquid with an aromatic odour (odour threshold between 0.07 and 40 ppm (ACGIH, 2001). It is used in the production of solvents and in paints and coatings. It occurs naturally in coal tar and petroleum. Xylene may be released to air by industries using or producing xylene, by motor vehicle exhaust fumes and by using consumer products that contain xylene as well as by evaporation from contaminated soil and water. Inhalation is the most important route of exposure when xylene is rapidly absorbed and 50 to 70% is retained in the body. Long-term exposure to concentrations found in occupational environment may cause upper respiratory irritation and central nervous system effects such as headaches, dizziness and tremors. ACGIH and EPA consider xylene as not classifiable as a human carcinogen. There are no South African ambient air guidelines or standards for xylene. The WHO (2000) ambient air quality guidelines for xylene are a 24-hour guideline value of 4 800 µg/m^3 (uncertainty factor 60) based on CNS effects in humans and an annual guideline value of 870 µg/m^3 (uncertainty factor 1 000) based on neurotoxicity in rats. The Government of Alberta health-based ambient air quality guidelines for xylene are a 1-hour guideline of 2 300 µg/m^3 and a 24-hour guideline of 700 µg/m^3 (Government of Alberta, 2013).

5.1.3 Current Status of Ambient Air Quality

There are no ambient monitoring programs for PM_{10}, NO_X, SO_2, CO and BTEX in the municipality or in the vicinity of the proposed South African Road Binders – Emulsion plant.

It is therefore not possible to provide the current status of ambient air quality in terms of these selected pollutants in the vicinity of the proposed plant.

Ambient air quality in Harrismith is influenced by a number of sources of air pollution, including small industry, transportation, agricultural burning, mining and the longrange transport of pollutants from the interior. Emissions from industrial facilities include SO_2, NO_X and particulate matter. Emissions from vehicles travelling on nearby roads are important sources of NO_X, SO_2, CO, CO_2, Pb, particulates and volatile organic compounds (VOCs). Biomass burning is an important source of atmospheric emissions in the province. Uncontrolled and controlled burning of natural vegetation, agricultural residue and waste burning are the main types of biomass burning that occur in the province. Fires can emit large quantities of particulate matter, ranging from coarse smut that deposit on surfaces (a nuisance) to fine inhalable particulate matter (PM_{10}). Gases emitted from biomass burning include CO, NOx and VOCs. Other activities in the area include the handling of petrochemical products which mainly emit VOCs.

5.1.4 Dispersion Modelling

Dispersion modelling is used to predict ambient concentrations of PM_{10}, NO_2, SO_2, CO and BTEX resulting from emissions from the proposed South African Road Binders – Emulsion plant. The approach to the dispersion modelling in this assessment is based on the requirements of the DEA guideline for dispersion modelling (DEA, 2014).

According to the DEA guideline for dispersion modelling, a Level 1 air quality assessment is conducted in situations where the purpose of the assessment is to provide an estimate of the worst-case air quality impacts. As such, screening models are sufficient for this level. In the case of this study, a Level 1 assessment is appropriate since the focus of the study is on a licence approval decision; and it deals with the preliminary identification of air quality issues associated with proposed new sources or modifications to existing sources. The DEA recommend the US-EPA approved SCREEN3 model for Level 1 assessments (DEA, 2014).

Operating Scenarios for Emission Units

Emission sources are modelled for a production rate of 57 600 tons/year of bitumen for the emulsion plant to provide an understanding of the effect of emissions from the proposed operations in the ambient environment. The following sources are modelled individually and altogether, for normal operations:

- Emulsion Plant Diesel Burners
- Emulsion Plant Storage Tanks

Dispersion Modelling Procedures

SCREEN3 is the US EPA’s current regulatory screening model for many air permitting applications. It is the recommended tool to calculate screening-level impact estimates for stationary sources. The model is based on steady-state Gaussian plume algorithms and is applicable for estimating ambient impacts from point, area, and volume sources out to about 50 km. In addition. SCREEN3 can be used to model flares. SCREEN3 also includes algorithms for addressing building downwash influences, including the cavity recirculation region, and incorporates the valley 24-hour screening algorithm for estimating complex terrain impacts. The SCREEN3 model uses a matrix of meteorological conditions covering a range of wind speed and stability categories. The model is designed to estimate the worst-case impact based on the meteorological matrix for use as a conservative screening technique. The SCREEN3 model does not use hourly meteorological data. Instead, the user can select one of the following options:

- Full Meteorology – model uses a predefined matrix of meteorological conditions that references all stability classes (A through F) and associated wind speeds, where the maximum wind speed is stability-dependent;
- Single Stability Class – user selects a single stability category, and the model automatically examines all wind speeds appropriate for that category; or
- Single Stability Class and Wind Speed – user selects a single stability category and wind speed combination.

The Full Meteorology option is used for routine application of the SCREEN3 model.

SCREEN3 is a single source model. Nevertheless, the impacts from multiple SCREEN3 model runs can be summed to conservatively estimate the impact from several sources. The SCREEN3 Model User's Guide (US EPA, 1995b) can be consulted for more technical information on the model.

SCREEN3 does not take wind direction and topography into account. The model calculates maximum concentrations at specified distances, but these may occur in any direction from the source. The prevailing wind directions are used to obtain an indication of the general direction in which the pollution plume would travel.

Dispersion Modelling Domain and Grid Receptors

In SCREEN3, the model domain is defined by of the distance from the sources of concern to the receptors of interest. In this study a modelling domain of 25 km^2 which is 5 km (west-east) by 5 km (north-south), centred on the proposed South African Road Binders – Emulsion plant is used for the model runs. Receptor points are spaced 50 m apart from the source to 5 km away from the source.

Model Parameterisation

The parameterisation of key variables used in SCREEN3 are listed in Table 17.

Table 17: Parameterisation of key variables for SCREEN3

AREA SOURCES	
Parameter	Model value
Source type	Area
Source height (m)	Variable
Length (long/short side) (m)	Variable
Receptor height (m)	0
Automated distances (m)	1 – 5 000
Buoyancy flux (m^4/s^3)	0
Momentum flux m^4/s^2)	0
Anemometer height (m)	10

AREA SOURCES	
Parameter	Model value
AREA SOURCES	
Parameter	Model value
Mixing height option	Regulatory
Urban/rural option	Rural
Meteorology	Full meteorology
Terrain	Simple terrain

Model Accuracy

Air quality models attempt to predict ambient concentrations based on "known" or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called "unknown" parameters as well as unresolved details of atmospheric turbulent flow. Variations in these "unknown" parameters can result in deviations of the predicted concentrations of the same event, even though the "known" parameters are fixed.

There are also "reducible" uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. "Reducible" uncertainties can be controlled or minimised. This is achieved by making use of the most appropriate input data, preparing the input files correctly, checking and re-checking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2014) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). It is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

For the proposed South African Road Binders – Emulsion plant, the reducible uncertainty in SCREEN3 is minimised by:

- Applying appropriate parameterisation of the model;
- Using representative emission data; and
- Using a competent modelling team with considerable experience using SCREEN3.

The limitations of SCREEN3 being a one-dimensional model need to be borne in mind when evaluating the model outputs.

Background Concentrations and Other Sources

A background concentration is the portion of the ambient concentration of a pollutant due to sources, both natural and anthropogenic, other than the source being assessed. Other sources of PM_{10}, NO_2, SO_2, CO and BTEX are not characterised and included in the model run. The proposed South African Road Binders – Emulsion plant is modelled in isolation of other sources.

Sensitive Receptors

According to the USEPA, sensitive receptors include, but are not limited to, hospitals, schools, day care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Extra care must be taken when dealing with contaminants and pollutants near areas recognised as sensitive receptors. In this assessment, all neighbouring residential and commercial areas (Figure 1) are treated as sensitive areas as they as expected to include sensitive areas as identified by the USEPA. The sensitive receptors in the vicinity of the proposed South African Road Binders – Emulsion plant were in excess of 5 km from the site and concentrations were not predicted to travel in significant concentrations to this distance.

Dispersion Modelling Results

The dispersion modelling results for the predicted 1-hour, 24-hour and annual average ambient concentrations of PM_{10}, NO_2, SO_2, CO and BTEX resulting from emissions from the proposed South African Road Binders – Emulsion plant are presented in Figures 5-12. The predicted ambient concentrations for PM_{10}, NO_2, SO_2, CO and benzene are assessed against the National Ambient Air Quality Standards (NAAQS). Ambient concentrations for toluene, ethylbenzene and xylene are assessed against relevant international guidelines. The highest predicted ambient concentrations from the dispersion modelling exercise is presented in Table 18.

Particulate Matter - PM_{10}

The predicted 24-hour average and annual average ambient PM_{10} concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (diesel burners) are presented in Figure 5. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

The predicted 24-hour average ambient PM_{10} concentrations for the proposed plant as a whole does not exceed the NAAQS of 75 $\mu g/m^3$ on site. The contribution from the diesel burners is small. In all cases, the predicted concentrations reach a maximum approximately 145 m downwind of the sources, and decrease rapidly thereafter. The predicted 24-hour average ambient PM_{10} concentrations for the proposed plant as a whole, is below NAAQS within and beyond the site boundaries. No exceedance of the NAAQS is therefore predicted in residential and sensitive receptor areas around the site. The predicted PM_{10} concentrations therefore comply with the NAAQS in the ambient environment.

The predicted annual average ambient PM_{10} concentrations for the proposed plant as a whole is well below the NAAQS of 40 $\mu g/m^3$. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted PM_{10} concentrations therefore comply with the NAAQS in the ambient environment.

The highest impacts of PM_{10} from the proposed South African Road Binders – Emulsion plant is expected to the west to west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be low.

Oxides of Nitrogen (NO_X)

For the purpose of this assessment, the modelled NO_X concentrations (NO and NO_2) were assumed to be equal to NO_2 as NO is rapidly converted to NO_2 in the atmosphere. This represents a conservative approach for the modelled predictions.

The predicted 1-hour average and annual average ambient NO_2 concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (diesel burners) are presented in Figure 6. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions from the diesel burners are the largest contributor to the predicted ambient NO_2 concentrations. In all cases, NO_2 concentrations are low on site, reach a maximum approximately 150-200 m downwind of the sources, and decrease rapidly thereafter.

The predicted 1-hour average ambient NO_2 concentrations for the proposed plant as a whole is well below the NAAQS of 200 $\mu g/m^3$. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted NO_2 concentrations therefore comply with the NAAQS in the ambient environment.

The predicted annual average ambient NO_2 concentrations for the proposed plant as a whole is well below the NAAQS of 40 $\mu g/m^3$. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted NO_2 concentrations therefore comply with the NAAQS in the ambient environment.

The highest impacts of NO_2 from the proposed South African Road Binders – Emulsion plant is expected to the west to west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be low.

Sulphur Dioxide (SO_2)

The predicted 1-hour average, 24-hour average and annual average ambient SO_2 concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (diesel burners) are presented in Figure 7. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions from the diesel burners provide a much smaller contribution to the predicted ambient SO_2 concentrations. In all cases, SO_2 concentrations are relatively low on site, reach a maximum approximately 150 m downwind of the sources, and decrease rapidly thereafter.

The predicted 1-hour average ambient SO_2 concentrations for the proposed plant as a whole is well below the NAAQS of 350 $\mu g/m^3$. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted SO_2 concentrations therefore comply with the NAAQS in the ambient environment.

The predicted 24-hour average ambient SO_2 concentrations for the proposed plant as a whole is well below the NAAQS of 125 µg/m^3. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted SO_2 concentrations therefore comply with the NAAQS in the ambient environment.

The predicted annual average ambient SO_2 concentrations for the proposed plant as a whole is well below the NAAQS of 50 µg/m^3. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted SO_2 concentrations therefore comply with the NAAQS in the ambient environment.

The highest impacts of SO_2 from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be low.

Carbon Monoxide (CO)

The predicted 1-hour average and 8-hour average ambient CO concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (diesel burners) are presented in Figure 8. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions of CO have a small contribution from the diesel burners. In all cases, CO concentrations are very low on site, reach a maximum approximately 100-200 m downwind of the source, and decrease rapidly thereafter.

The predicted 1-hour average and 8-hour average ambient CO concentrations for the proposed plant as a whole is very low and well below the NAAQS of 30 000 µg/m^3 and 10 000 µg/m^3 respectively. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted CO concentrations therefore comply with the NAAQS in the ambient environment.

The highest impacts of CO from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be low.

Benzene (C_6H_6)

The predicted annual average ambient benzene concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (emulsion plant storage tanks) are presented in Figure 9. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions from emulsion plant storage tanks is the only contributor to the predicted ambient benzene concentrations. In all cases, benzene concentrations are very low on site, reach a maximum approximately 50 m downwind of the source, and decrease rapidly thereafter.

The predicted annual average ambient benzene concentrations for the proposed plant as a whole is well below the NAAQS of 5 µg/m^3. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted benzene concentrations therefore comply with the NAAQS in the ambient environment.

The highest impacts of benzene from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be negligible.

Toluene

The predicted 1-hour average and 24-hour average ambient toluene concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (emulsion plant storage tanks) are presented in Figure 10. The highest predicted ambient concentrations for all modelled categories are presented in Table 10.

Emissions from the emulsion plant storage tanks are the only contributor to toluene. In all cases, toluene concentrations are very low on site, reach a maximum approximately 50 m downwind of the source, and decrease rapidly thereafter.

The predicted 1-hour average and 24-hour average ambient toluene concentrations for the proposed plant as a whole is very low and well below the WHO guideline of 1 000 µg/m^3 and 7 500 µg/m^3 respectively. No exceedance of the guideline is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted toluene concentrations therefore comply with the guideline in the ambient environment.

The highest impacts of toluene from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be negligible.

Ethylbenzene

The predicted 1-hour average ambient ethylbenzene concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (emulsion plant storage tanks) are presented in Figure 11. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions from the emulsion plant storage tanks are the only contributor to ethylbenzene. In all cases, ethylbenzene concentrations are very low on site, reach a maximum approximately 50 m downwind of the source, and decrease rapidly thereafter.

The predicted 1-hour average ambient ethylbenzene concentrations for the proposed plant as a whole is very low and well below the Government of Alberta guideline of 2 000 μg/m^3. No exceedance of the guideline is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted ethylbenzene concentrations therefore comply with the guideline in the ambient environment.

The highest impacts of ethylbenzene from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be negligible.

Xylene

The predicted 1-hour average and 24-hour average ambient xylene concentrations resulting from individual sources at the proposed South African Road Binders – Emulsion plant (emulsion plant storage tanks) are presented in Figure 12. The highest predicted ambient concentrations for all modelled categories are presented in Table 18.

Emissions from the emulsion plant storage tanks are the only contributor to xylene. In all cases, xylene concentrations are very low on site, reach a maximum approximately 50 m downwind of the source, and decrease rapidly thereafter.

The predicted 1-hour average and 24-hour average ambient xylene concentrations for the proposed plant as a whole is very low and well below the Government of Alberta guideline of 2 300 μg/m^3 and 700 μg/m^3 respectively. No exceedance of the guideline is therefore predicted within the site or in residential and sensitive receptor areas around the site. The predicted xylene concentrations therefore comply with the guideline in the ambient environment.

The highest impacts of xylene from the proposed South African Road Binders – Emulsion plant is expected to the west-northwest and east to east-southeast of the site, based on the predominant wind directions for Harrismith. The predicted ambient concentrations will not significantly impact on air quality beyond the site, and the significance beyond the industrial area are likely to be negligible.

Table 18: Maximum predicted ambient concentrations for the proposed South African Road Binders – Emulsion plant

Pollutant	Averaging Period	Diesel Burners	Emulsion Plant Storage Tanks	All Sources	Ambient Air Quality Standard/Guideline
PM_{10} (µg/m³)	24-Hour	2.17		2.17	NAAQS = 75 µg/m³
	Annual	0.43		0.43	NAAQS = 40 µg/m³
SO_2 (µg/m³)	1-Hour	0.51		0.51	NAAQS = 350 µg/m³
	24-Hour	0.08		0.08	NAAQS = 125 µg/m³
	Annual	0.02		0.02	NAAQS = 50 µg/m³
NO_2 (µg/m³)	1-Hour	144.71		144.71	NAAQS = 200 µg/m³
	Annual	4.34		4.34	NAAQS = 40 µg/m³
CO (µg/m³)	1-Hour	36.18		36.18	NAAQS = 30 000 µg/m³
	8-Hour	25.32		25.32	NAAQS = 10 000 µg/m³
Benzene (µg/m³)	Annual		0.0001	0.0001	NAAQS = 5 µg/m³
Toluene (µg/m³)	1-Hour		0.024	0.024	WHO = 1 000 µg/m³
	24-Hour		0.004	0.004	WHO = 7 500 µg/m³
Ethylbenzene (µg/m³)	1-Hour		0.003	0.003	ALBERTA = 2 000 µg/m³
Xylene (µg/m³)	1-Hour		0.062	0.062	ALBERTA = 2 300 µg/m³
	24-Hour		0.009	0.009	ALBERTA = 700 µg/m³

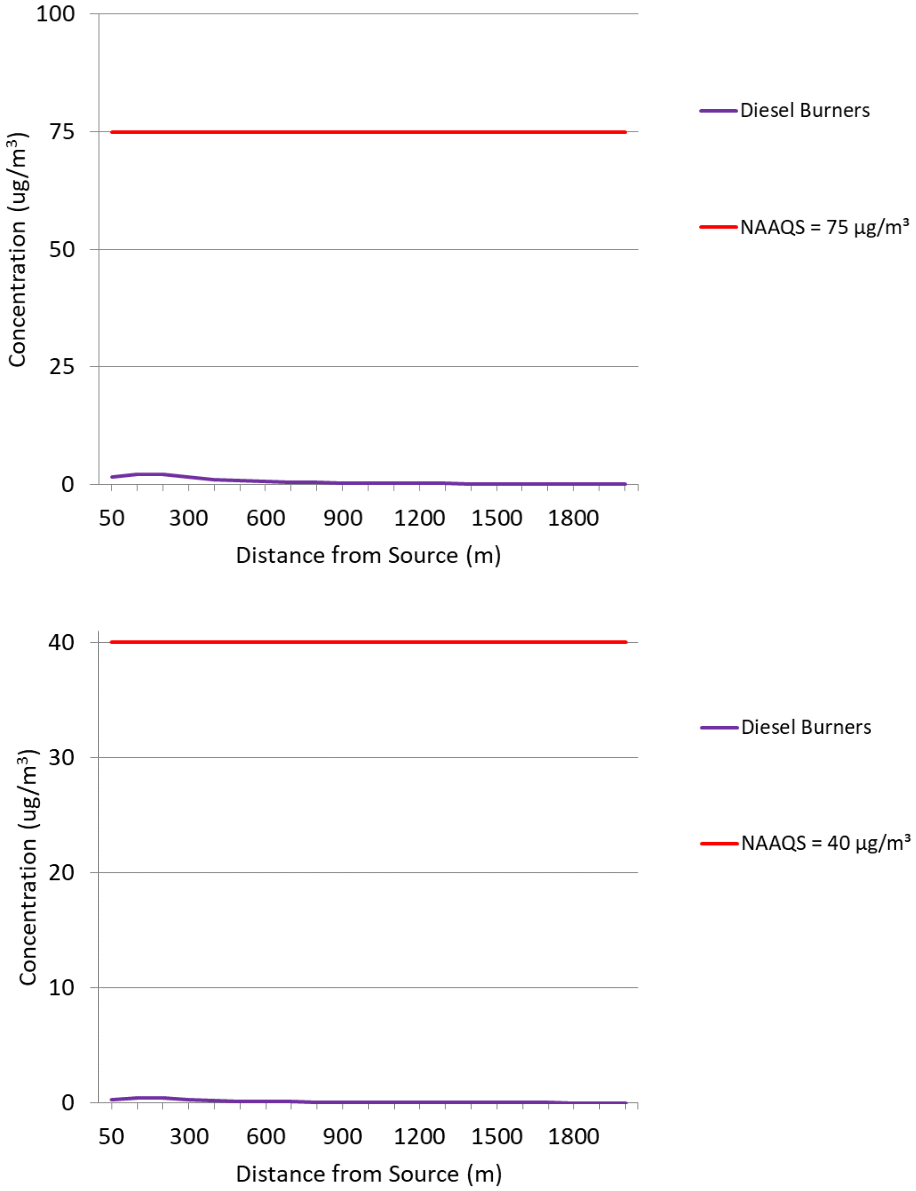


Figure 5: Predicted 24-hour average (top) and annual average (bottom) ambient PM_{10} concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

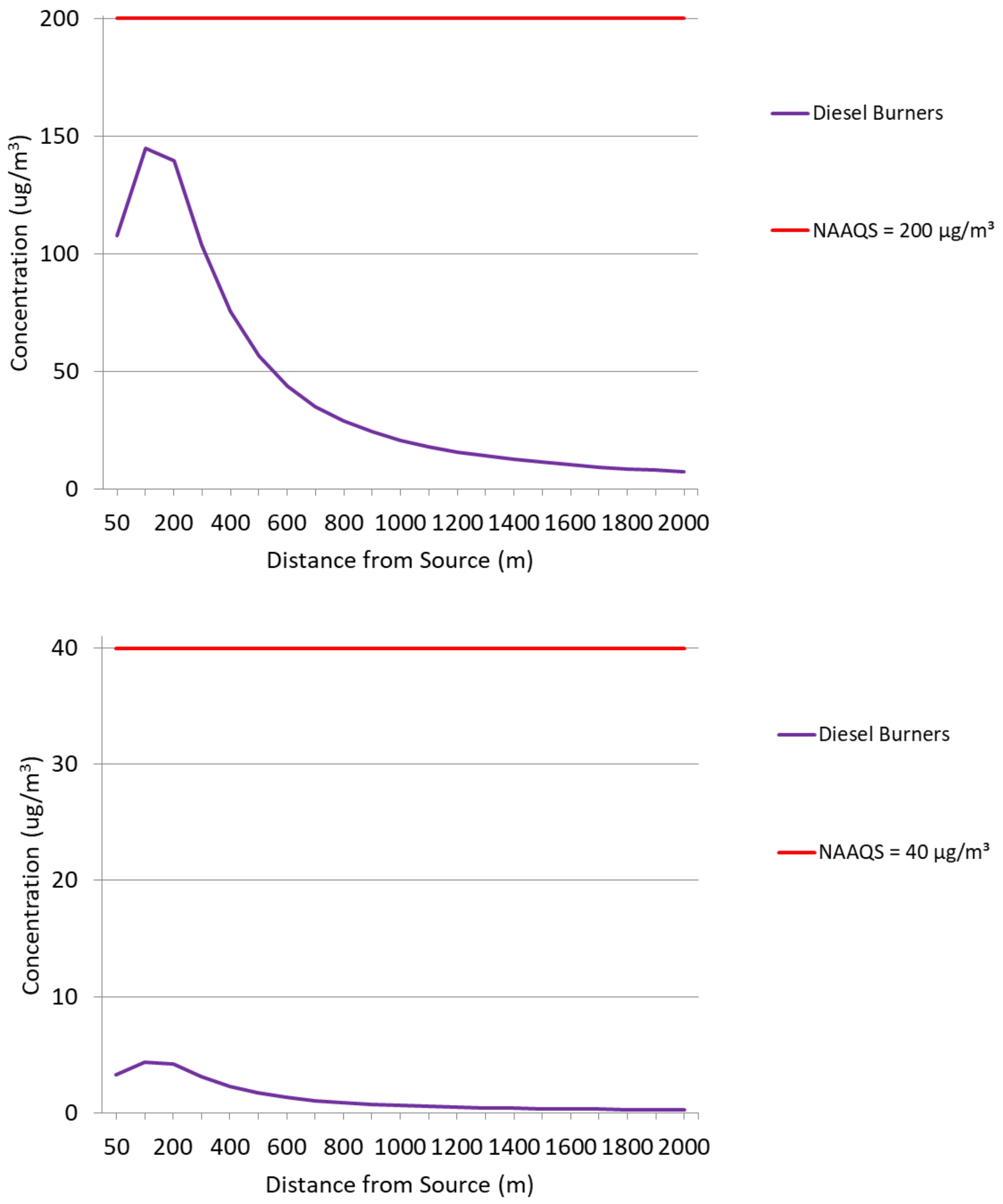
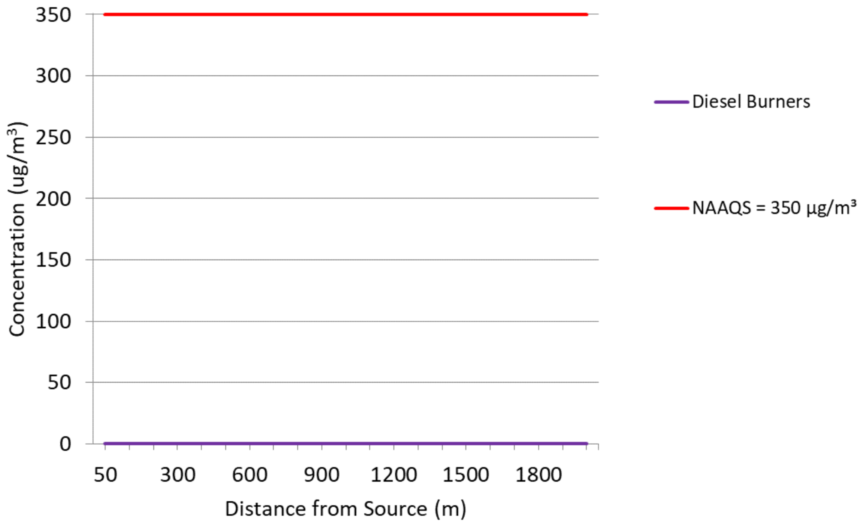
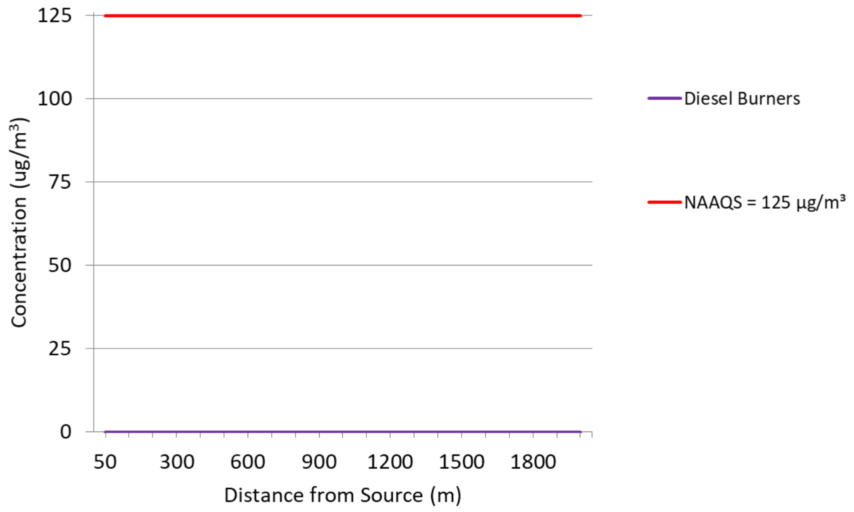


Figure 6: Predicted 1-hour average (top) and annual average (bottom) ambient NO_2 concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources





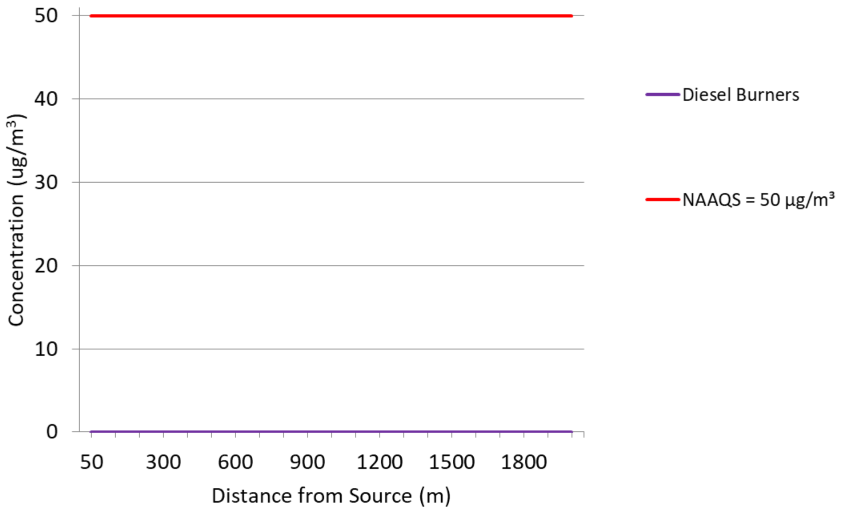
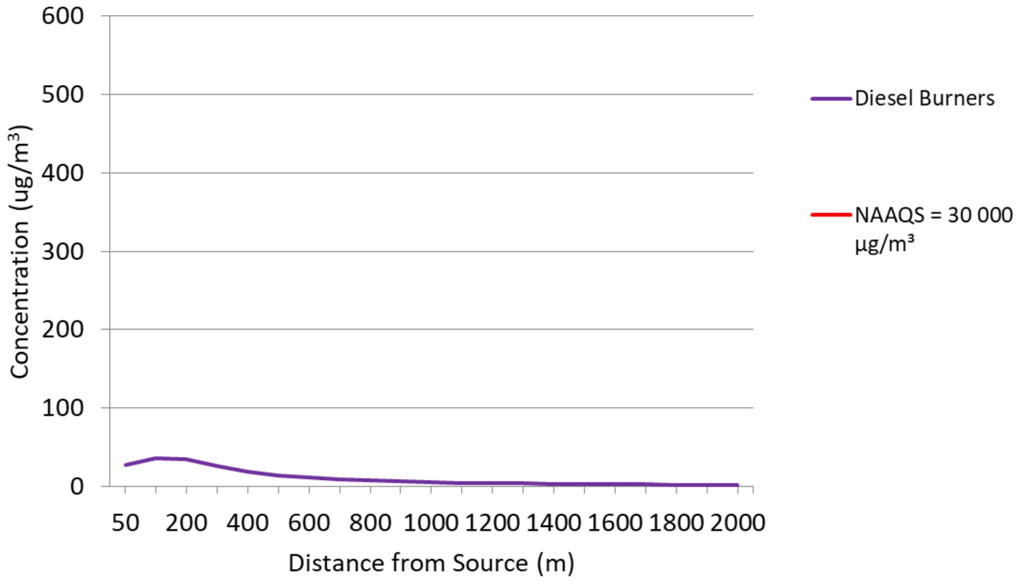


Figure 7: Predicted 1-hour average (top), 24-hour average (middle) and annual average (bottom) ambient SO_2 concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources



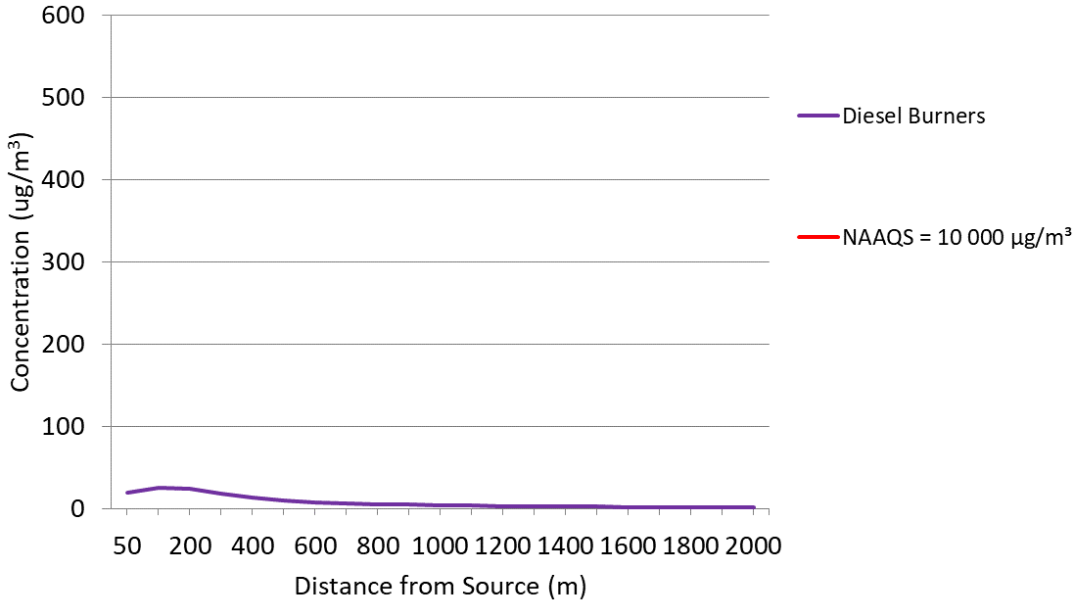


Figure 8: Predicted 1-hour average (top) and 8-hour average (bottom) ambient CO concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

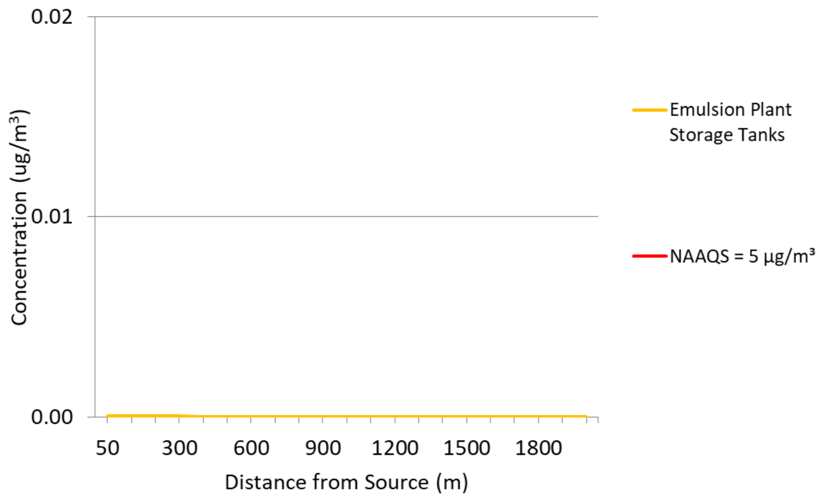


Figure 9: Predicted annual average ambient benzene concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

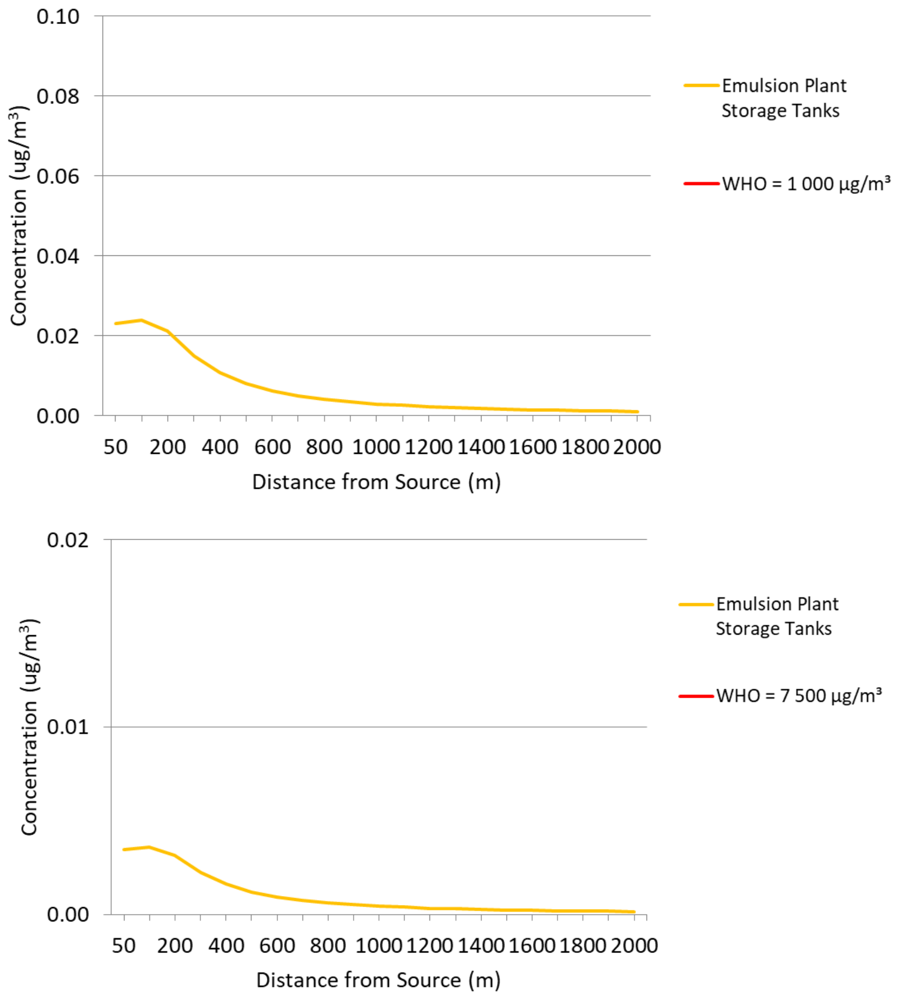


Figure 10: Predicted 1-hour average (top) and 24-hour average (bottom) ambient toluene concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

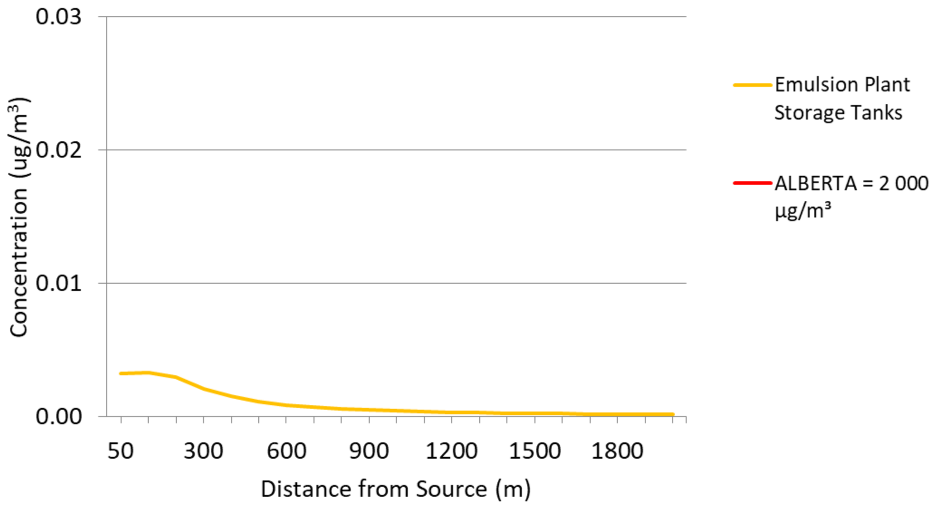


Figure 11: Predicted 1-hour average ambient ethylbenzene concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

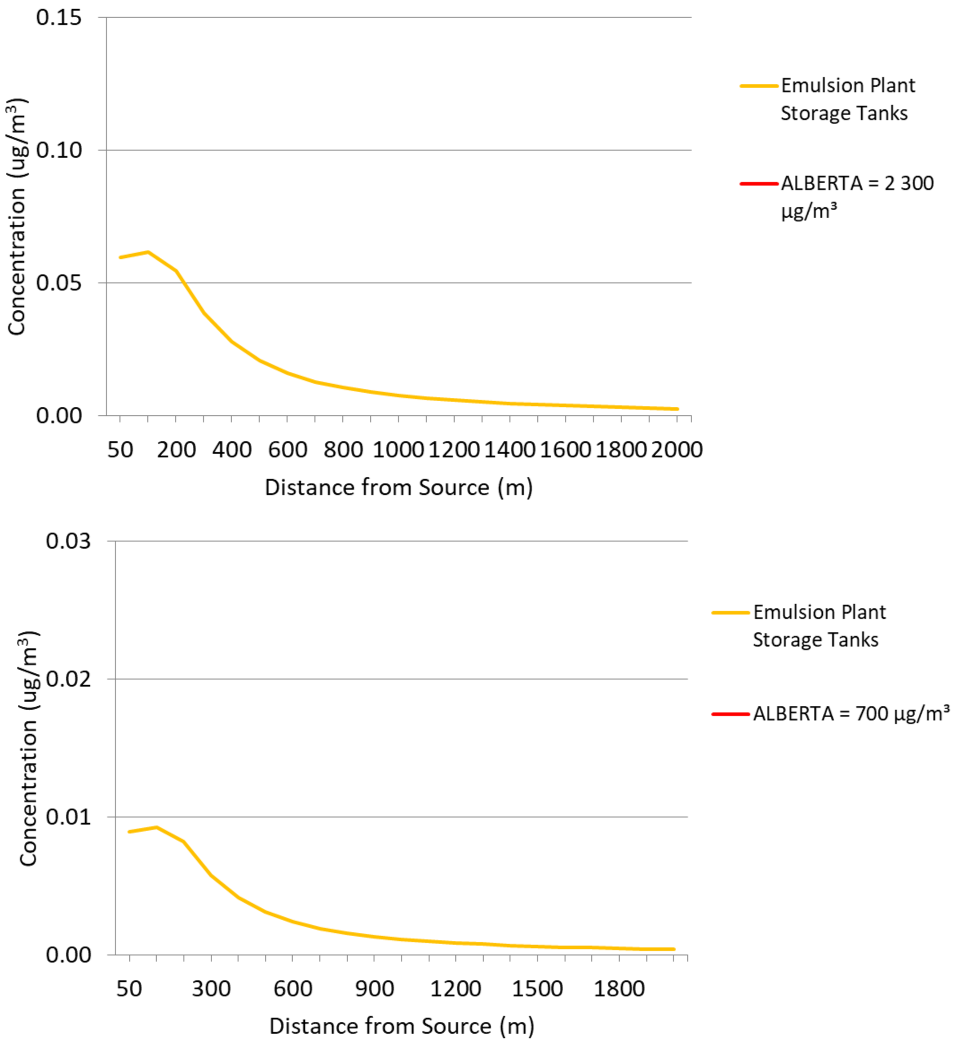


Figure 12: Predicted 1-hour average (top) and 24-hour average (bottom) ambient xylene concentrations in µg/m³ resulting from emissions from the proposed South African Road Binders – Emulsion plant sources

Impact Assessment

The potential impact of emissions of PM_{10}, NO_X, SO_2, CO and BTEX resulting from various sources at the proposed South African Road Binders – Emulsion plant is assessed according to standard Environmental Impact Assessment criteria (Table 19). The following criteria are applied:

Extent – indicates whether the impact will be local and limited to the immediate area of the site, limited to within 5 km of the site (neighbouring), or whether the impact may be realised regionally, nationally or even internationally.
Duration – this considers the lifetime of the impact, as being short term (0 – 5 years), medium term (5 – 15 years), long term (>15 years but where the impacts will cease after the operation of the site) or permanent.
Intensity – establishes whether the impact is destructive or innocuous and is described as either low (where no environmental functions and processes are affected), medium (where the environment continues to function but in a modified way) or high (where environmental functions and processes are altered such that they temporarily or permanently cease).
Probability – considers the likelihood of the impact occurring and is described as improbable (low likelihood), probable (distinct likelihood), highly probable (most likely) or definite (impact will occur regardless of prevention measures).
Status of the impact – is a description as to whether the impact will be positive (a benefit), negative (a cost) or neutral.
Degree of confidence – in the predictions, based on the availability of information and specialist knowledge.
The significance of impacts – is derived from an assessment of all of the above and can be categorised as low, medium or high.

Table 19: Impact assessment for operations at the proposed South African Road Binders – Emulsion plant

Criteria	diesel burners, emulsion plant storage tanks
Extent	**Local and limited to the immediate area of the site** Predicted ambient PM_{10}, NO_X, SO_2, CO and BTEX concentrations are below the respective NAAQS and international guidelines in the ambient environment
Duration	**Long term** As long as the proposed South African Road Binders – Emulsion plant is in operation
Intensity	**Low** Predicted ambient PM_{10}, NO_X, SO_2, CO and benzene concentrations are relatively low in the ambient environment and no environmental functions and processes are likely to be affected
Probability	**Improbable** Predicted ambient PM_{10}, NO_X, SO_2, CO and BTEX concentrations in the ambient environment are relatively low and impacts are improbable

Criteria	diesel burners, emulsion plant storage tanks
Status	**Negative** Air pollution impacts on human health may be negative despite the low concentrations of the particulates, gases and chemical compounds, predicted in the ambient environment
Confidence	**High** Good data, sound methodology, and a USEPA and DEA approved screening dispersion model have been used for the dispersion model simulations
Significance	**Low** Predicted ambient PM_{10}, NO_X, SO_2, CO and BTEX concentrations are below the respective NAAQS and international guidelines in the ambient environment. This facility is in an industrial zone.

5.2 Analysis of Emissions' Impact on the Environment

An assessment of the atmospheric impact of the facility on the environment was not undertaken as part of this Atmospheric Impact Report.

6. SUMMARY AND CONCLUSION

USEPA AP42 emission factors are used to estimate emissions from the proposed South African Road Binders – Emulsion plant, and the DEA recommended and USEPA-approved SCREEN3 dispersion model is used to assess the effects and potential consequences of emissions from the proposed plant in the surrounding environment.

The impact of modelled ambient concentrations of PM_{10}, NO_2, SO_2, CO and BTEX are well below the respective national and international health-based ambient air quality standards and guidelines. No exceedance of the respective standards or guidelines are predicted within the site or in residential and sensitive receptor areas around the site. The predicted ambient concentrations therefore comply with the national health-based ambient air quality standards in the ambient environment.

From an air quality perspective, it is therefore recommended that the application for the proposed project is approved.

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8. FORMAL DECLARATIONS

A declaration of the accuracy of the information contained in this Atmospheric Impact Report is included here. A declaration of the independence of the practitioners in the uMoya-NILU consultancy team that compiled this AIR is also included.

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: uMoya-NILU Consulting (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel [duly authorised], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 28th day of November, 2019

____
SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: Mark Zunckel

Name of Registered Body: South African Council for Natural Scientific Professionals

Professional Registration Number: 400449/04

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel declare that I am independent of the applicant. I have the necessary expertise to conduct the assessment required for the report and will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in the atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 28th day of November, 2019

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY