# Atmospheric Impact Assessment for the EIA for the proposed Mutsho Power Project near Makhado, Limpopo Province

## Circulating Fluidized Bed (CFB) Technology


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## Report Details

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# EXECUTIVE SUMMARY


Mutsho Power (Pty) Ltd is evaluating the potential of establishing the proposed Mutsho Power Project and associated infrastructure on a site near Makhado in the Limpopo Province. It is proposed that the power plant will have a maximum capacity of 600 MW. Savannah Environmental (Pty) Ltd has been appointed as an independent environmental consultant by Mutsho Power to conduct the Environmental Impact Assessment for the proposed project. uMoya-NILU Consulting has in turn been appointed to conduct an Atmospheric Impact Assessment for the project, in support of both the Environmental Impact Assessment (EIA) and Atmospheric Emission License (AEL) application for the proposed project. This report therefore provides the information required by an Atmospheric Impact Report (AIR)[1].

The approach to the dispersion modelling in this assessment is based on the requirements of the Department of Environmental Affairs' (DEA, 2014) regulations regarding air dispersion modelling. This assessment is a Level 3 assessment, according to the definition on the air dispersion modelling regulations. The United States Environmental Protection Agency (USEPA) approved and DEA recommended California Puff (CALPUFF) suite of models is therefore used to assess the effects and potential consequences of emissions from the proposed Mutsho Power Project on the surrounding environment.

The main source of emissions from the proposed Mutsho Power Project includes the Boiler Stack, the coal stockpile, ash dump and the unpaved site access road. Two Scenarios are considered in this assessment: Scenario 1 - Boiler Stack in Isolation and Scenario 2 - All Sources (which include the Boiler Stack, coal stockpile, ash dump and unpaved site access road). This provides an understanding of the relative contribution of the elevated source (Boiler stack) and the low-level sources (coal stockpile, ash dump, site roads. Three site layout options are proposed for the Mutsho Power Project. Dispersion modelling is conducted for the preferred site layout.

In Scenario 1, the predicted dustfall and ambient concentrations of $PM_{10}$, $SO_2$, $NO_X$ and CO are considerably less than the respective national dust standard and National Ambient Air Quality Standards for all averaging periods throughout the modelling domain. There are no predicted exceedances of the national dust standard or NAAQS within the proposed Mutsho Power Project site or in residential and sensitive receptor areas around the site. The predicted dustfall and ambient concentrations are therefore compliant in the ambient environment.

In Scenario 2, exceedance of the dust standard for the residential area category, $PM_{10}$ and $PM_{2.5}$ are predicted over a very small area along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. Predicted dustfall and ambient $PM_{10}$ and $PM_{2.5}$ concentrations are well below the respective national dust standard and NAAQS beyond the Mutsho Power Project site and are therefore compliant in the ambient environment.


[1] DEA, 2013: Regulations prescribing the format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice No. 747 of 11 October 2013.

According to the dispersion modelling results and air quality impact assessment, emissions from the Mutsho Power Project site operations are expected to result in dustfall and ambient concentrations of air pollutants that are well below the respective national dust standard and NAAQS in the ambient environment. The relatively small changes between the three layout options will result in very small changes to the predicted ambient concentrations, but importantly, there is no change to the conclusion. Air quality impacts are therefore considered to have a low significance regardless of the site configuration. From an air quality perspective, it is therefore a reasonable opinion that the project should be authorised considering the outcomes of this study for the preferred site layout option.

# GLOSSARY OF TERMS AND ACRONYMS

| | |
|---|---|
| AEL | Atmospheric Emission License |
| APPA | The Atmospheric Pollution Prevention Act (Act 45 of 1965) |
| DEA | Department of Environmental Affairs |
| CBIPPPP | Coal Baseload Independent Power Producer Procurement Programme |
| CFB | Circulating Fluidised Bed |
| CoAL | Coal of Africa Limited |
| DoE | Department of Energy |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| GHG | Greenhouse Gas |
| HRA | Health Risk Assessment |
| IEP | Integrated Energy Plan |
| IFC | International Finance Corporation |
| IPP | Independent Power Producer |
| $mg/m^3$ | Milligrams per cubic meter |
| NDP | National Development Plan |
| NEMAQA | National Environmental Management: Air Quality Act (Act No. 39 of 2004) |
| NO | Nitrogen oxide |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Oxides of nitrogen ($NO_x = NO + NO_2$) |
| PC | Pulverised Coal |
| $PM_{10}$ | Particulate matter with a diameter less than 10 microns |
| $PM_{2.5}$ | Particulate matter with a diameter less than 2.5 microns |
| $SO_2$ | Sulphur dioxide |
| $\mu g/m^3$ | Micrograms per cubic meter |
| VOC | Volatile organic compound |
| WML | Waste Management License |

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# *DETAILS OF THE SPECIALISTS*

This air quality specialist study is conducted by Dr Mark Zunckel and Atham Raghunandan of uMoya-NILU Consulting (Pty) Limited.

Dr Mark Zunckel has a PhD from the University of the Witwatersrand. He is a meteorologist with 13 years of operational meteorology and research experience at the South African Weather Service before he joined the air pollution group at CSIR. There he developed his career further by leading the research group and many small and large research and consultancy projects over a 15-year period in a number of southern African countries and in South America. These included air quality specialist studies for industrial developments, leading the development of the National Framework for Air Quality Management and developing Priority Area, provincial and municipal air quality management plans. Dr Zunckel has conducted courses in Air Quality Management and dispersion modelling. He is a co-founder of uMoya-NILU Consulting (Pty) Limited, a South African air quality management consultancy company. He is registered as a Professional Natural Scientist.

Atham Raghunandan has a Masters degree from the University of KwaZulu-Natal where his research focussed on ozone profiles in the lower troposphere. He has since developed extensive dispersion modelling skills with models such as CALPUFF, TAPM, CALINE and HYSPLIT through his involvement in numerous air quality assessment projects in Richards Bay, Coega, Port Shepstone, Atlantis, Wild Coast, Western Cape, the Highveld, Uruguay and elsewhere. In 2006, Atham attended the European Research Course on Atmospheres (ERCA) which largely focused on atmospheric science and climate change. He therefore has a good research background which he has adapted to suit the consultancy environment. Recently, he has gained vast experience with dispersion modelling in the mining field, in KwaZulu-Natal, Mozambique and Zambia. Atham has been a key member of uMoya-NILU's professional team since 2008.

# *SCOPE AND PURPOSE OF THE STUDY*

The Mutsho Power Company proposes the development of a new coal-fired power plant and associated infrastructure on a site near Makhado, in the Limpopo Province. The power plant will utilise coal mined at the Makhado Mine (roughly 20 km south-east of the project site), owned and operated by Coal of Africa Limited (CoAL), to fuel its operations. Once developed, the power plant is intended to form part of the Department of Energy's (DoE's) Coal Baseload Independent Power Producer (IPP) Procurement Programme (CBIPPPP). The project would have a generation capacity of up to 660 MW, and will make use of either Pulverised Coal (PC) or Circulating Fluidised Bed (CFB) technology.

The Mutsho Power Company (Pty) Ltd has appointed Savannah Environmental (Pty) Ltd to undertake an integrated Environmental Impact Assessment (EIA) process to obtain Environmental Authorisation and a Waste Management License (WML) for the proposed Mutsho Power Project. uMoya-NILU (Pty) Ltd has been sub-contracted to undertake the air quality specialist study for the EIA.

# 1. ENTERPRISE DETAILS

## 1.1 Enterprise Details

The enterprise details relating to the proposed Mutsho Power Project is listed in Table 1.

**Table 1: Enterprise details**

| | |
|---|---|
| **Entity Name:** | Mutsho Power (Pty) Ltd |
| **Trading as:** | Mutsho Power (Pty) Ltd |
| **Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:** | Company |
| **Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):** | |
| **Registered Address:** | |
| **Postal Address:** | |
| **Telephone Number (General):** | |
| **Fax Number (General):** | |
| **Company Website:** | |
| **Industry Type/Nature of Trade:** | Power Generation |
| **Land Use Zoning as per Town Planning Scheme:** | Agricultural |
| **Land Use Rights if outside Town Planning Scheme:** | Agricultural |
| **Responsible Person:** | |
| **Emissions Control Officer:** | |
| **Telephone Number:** | |
| **Cell Phone Number:** | |
| **Fax Number:** | |
| **Email Address:** | |
| **After Hours Contact Details:** | |

## 1.2 Location and Extent of the Plant

The site information relating to the proposed Mutsho Power Plant is listed in Table 2.

**Table 2: Site information**

| | |
|---|---|
| **Physical Address of the Licensed Premises:** | Farm Du Toit 563 and Farm Vrienden 589 |
| **Description of Site:** | |
| **Property Registration Number (Surveyor-General Code):** | T0MS00000000056300000<br>T0MS00000000058900000 |
| **Coordinates (latitude, longitude) of Approximate Centre of Operations (Decimal Degrees):** | 22.6919°S and 29.8265°E |
| **Coordinates (UTM) of Approximate Centre of Operations:** | 790400.57 m E and 7487821.32 m S |
| **Extent (km²):** | |
| **Elevation Above Mean Sea Level (m):** | 727 m |
| **Province:** | Limpopo |
| **District/Metropolitan Municipality:** | Vhembe District Municipality |
| **Local Municipality:** | Musina Local Municipality |
| **Designated Priority Area (if applicable):** | N/A |

## Description of surrounding land use (within 5 km radius)

Mutsho Power proposes the development of a new coal-fired power plant and associated infrastructure on a site near Makhado, in the Limpopo Province. The power plant will utilise coal mined at the Makhado Mine (to be developed roughly 20 km south-east of the project site), to be owned and operated by MC Mining Ltd (MCM) (previously known as Coal of Africa Limited (CoAL)), to fuel its operations.

The proposed Mutsho Power Project will be located on the farm Vrienden 589 and/or on the Farm Du Toit 563. The surrounding land use within a 5 km radius from the centre of the proposed operations (taken as the centre of the power plant) is mainly comprised of farm land. There are no commercial or industrial areas within a 5 km radius from the centre of the proposed operations. There are several residences on farms within 5 km of the proposed site, the closest three are 1.5 km respectively to the west-northwest, the west and to the east-southeast. The main residential and commercial areas are the town of Musina and Makhado which are 45 km to the northeast and 30 km to the southeast of the site, respectively. A Google Earth image showing the relative location of the proposed power plant and the land use in a 5 km radius is shown in Figure 1.

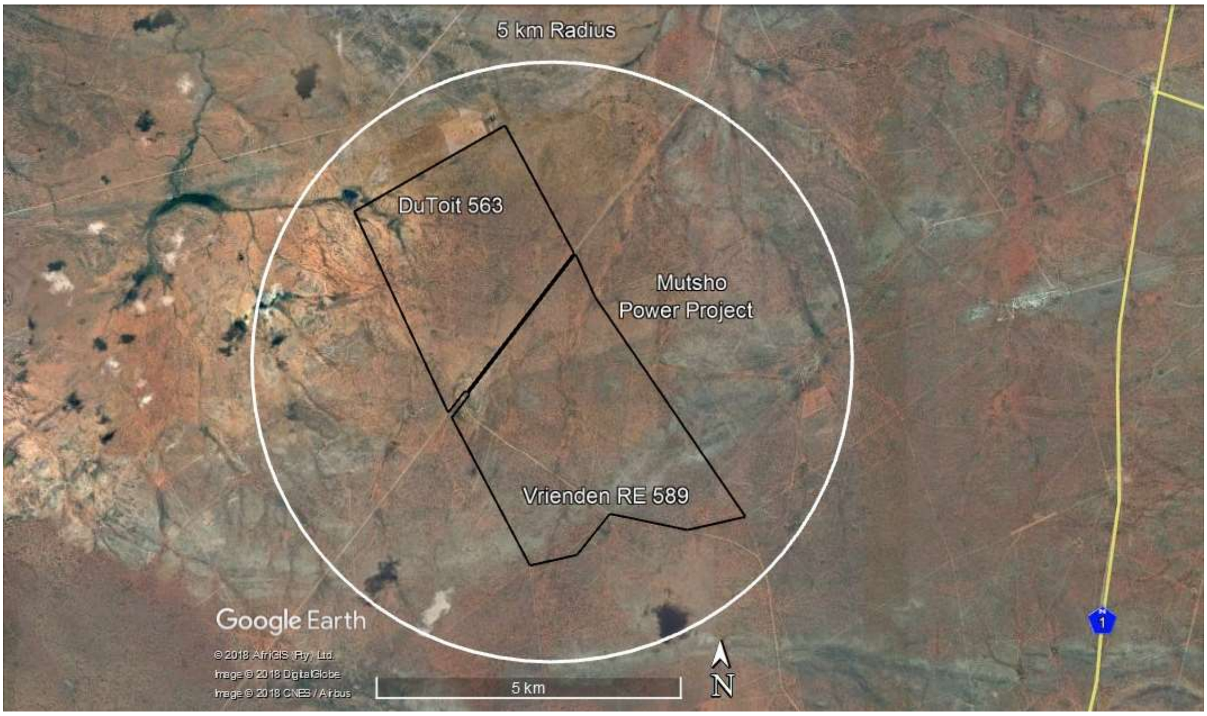



**Figure 1: The location of the proposed Mutsho Power Project, showing a 5 km radius around the proposed operations (Google Earth, 2018)**

### 1.3 Atmospheric Emission License (AEL) and Other Authorisations

The proposed Mutsho Power Project located on a site near Makhado is not yet in possession of an Atmospheric Emissions License (AEL) or any other authorisations related to air quality (Table 3) as the project is still in the feasibility (i.e. EIA) stage.

**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

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). The processes at the proposed Mutsho Power Project include two Listed Activities. The Listed Activity with the respective MES is shown in Table 4.

According to the MES, existing industrial facilities must comply with the MES for 'New Plants' by 1 April 2020 (Table 5). New facilities must immediately comply with the MES for new plants. The proposed Mutsho Power Project should comply with the MES for new plants when the plant is in operation.

**Table 4: Details of the Listed Activities proposed to be carried out at the Mutsho Power Project, according to GN 248 (DEA, 2013a)**

| Category of Listed Activity | Sub-category of the Listed Activity | Description of the Listed Activity |
|---|---|---|
| Category 1: Combustion Installations | Sub-category 1.1: Solid Fuel Combustion Installations | Solid fuels combustion installations used primarily for steam raising or electricity generation, design capacity equal to or greater than 50MW heat input per unit |
| Category 5: Mineral processing, storage and handling | Category 5.1: Storage and handling of ore and coal | Storage and handling of ore and coal not situated on the premises of a mine or works defined in the Mines Health and Safety Act 29/1996, holding more than 100 000 tons |

**Table 5: Minimum Emission Standards for Sub-category 1.1 Listed Activities according to GN 248 (DEA, 2013a)**

| Substance or mixture of substances | | Plant Status | Minimum Emission Standards ($mg/Nm^3$) under normal conditions of 10% $O_2$, 273 Kelvin and 101.3 kPa. |
|---|---|---|---|
| Common name | Chemical symbol | | |
| Particulate matter | N/A | New | 50 |
| Sulphur dioxide | $SO_2$ | New | 500 |
| Oxides of nitrogen | $NO_X$ expressed as $NO_2$ | New | 750 |

## 2.2 Process Description

The total generation capacity of the Mutsho Power Project is up to 660MW (with an export capacity below 600MW in line with DoE requirement), consisting of Circulating Fluidised Bed (CFB) technology operating under supercritical conditions with two 300 MW boilers, a single flue stack, ash dump, coal stock pile and lime supply. Coal mined at the Makhado Colliery will be transported to the power station either via railway loop or via road transport. Coal will then be transported from the railway siding via overland coal conveyor to the coal stockpile located onsite.

Fluidization is the phenomenon by which solid particles are transported into a fluid like state through suspension in a gas or liquid. Circulating Fluidized Bed (CFB) is a relatively new technology with the ability to achieve lower emission of pollutants. The importance of this technology has grown recently because of stricter environmental regulations for pollutant emission.

A schematic of the CFB boiler process is shown in Figure 2. At the bottom of the boiler furnace is a bed of inert material, typically sand. The coal is spread on the bed. Air supply from under the bed is at high pressure which lifts the bed material and the coal and keeps it in suspension. This ensures that the gas and solids mix together turbulently for better heat transfer and chemical reactions. Coal combustion takes place in this suspended condition at a temperature of 760°C to 927°C to prevent the formation of nitrogen oxide ($NO_x$).

During combustion flue gas containing sulphur dioxide ($SO_2$) and particulates is released. Sulphur-absorbing chemicals such as limestone or dolomite are typically mixed with the coal in the fluidisation phase. These absorb up to 95% of the $SO_2$. Fine particles of partly burned coal, ash and bed material are carried along with the flue gases to the upper areas of the furnace and then into a cyclone. In the cyclone the heavier particles separate from the gas and fall into the hopper. This is returned to the furnace for recirculation, leading to the technology name of Circulating Fluidised Bed combustion. The hot gases from the cyclone pass to the heat transfer surfaces and go out of the boiler. The steam then drives turbines that generate electricity.

The main product resulting from the oxidation of carbon in coal is carbon dioxide ($CO_2$). However, incomplete combustion results in the formation of CO, albeit at a much smaller proportion than $CO_2$. $SO_2$ is produced from the combustion of sulphur that is bound in coal. $NO_X$ is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the coal. The quantity of $NO_X$ produced is directly proportional to the temperature of the flame. $SO_2$ and $NO_X$ are released to the atmosphere via the power plant stack. The non-combustible portion of the fuel remains as solid waste. The coarser, heavier waste is called 'bottom ash' and is extracted from the burner. The lighter, finer portion is 'fly ash' and is emitted as particulates through the stacks. More than 99% of the particulates (or ash) are removed from the flue gas stream by electrostatic precipitators (ESP) and collected in hoppers before being transported to the ash dump. $SO_2$ will be removed from the flue gas using flue gas desulphurisation.

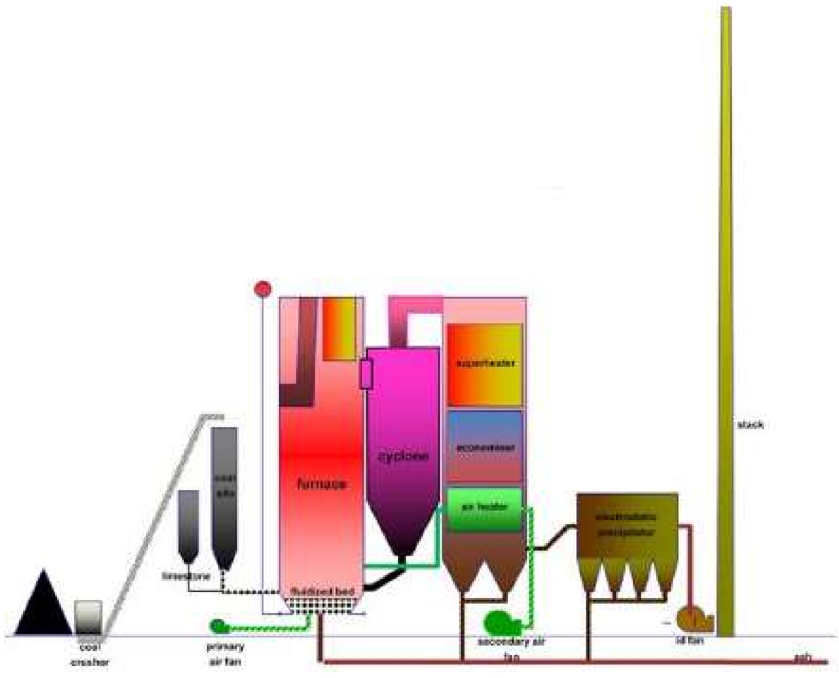



**Figure 2: Schematic of a CFB boiler configuration**
**http://www.brighthubengineering.com/power-plants/**

The inputs and outputs of a typical power plant using CFB technology is illustrated with the aid of a simplified block diagram in Figure 3.

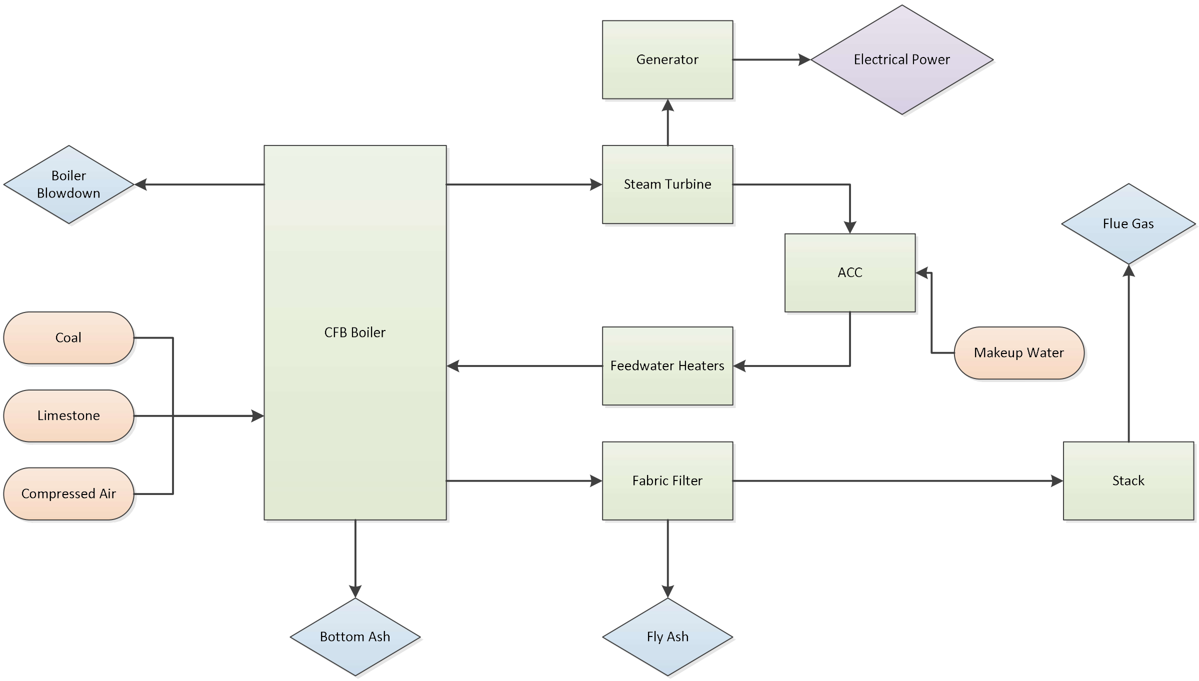



**Figure 3: A basic block flow diagram for the operation at the proposed Mutsho Power Project using a CFB boiler**

## 2.3 Unit Processes

The unit processes at the proposed Mutsho Coal-Fired Power Plant are listed in Table 6.

**Table 6: Unit processes at the proposed Mutsho Coal-Fired Power Plant**

| Name of the Unit Process | Unit Process Function | Batch or Continuous |
|---|---|---|
| Boiler Unit 1 | Power generation | 24-hours per day |
| Boiler Unit 2 | Power generation | 24-hours per day |

# 3. TECHNICAL INFORMATION

## 3.1 Raw Materials Used

The power plant will utilise coal from the Makhado Colliery. The design consumption rate of coal for the proposed Mutsho Power Project are listed in Table 7 with the coal characteristics.

**Table 7: Raw material type and design consumption rate**

| Raw Material Type | Design Consumption Rate (quantity) | Sulphur content | Ash content |
|---|---|---|---|
| Coal | 273.66 tons/hour | 1% | 31% |

## 3.2 Appliances and Abatement Equipment Control Technology

Air pollution control and abatement technology proposed for implementation at the Mutsho Power Project is listed in Table 8. A Cottrell ESP will be fitted to each boiler to remove particulates from the flue gas. The design efficiency is 99.92%. Each boiler unit is fitted with an electrostatic precipitator to remove $SO_2$.

**Table 8: Appliances and abatement equipment and control technology currently in use**

| Appliance Name | Appliance Type/Description | Appliance Function/Purpose | Efficiency |
|---|---|---|---|
| Cottrell electrostatic precipitator (ESP) | Cottrell ESP units fitted to each boiler unit | To remove particulates from the flue gas | Efficiency of Cottrell ESP is 99.92% |
| Flue gas desulphurisation | Flue gas desulphurization units fitted to each boiler unit | To remove $SO_2$ from the flue gas | Efficiency of flue gas desulphurization is 81.8% |

# 4. ATMOSPHERIC EMISSIONS

In the absence of emission testing data, the alternate method to estimate emissions is to apply appropriate emission factors. This section describes the methodology used to estimate emissions of total particulate matter (TPM or dust), $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$ and CO resulting from the proposed Mutsho Power Project.

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 simply 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 TPM, $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$ and CO for the proposed Mutsho Power Project 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, 1995). The emission factors listed in Table 9 is used to develop the emission inventory for the proposed Mutsho Power Project.

**Table 9: Emissions factors for the proposed Mutsho Power Project for CFB boiler technology**

| Emission Source | Pollutant | Emission Factor | Unit |
|---|---|---|---|
| **materials handling – coal stockpile** | TPM | 0.00008 | kg/ton |
| | $PM_{10}$ | 0.00004 | kg/ton |
| | $PM_{2.5}$ | 0.00001 | kg/ton |
| **materials handling – ash dump** | TPM | 0.000031 | kg/ton |
| | $PM_{10}$ | 0.000014 | kg/ton |
| | $PM_{2.5}$ | 0.000002 | kg/ton |
| **wind erosion - coal stockpile** | TPM | 0.00096 | $kg/m^2$ |
| | $PM_{10}$ | 0.00048 | $kg/m^2$ |
| | $PM_{2.5}$ | 0.00019 | $kg/m^2$ |
| **wind erosion – ash dump** | TPM | 0.03491 | $kg/m^2$ |
| | $PM_{10}$ | 0.01745 | $kg/m^2$ |
| | $PM_{2.5}$ | 0.00698 | $kg/m^2$ |
| **Stacks – Boiler Stack** | TPM | 7.7 | kg/ton |
| | $PM_{10}$ | 5.6 | kg/ton |
| | $SO_2$ | 14.1 | kg/ton |
| | $NO_X$ | 2.3 | kg/ton |
| | CO | 8.2 | kg/ton |

## 4.1 Point Source Parameters

The proposed Mutsho Power Project will emit emissions from a single stack. The location of the stack and stack parameters are provided in Table 10 for the preferred site layout option (see Section 5.1.4).

**Table 10: Location of stack and stack parameters**

| Point source number | Point source name | Point source coordinates (decimal degrees) | Height of release above ground (m) | Height above nearby building (m) | Diameter at stack tip/vent exit (m) | Actual gas exit temperature (K) | Actual gas volumetric flow ($Nm^3/hr$) | Actual gas exit velocity (m/s) | Type of emission (continuous/ batch) |
|---|---|---|---|---|---|---|---|---|---|
| S1 | Boiler Stack | Latitude: -22.69° Longitude: 29.82° | 150 | N/A | 7.5 | 408.15 | $2.93 \times 10^6$ | 18 | Continuous |

## 4.2 Point Source Maximum Emission Rates (Normal Operating Conditions)

The proposed Mutsho Power Project will consist of two Circulating Fluidized Bed (CFB) boiler units, each with a power rating of 300 MWe, providing a combined output of 600 MWe. Emissions from two boiler units will be routed to a single stack. The boiler units will operate continuously for 20 hours a day (in order to simulate a worst-case scenario, the emission inventory and modelling is based on the assumption that the boiler units will operate for 24 hours of the day). Each boiler will consume coal at a maximum rate of

136.83 tons/hour. The coal has a sulphur content of 1%, and average ash content of 31%. Each boiler unit will be fitted with a Cottrell ESP and a flue gas desulphurization unit, which has a cleaning efficiency of 99.92% and 81.8% respectively, with an availability of 90%.

The point source maximum emission rates of key pollutants from the proposed Mutsho Power Project for normal operating conditions are provided in Table 11 in mg/Nm$^3$ at 10% $O_2$; and in Table 12 in tons per annum.

**Table 11: Point source maximum emission rates in mg/Nm³ for normal operating conditions**

| Point source number | Point source name | Pollutant name | Average emission rate[1] | | Duration of emissions |
|---|---|---|---|---|---|
| | | | (mg/Nm³) at 10% $O_2$ | Averaging period | |
| S1 | Boiler Stack | TPM | 0.7 | Hourly | 20 hrs/day, 365 days/year, i.e. 7300 hours/year |
| | | $PM_{10}$ | 0.5 | Hourly | |
| | | $SO_2$ | 298.5 | Hourly | |
| | | $NO_X$ | 238.1 | Hourly | |
| | | CO | 857 | Hourly | |

1 the average emission rate is based on the assumption that the boiler units will operate for 24 hours of the day.

**Table 12: Point source maximum emission rates in tons/annum for normal operating conditions**

| Point source number | Point source name | TPM | $PM_{10}$ | $SO_2$ | $NO_X$ | CO |
|---|---|---|---|---|---|---|
| S1 | Boiler Stack | 16.4 | 12 | 6 804.1 | 5426.9 | 19 536.7 |

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

A description of start-up, shut-down, upset and maintenance operating conditions with specific reference to the emissions profile that will be expected for the pollutant/s identified for the specific listed activity is not currently available for the proposed Mutsho Power Project. An estimated raw gas emission rate for each of these operating conditions is also not available.

A summary of the frequency of start-up, shut-down, upset and maintenance operating conditions experienced over the last 2 years is not available for the proposed Mutsho Power Project as it has not been commissioned.

## 4.4 Fugitive Emissions

### Potential sources

Potential sources of fugitive emission identified at the proposed Mutsho Power Project include the coal stockpile, limestone stockpile, ash dump, site roads and vehicles, coal conveyors and transfer towers, coal and limestone crushers, material handling activities and evaporation losses from the fuel oil storage tank.

Coal will be transported to the proposed Mutsho Power Project from the Makhado Colliery via rail or road transport. Dust pollution from unpaved site access roads therefore has the potential to be significant if these roads are used on a continuous basis. Emissions from roads are therefore considered in this assessment. Emissions from conveyors and transfer towers are not considered in this assessment as they will be enclosed and are therefore not a major source of dust. Emissions from the coal and limestone crusher is expected to be relatively small as these operations will take place within an enclosure and are therefore not considered in this assessment. The limestone stockpile is not considered in this assessment as it is a relatively small source of particulates in comparison to the coal stockpile and ash dump. Due to the relatively small storage capacity and low volatility of the fuel oil, fugitive emissions from the fuel storage tank is expected to be very low. Emissions from storage tanks are therefore not considered in this assessment.

**Emissions from the unpaved site access road**

Wind entrainment of TPM, $PM_{10}$ and $PM_{2.5}$ from the unpaved site access road is a function of the length of the road, number of operating days, silt content, number of days of precipitation (> 0.2 mm) and average daily traffic based on the vehicle fleet.

Characteristics of the unpaved site access road at the proposed Mutsho Power Project is shown in Table 13 and emissions from the road is provided in Table 14.

**Table 13: Characteristics of the unpaved site access road in tons per annum**

| Parameter | Value |
|---|---|
| Unpaved Segment Road Length | 3.2 km |
| Number of operating days per year | 365 days |
| Silt Content | 5.1% |
| Estimated working days with precipitation exceeding 0.2 mm | 69 days |
| Vehicle Fleet | 35 Heavy duty vehicles<br>10 light duty vehicles |

**Table 14: Emissions from the unpaved site access road in tons per annum**

| Source | TPM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Unpaved site access roads | 766 | 198 | 20 |

**Emissions from the coal stockpile and ash dump**

Wind entrainment of TPM, $PM_{10}$ and $PM_{2.5}$ from the coal stockpile and ash dump is a function of the physical size of the facility and the nature of the exposed surface, i.e. the moisture content, amount of vegetation cover, size of the particles on the surface and wind speed. Characteristics of the coal stockpile and ash dump at the proposed Mutsho Power Project is shown in Table 15.

**Table 15: Characteristics of the coal stockpile and ash dump at the proposed Mutsho Power Project**

| Parameter | Coal stockpile | Ash dump |
|---|---|---|
| Quantity of material transferred daily (ton/day) | 6 000 | 1 200 |
| Moisture content (%) | 4 | 28 |
| Area of stockpile (Ha) | 4.4 | 122 |
| Height of stockpile (m) | 13.5 | 10 |
| Aggregate size spectrum (mm) | 0 - 50 | 0.005 to 0.1 |
| Dust abatement method | Water spraying, wind-proof and dust suppression net covered with a roof over steel structure | Ash rolling and compaction. Ash spraying. Afforestation around the ash dump |
| Material transfer method | Conveyors (front end loaders in case of emergency) | Conveyors (front end loaders in case of emergency) |

The coal stockpile will cover an area of approximately 44 000 m$^2$ (205 m by 215 m), with the longer side orientated at 36 degrees to true north. The ash dump will cover an area of approximately 1 175 400 m$^2$ (1 890 m by 622 m), with the longer side orientated at 5 degrees to true north. The ash dump is not perfectly symmetrical.

As a mitigation measure, water will be sprayed onto the coal stockpiles occasionally; and a wind-proof and dust suppression net will be used to reduce dust generation. In this assessment, the coal stockpile is assessed under worst case conditions (e.g. drought conditions), where it is assumed that no water will be sprayed onto the coal stockpile and 100% of the area is exposed to wind erosion.

The ash dump will cover an area of 120 Ha. Dry-ashing is proposed in order to reduce the project's water requirements. Rising vegetated green walls will provide vegetation cover on the sides of the ash dump and it is expected that. Together with occasional wetting, ash rolling and compaction will reduce the amount of dust entrainment from the ash dump. In this assessment, it is assumed that 25% of the area of the ash dump is exposed to wind erosion. Emissions from the coal stockpile and ash dump is provided in Table 16.

**Table 16: Emissions from the coal stockpile and ash dump in tons per annum**

| Source | TPM | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|
| Material Handling - coal yard | 1.34 | 0.63 | 0.10 |
| Material Handling - ash dump | 0.02 | 0.01 | 0.00 |
| Wind Erosion - coal yard | 2.44 | 1.22 | 0.49 |
| Wind Erosion - ash dump | 594.5 | 297.2 | 118.9 |
| Total emissions | 598.3 | 299.1 | 119.5 |

## 4.5 Emergency Incidents

The Mutsho Power Project is a proposed facility. There are no incidents uncontrolled atmospheric emissions.

# 5. IMPACT OF THE MUTSHO POWER PROJECT ON THE RECEIVING ENVIRONMENT

## 5.1 Analysis of Emissions' Impact on Human Health

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 as well as prevailing ambient air concentrations into account. A compliance assessment was undertaken using the national dustfall standard and 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 at the proposed Mutsho Power Project in terms of temperature, rainfall and wind; the national dustfall standard and NAAQS; and the status of ambient air quality near the power plant. This is then followed by the dispersion modelling procedure, results of the dispersion modelling and an assessment of air quality impacts.

### 5.1.1 Prevailing Climatic Conditions

### Temperature and Rainfall

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 the typical ranges of different variables, most commonly temperature and precipitation.

The proposed Mutsho Power Project is located at approximately 22.6919˚S and 29.8265° E, and approximately 727 m above sea level. The climate in Makhado is warm and temperate, with most rainfall in summer. This location is classified as Cwb (sub-tropical highland) by Köppen and Geiger. The average annual temperature is 18.7 °C in Makhado with an annual average rainfall of 748 m with more than 80% of the rainfall occurring in the summer months from October to March. Temperature and rainfall climatology at Makhado is best illustrated by the long-term measurements at the South African Weather Service's meteorological station (Figure 4).

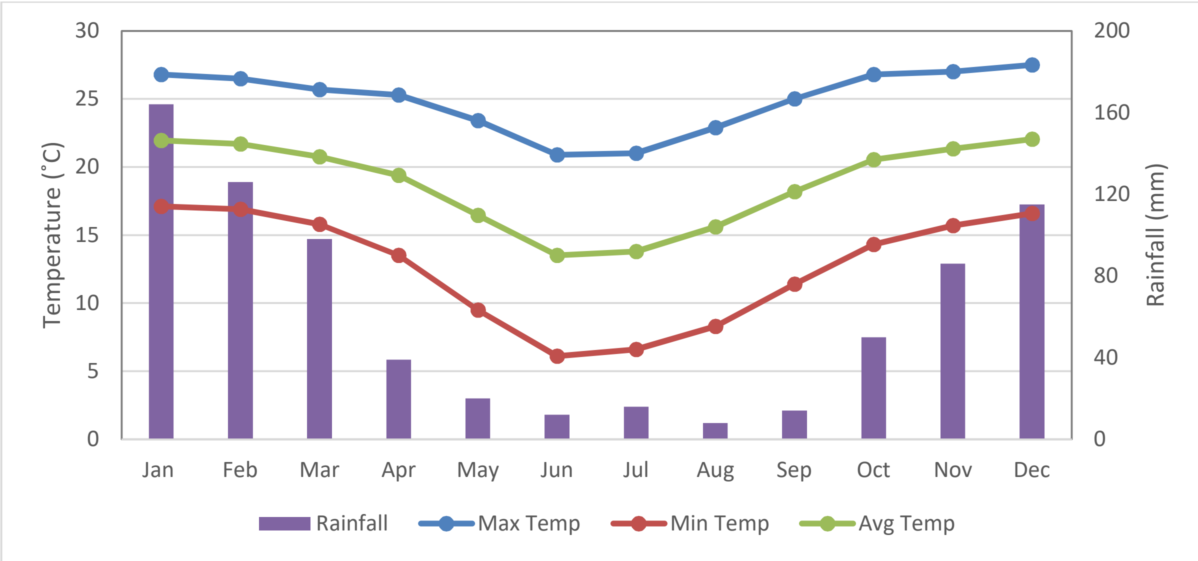



**Figure 4: Average monthly maximum and minimum temperature, and average monthly rainfall at Makhado 1982 to 1992 (SAWS, 1992)**

## Wind

The winds at Makhado are generally light and rarely exceed 5.5 m/s (Figure 5). All winds occur from the broad sector east-northeast to southeast. Wind data for Makhado is obtained from Metroblue (www.metroblue.com) and is represented by a windrose in Figure 5. The windrose simultaneously depicts the frequency of occurrence of wind from the 16 cardinal wind directions and defined wind speed classes. Wind direction is given as the direction from which the wind blows, i.e., southwesterly 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.

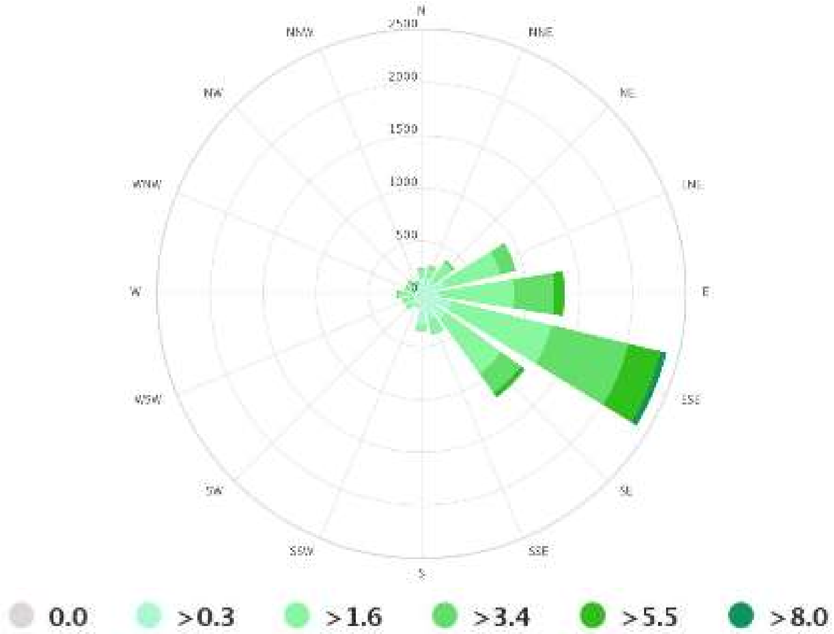



**Figure 5: Annual wind rose at Makhado showing wind speed in m/s (https://www.meteoblue.com/)**

### 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 particular air pollutant.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented by the World Health Organisation (WHO) (e.g. WHO, 1999; 2003; 2005). South Africa has accordingly established NAAQS for the criteria pollutants, i.e. $SO_2$, $NO_2$, CO, respirable particulate matter ($PM_{10}$), ozone ($O_3$), Pb and benzene ($C_6H_6$) (DEA, 2009) and $PM_{2.5}$ (DEA, 2012). National dust control regulations were published on 1 November 2013 (DEA, 2013b), setting limits for acceptable dustfall rates for residential and non-residential areas. The national dustfall standard and NAAQS for $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO are listed in Table 17.

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 99$^{th}$ 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 17: Ambient air quality standards and guidelines**

| Pollutant | Averaging period | Limit value (µg/m$^3$) | Tolerance |
|---|---|---|---|
| Dustfall | 30-day | D<600 mg/m$^2$/day (residential) | 2 within year, not sequential months |
| | 30-day | 600<1200 mg/m$^2$/day (non-residential) | 2 within year, not sequential months |
| $PM_{10}$ | 24 hour | 75 | 4 |
| | 1 year | 40 | 0 |
| $PM_{2.5}$ | 24 hour | 40 | 0 |
| | 1 year | 20 | 0 |
| $SO_2$ | 1 hour | 350 | 88 |
| | 24 hour | 125 | 4 |
| | 1 year | 50 | 0 |
| $NO_2$ | 1 hour | 200 | 88 |
| | 1 year | 40 | 0 |
| CO | 1-hour | 30 000 | 88 |
| | 8-hour running mean | 10 000 | 11 |

The sections below provide a literature review of particulates (TSP (or dust), $PM_{10}$ and $PM_{2.5}$), $SO_2$, $NO_2$ and CO 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, into TSP, $PM_{10}$ and $PM_{2.5}$.

**Total suspended particulates (TSP)** consist of all particles smaller than 100 µm suspended within the air. TSP is useful for understanding nuisance effects of PM, e.g. settling on houses, deposition on and discolouration of buildings, and reduction in visibility.

**$PM_{10}$** 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 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.

**$PM_{2.5}$** describes all particulate matter in the atmosphere with a diameter equal to or less than 2.5 µm. They are often called fine particles, and are mostly related to combustion (motor vehicles, smelting, incinerators), rather than mechanical processes as is the case with $PM_{10}$. $PM_{2.5}$ may be suspended in the atmosphere for long periods and can be transported over large distances. Fine particles can form in the atmosphere in three ways: when particles form from the gas phase, when gas molecules aggregate or cluster together without the aid of an existing surface to form a new particle, or from reactions of gases to form vapours that nucleate to form particles.

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).

## 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).

## 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).

## Carbon Monoxide (CO)

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 foetus.

### 5.1.3 Current Status of Ambient Air Quality

There are no major sources of air pollution near the proposed Mutsho Power Project. Similarly, there is no ambient air quality monitoring. Ambient air quality is however expected to be good and may be influenced at times by wind entrained dust.

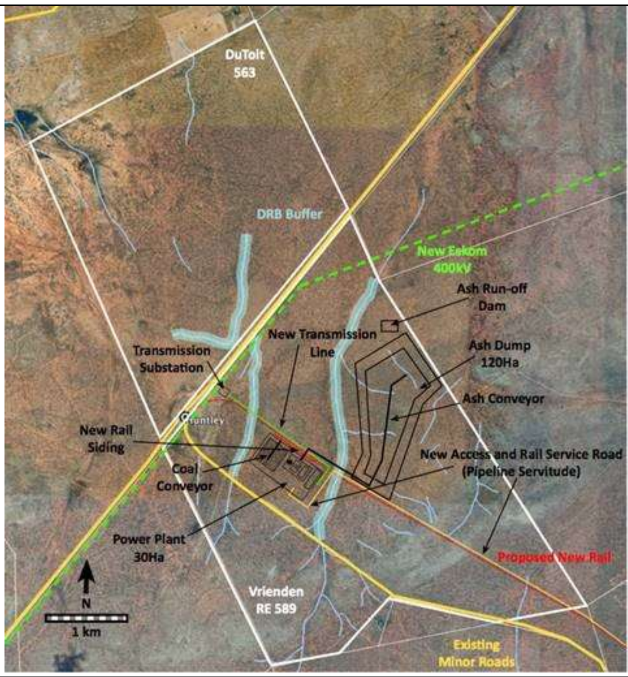
### 5.1.4 Dispersion Modelling

Dispersion modelling is used to predict dustfall and ambient concentrations of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$ and CO emitted from the proposed Mutsho Power Project. The approach to the dispersion modelling in this assessment is based on the requirements of the DEA guideline for dispersion modelling (DEA, 2014).

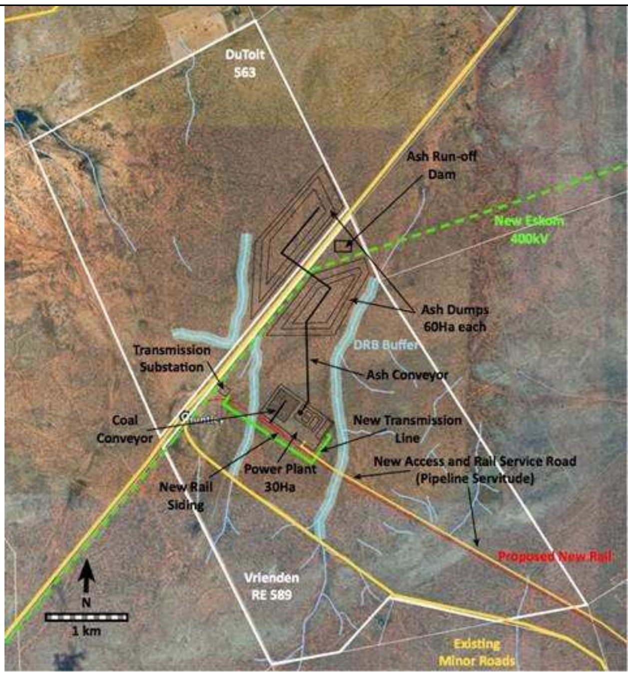
According to the DEA guideline for dispersion modelling, a Level 3 air quality assessment is conducted in situations where the purpose of the assessment requires a detailed understanding of the air quality impacts (time and space variation of the concentrations) and when it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types and chemical transformations. A Level 3 assessment may be used in situations where there is a need to evaluate air quality consequences under a permitting or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences. Under these circumstances, this study clearly demonstrates the need for a Level 3 assessment.

## Site layout options

Three site layout options are proposed for the Mutsho Power Project (Figure 6). In the preferred layout the Mutsho Power Project will be located on Farm Vrienden 589, with the 120 Ha ash dump located east of the power plant. In option 2, the preferred alternative layout, the power plant is located approximately 500 m of northeast of the preferred location and the ash dump consists of two 60 Ha components, located to the north-northeast of the power plant on Farm Vrienden 589 and the other on Farm du Toit 563 and separated by the railway. In least preferred layout, the power plant is located as in the option 1, and the 120 Ha ash dump is immediately to its northeast on Farm Vrienden 589. The dispersion modelling for the air quality assessment is based on the preferred layout.

| | |
|---|---|
| Option 1: Preferred layout |  |

Option 2: Preferred alternative layout




Option 3: Least preferred layout

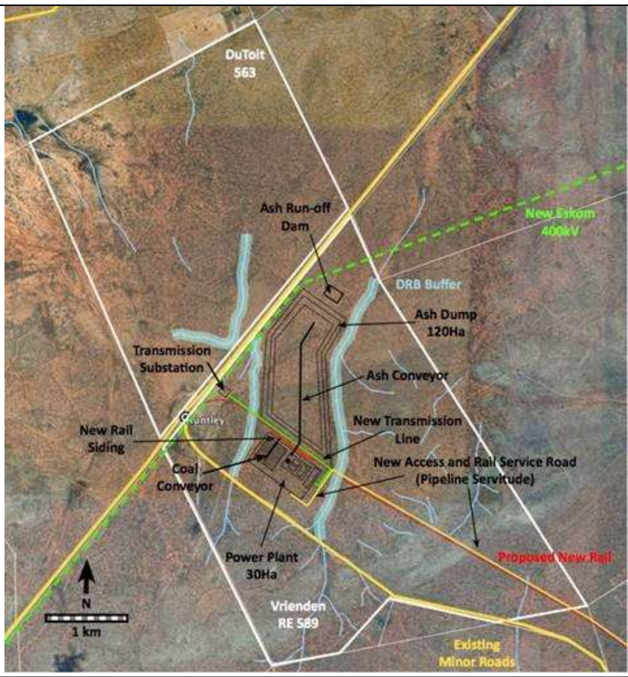



**Figure 6: Mutsho Power Project site layout options**

## Operating Scenarios for Emission Units

Emissions from the proposed Mutsho Power Project includes the single stack, the coal stockpile, ash dump and roads. The primary pollutants that are assessed are dust, $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$ and CO. Two emission scenarios are assessed. In Scenario 1, the Boiler Stack is assessed in isolation and in Scenario 2, the Boiler Stack, the coal stockpile, ash dump and unpaved site access road is assessed cumulatively. These scenarios will provide an understanding of the effect of emissions for normal operations in the ambient environment.

## Meteorological and Dispersion Modelling Procedures

The South African Weather Service (SAWS) is the main source of reliable observed surface meteorological data in South Africa as it has been collected in accordance with the requirements established by the World Meteorological Organisation (WMO). While there is a good network of SAWS observation stations across the country, the coverage is not always adequate to meet the requirements for robust dispersion modelling.

To address the challenges relating to data scarcity in the area of interest, The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) meteorological data is used to supplement the meteorology in the modelling domain. TAPM is used to model spatially and temporally continuous surface and upper air meteorological fields for the modelling domain. Mesoscale models such as TAPM use gridded meteorological data and sophisticated physics algorithms to produce meteorological fields at defined horizontal grid resolutions and in multiple vertical levels over a large domain. They therefore offer an alternative to meteorological measurements as input for advanced dispersion models.

TAPM is set-up in a nested configuration of three domains. The outer domain is 480 km by 480 km at a 24 km grid resolution, the middle domain is 240 km by 240 km at a 12 km grid resolution and the inner domain is 60 km by 60 km at a 3 km grid resolution (Figure 6). The nesting configuration ensures that topographical effects on meteorology are captured and that the modelled meteorology is well resolved and characterised across the boundaries of the inner domain, i.e. the CALPUFF dispersion modelling domain.

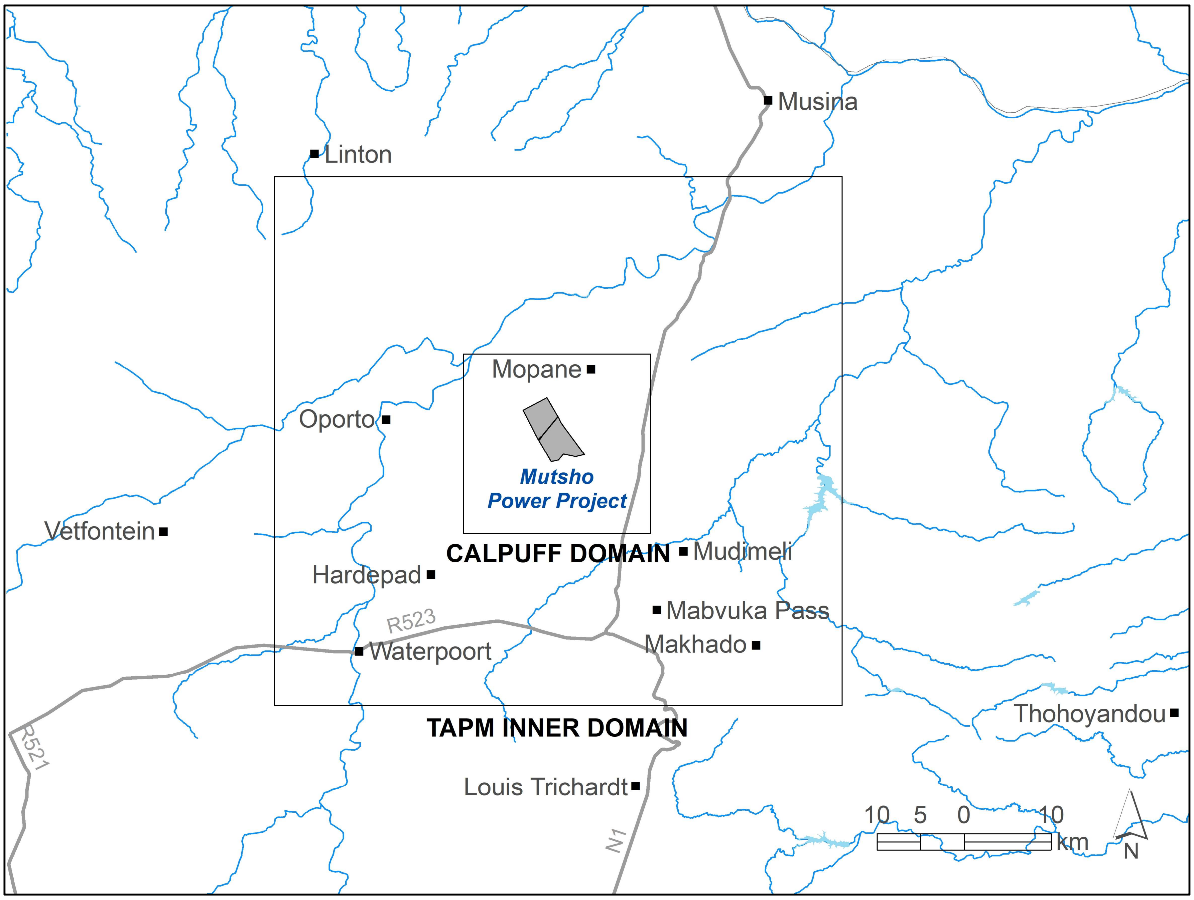



**Figure 7: Large TAPM and smaller CALPUFF modelling domains centred on the Project site**

TAPM produces an output file for the modelling domain that includes hourly wind speed and direction, temperature, relative humidity, total solar radiation, net radiation, sensible heat flux, evaporative heat flux, convective velocity scale, precipitation, mixing height, friction velocity and Obukhov length for a 3-year period, 2014 to 2016. The subset of the entire TAPM model output in the form of pre-processed gridded surface and upper air meteorological data fields is input into CALMET. This approach negates the potential issues associated with missing observational data. The 3-year data set ensures that seasonal variations are accounted for .

Upper air data is included in the pre-processed TAPM meteorological fields. The upper air data is spatially and temporally continuous and includes data at 27 vertical levels between 10 m to 5 km above ground level. There are more levels close to the surface and decreasing with increasing altitude up to the last level.

CALPUFF is a USEPA approved air dispersion model (http://www.src.com/calpuff/calpuff1.htm) and is recommended by the DEA for Level 3 assessments (DEA, 2014). It is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometres. It includes algorithms for sub-grid scale effects (such as terrain impingement), as well as longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations). CALPUFF is an appropriate air dispersion model for this assessment as it is well suited to simulate dispersion from the proposed Mutsho Power Project.

## Dispersion Modelling Domain and Grid Receptors

A modelling domain of 400 $km^2$ which is 20 km (west-east) by 20 km (north-south), centred on the proposed Mutsho Power Project is used for the CALMET and CALPUFF model runs. It consists of a uniformly spaced receptor grid with 0.25 km spacing, giving 6 400 grid cells (80 x 80 grid cells).

## Model Parameterisation

The parameterisation of key variables that will apply in CALMET and CALPUFF are indicated in Table 18 and Table 19 respectively.

**Table 18: Parameterisation of key variables for CALMET**

| Parameter | Model value |
|---|---|
| 12 vertical cell face heights (m) | 0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000, 4000 |
| Coriolis parameter (per second) | 0.0001 |
| Empirical constants for mixing height equation | Neutral, mechanical: 1.41<br>Convective: 0.15<br>Stable: 2400<br>Overwater, mechanical: 0.12 |
| Minimum potential temperature lapse rate (K/m) | 0.001 |

| Parameter | Model value |
|---|---|
| Depth of layer above convective mixing height through which lapse rate is computed (m) | 200 |
| Wind field model | Diagnostic wind module |
| Surface wind extrapolation | Similarity theory |
| Restrictions on extrapolation of surface data | No extrapolation as modelled upper air data field is applied |
| Radius of influence of terrain features (km) | 5 |
| Radius of influence of surface stations (km) | No used as continuous surface data field is applied |

**Table 19: Parameterisation of key variables for CALPUFF**

| Parameter | Model value |
|---|---|
| Chemical transformation | Default $NO_2$ conversion factor is applied |
| Wind speed profile | Rural |
| Calm conditions | Wind speed < 0.5 m/s |
| Plume rise | Transitional plume rise, stack tip downwash, and partial plume penetration is modelled |
| Dispersion | CALPUFF used in PUFF mode |
| Dispersion option | Pasquill-Gifford coefficients are used for rural and McElroy-Pooler coefficients are used for urban |
| Terrain adjustment method | Partial plume path adjustment |

## Model Accuracy - uncertainty

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). CALPUFF is one of the models that have been evaluated and 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 Mutsho Power Project, the reducible uncertainty in CALPUFF is minimised by:

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

## 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. Background concentrations are not considered in this assessment. Other sources of dust, $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$ and CO will not be characterised and included in the model run. The proposed Mutsho Power Project is therefore modelled in isolation of other sources. As there are currently no major air pollution sources in the area, ambient background concentrations are expected to be low (see section 5.1.3). Excluding these from the modelling will not have significant implications.

## 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 in close proximity to areas recognised as sensitive receptors. In this assessment, all neighbouring residential and commercial areas, including small farmsteads are treated as sensitive areas as they as expected to include sensitive areas as identified by the USEPA.

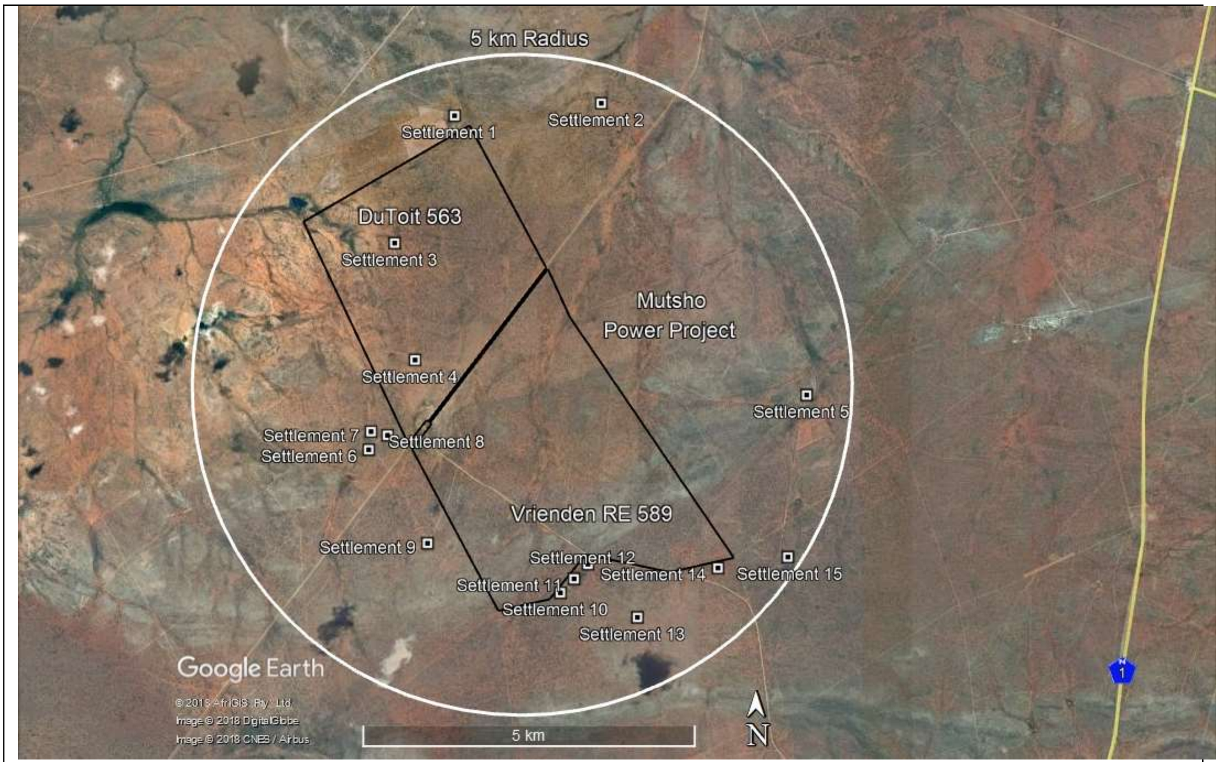



**Figure 8: Location of identified sensitive receptors relative to the Mutsho Power Project**

## Dispersion Modelling Results

The dispersion modelling results for the predicted dustfall, 1-hour, 24-hour and annual average ambient concentrations of $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$ and CO resulting from emissions from the proposed Mutsho Power Project are presented in Figure 7-17. The predicted dustfall is assessed against South African dustfall standard while ambient concentrations are assessed against the National Ambient Air Quality Standard for $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$ and CO. The highest predicted dustfall and ambient concentrations from the dispersion modelling exercise is presented in Table 20.

Two Scenarios are considered in this assessment:
Scenario 1: Boiler Stack in Isolation
Scenario 2: All Sources - Boiler Stack, coal stockpile, ash dump and unpaved site access road

**Table 20: Maximum predicted dustfall (mg/m²/day), annual average concentration and the highest 99th percentile concentration at the points of maximum ground-level impact, for $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_X$, and CO (µg/m³) showing the NAAQS**

| Scenarios | Pollutant | Averaging Period | | | | |
|---|---|---|---|---|---|---|
| | | 1-hour | 8-hour | 24-hour | 30-days | annual |
| Scenario 1: Boiler Stack in Isolation | Dustfall | | | | 0.014 | |
| | $PM_{10}$ | | | 0.03 | | 0.002 |
| | $NO_2$ | 21 | | | | 0.8 |
| | $SO_2$ | 33 | | 15 | | 1.3 |
| | CO | 94 | 72 | | | |
| Scenario 2: All Sources - Boiler Stack, Coal Stockpile, Ash Dump and Access Road | Dustfall | | | | 1060 | |
| | $PM_{10}$ | | | 667 | | 202 |
| | $PM_{2.5}$ | | | 71 | | 22.2 |
| | $NO_2$ | 21 | | | | 0.8 |
| | $SO_2$ | 33 | | 15 | | 1.3 |
| | CO | 94 | 72 | | | |
| NAAQS | Dustfall | | | | 600[1]<br>1 200[2] | |
| | $PM_{10}$ | | | 75 | | 40 |
| | $PM_{2.5}$ | | | 40 | | 20 |
| | $NO_2$ | 200 | | | | 40 |
| | $SO_2$ | 350 | | 125 | | 50 |
| | CO | 30 000 | 10 000 | | | |
| 1:<br>2: | For residential areas<br>For non-residential areas | | | | | |

## Dustfall

The source of dust from the proposed Mutsho Power Project includes the Boiler Stack, the coal stockpile, ash dump and the unpaved site access road. It is assumed that 100% of the area for the coal stockpile and 25% of the area for the ash dump is exposed to wind erosion. Predicted dustfall is compared with the South African dustfall standard for the residential area and non-residential area category of 600 mg/m$^2$/day and 1 200 mg/m$^2$/day respectively.

**30-days average**

**Scenario 1: Boiler Stack in Isolation**

At the point of maximum ground-level impact, the predicted 30-days average dustfall is 0.014 mg/m$^2$/day for the Boiler Stack in isolation (Figure 7 and Table 20). The highest dustfall is predicted about 1.5 km to the southwest of the Boiler Stack, which is within the boundary of the proposed Mutsho Power Project site. The predicted dustfall is well below the dustfall standard for the residential area and non-residential area category of 600 mg/m$^2$/day and 1 200 mg/m$^2$/day respectively; and no exceedance of the standard is predicted within the proposed Mutsho Power Project site or in residential and sensitive receptor areas around the site. The predicted dustfall therefore complies with the South African dustfall standard in the ambient environment.

**Scenario 2: All Sources**

At the point of maximum ground-level impact, the predicted 30-days average dustfall is 1060 mg/m$^2$/day for all sources (i.e. Boiler Stack, coal stockpile, ash dump and unpaved site access road) (Figure 7 and Table 20). The highest dustfall is predicted along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. The predicted dustfall exceeds the dustfall standard for the residential area category of 600 mg/m$^2$/day over a very small area along the access road but is below the non-residential area category of 1 200 mg/m$^2$/day. There are no predicted exceedances of the standard in residential and sensitive receptor areas around the site. The predicted dustfall therefore complies with the South African dustfall standard in the ambient environment.

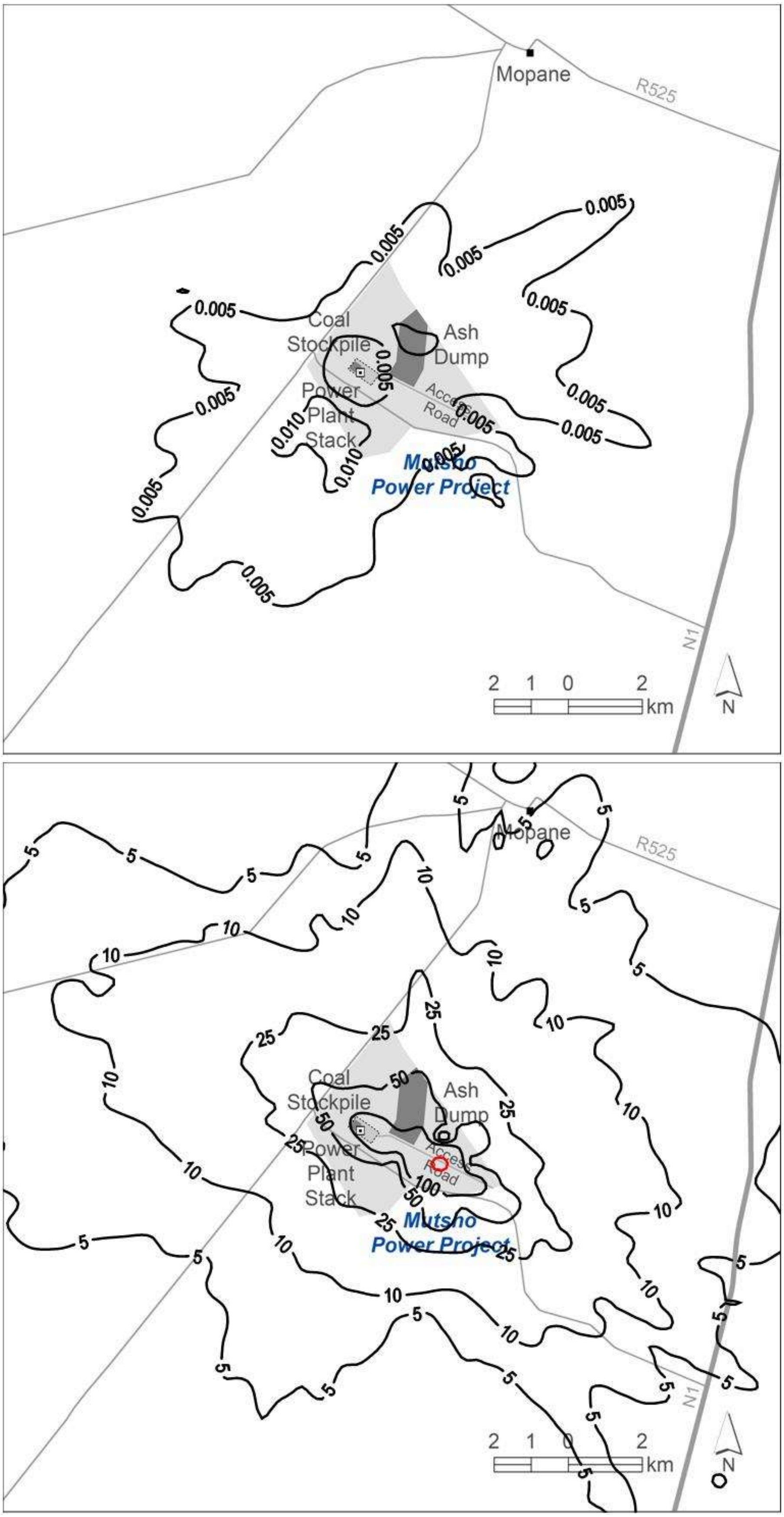



**Figure 9: Predicted 30-days average dustfall in mg/m²/day resulting from emissions from the proposed Mutsho Power Project Boiler Stack for the preferred site layout (top) and all sources (bottom)**

## Particulate Matter ($PM_{10}$)

The source of $PM_{10}$ from the proposed Mutsho Power Project includes the Boiler Stack, the coal stockpile, ash dump and the unpaved site access road. It is assumed that 100% of the area for the coal stockpile and 25% of the area for the ash dump is exposed to wind erosion. Predicted $PM_{10}$ concentrations are compared with the 24-hour and annual NAAQS.

**99th percentile 24-hour concentrations**

**Scenario 1: Boiler Stack in Isolation**

At the point of maximum ground-level impact, the predicted 99th percentile 24-hour $PM_{10}$ concentration is 0.03 µg/m$^3$ for the Boiler Stack in isolation (Figure 8 and Table 20). The highest concentrations are predicted about 1.5 km to the southwest of the Boiler Stack, which is within the boundary of the proposed Mutsho Power Project site. The predicted ambient concentrations are well below the NAAQS of 75 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

**Scenario 2: All Sources**

At the point of maximum ground-level impact, the predicted 99th percentile 24-hour $PM_{10}$ concentration is 667 µg/m$^3$ for all sources (Figure 8 and Table 20). The highest concentrations are predicted along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. The predicted ambient concentrations exceed the NAAQS of 75 µg/m$^3$ over a very small area along the access road. The NAAQS permits 4 exceedances of the 24-hour limit value per annum, so-called tolerance, implying 12 permitted exceedances in the three-year modelling period. Exceedances of the NAAQS are predicted on 968 days in the 3-year modelling period (~88% of the days for each year). Areas where the tolerance is exceeded include areas that coincide with areas where exceedances of the NAAQS are predicted (Figure 9). The predicted 24-hour $PM_{10}$ concentrations in these areas do not comply with the NAAQS. There are no predicted exceedances of the NAAQS in residential and sensitive receptor areas around the site. The predicted $PM_{10}$ concentrations therefore comply with the NAAQS in the ambient environment.

**Annual average**

**Scenario 1: Boiler Stack in Isolation**

At the point of maximum ground-level impact, the predicted annual average $PM_{10}$ concentration is 0.002 µg/m$^3$ for the Boiler Stack in isolation (Figure 10 and Table 20). The highest concentrations are predicted about 4 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 40 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

**Scenario 2: All Sources**

At the point of maximum ground-level impact, the predicted annual average $PM_{10}$ concentration is 202 µg/$m^3$ for all sources (Figure 10 and Table 20). The highest concentrations are predicted along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. The predicted ambient concentrations exceed the NAAQS of 40 µg/$m^3$ over a very small area along the access road. The predicted concentrations in this area do not comply with the NAAQS. There are no predicted exceedances of the NAAQS in residential and sensitive receptor areas around the site. The predicted $PM_{10}$ concentrations therefore comply with the NAAQS in the ambient environment.

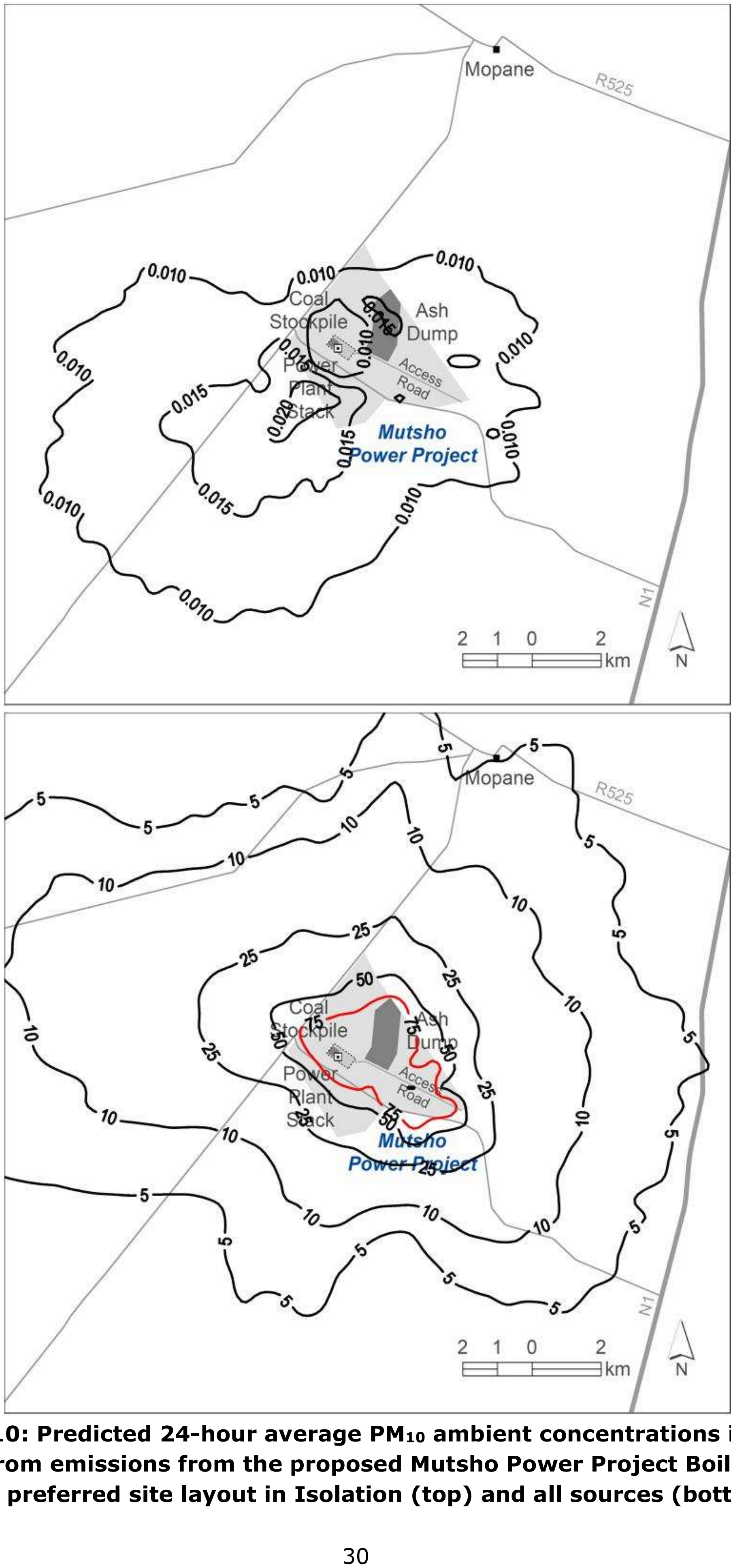



**Figure 10: Predicted 24-hour average $PM_{10}$ ambient concentrations in µg/m³ resulting from emissions from the proposed Mutsho Power Project Boiler Stack for the preferred site layout in Isolation (top) and all sources (bottom)**

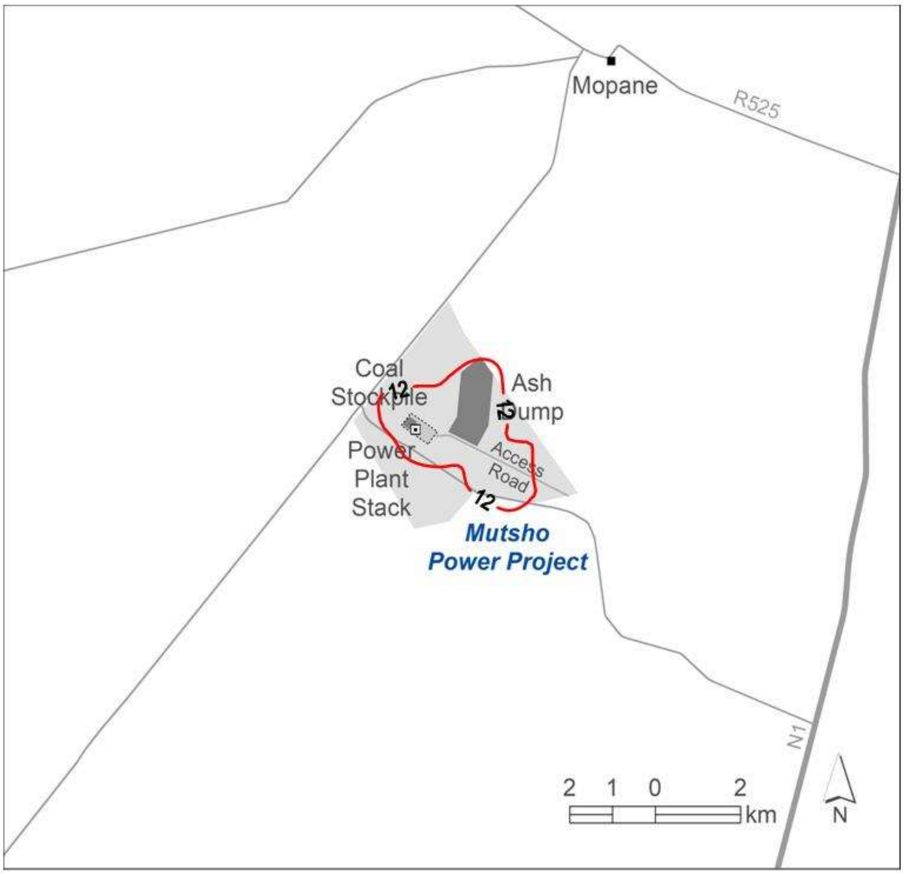



**Figure 11: Predicted number of exceedances of the 24-hour average $PM_{10}$ ambient concentrations resulting from emissions from all sources at the proposed Mutsho Power Project for the preferred site layout**

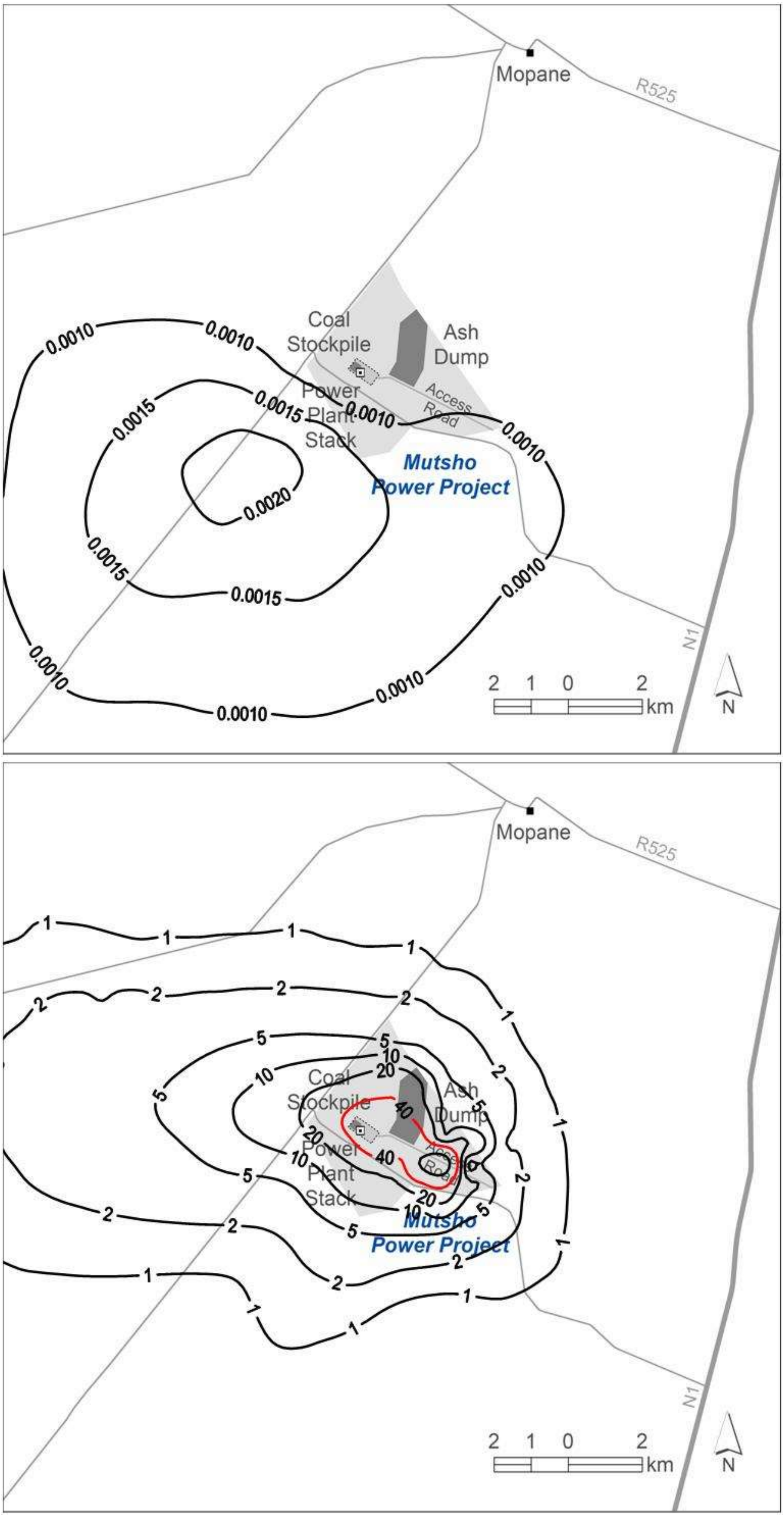



**Figure 12: Predicted annual average $PM_{10}$ ambient concentrations in µg/m³ resulting from emissions from the proposed Mutsho Power Project Boiler for the preferred site layout Stack in Isolation (top) and all sources (bottom)**

## Particulate Matter ($PM_{2.5}$)

The source of $PM_{2.5}$ from the proposed Mutsho Power Project includes the coal stockpile, ash dump and the unpaved site access road. It is assumed that 100% of the area for the coal stockpile and 25% of the area for the ash dump is exposed to wind erosion. Predicted $PM_{2.5}$ concentrations are compared with the 24-hour and annual NAAQS.

**Scenario 2: All Sources**

**99$^{th}$ percentile 24-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 24-hour $PM_{2.5}$ concentration is 71 µg/m$^3$ for all sources (Figure 11 and Table 20). The highest concentrations are located within the boundary of the proposed Mutsho Power Project site. The predicted ambient concentrations exceed the NAAQS of 40 µg/m$^3$ over a very small area along the access road. The predicted 24-hour $PM_{10}$ concentrations in these areas do not comply with the NAAQS. There are no predicted exceedances of the NAAQS in residential and sensitive receptor areas around the site. The predicted $PM_{2.5}$ concentrations therefore comply with the NAAQS in the ambient environment.

**Annual average**

At the point of maximum ground-level impact, the predicted annual average $PM_{2.5}$ concentration is 22.2 µg/m$^3$ for all sources (Figure 11 and Table 20). The highest concentrations are predicted along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. The predicted ambient concentrations exceed the NAAQS of 20 µg/m$^3$ over a very small area along the access road. The predicted concentrations in this area do not comply with the NAAQS. There are no predicted exceedances of the NAAQS in residential and sensitive receptor areas around the site. The predicted $PM_{2.5}$ concentrations therefore comply with the NAAQS in the ambient environment.

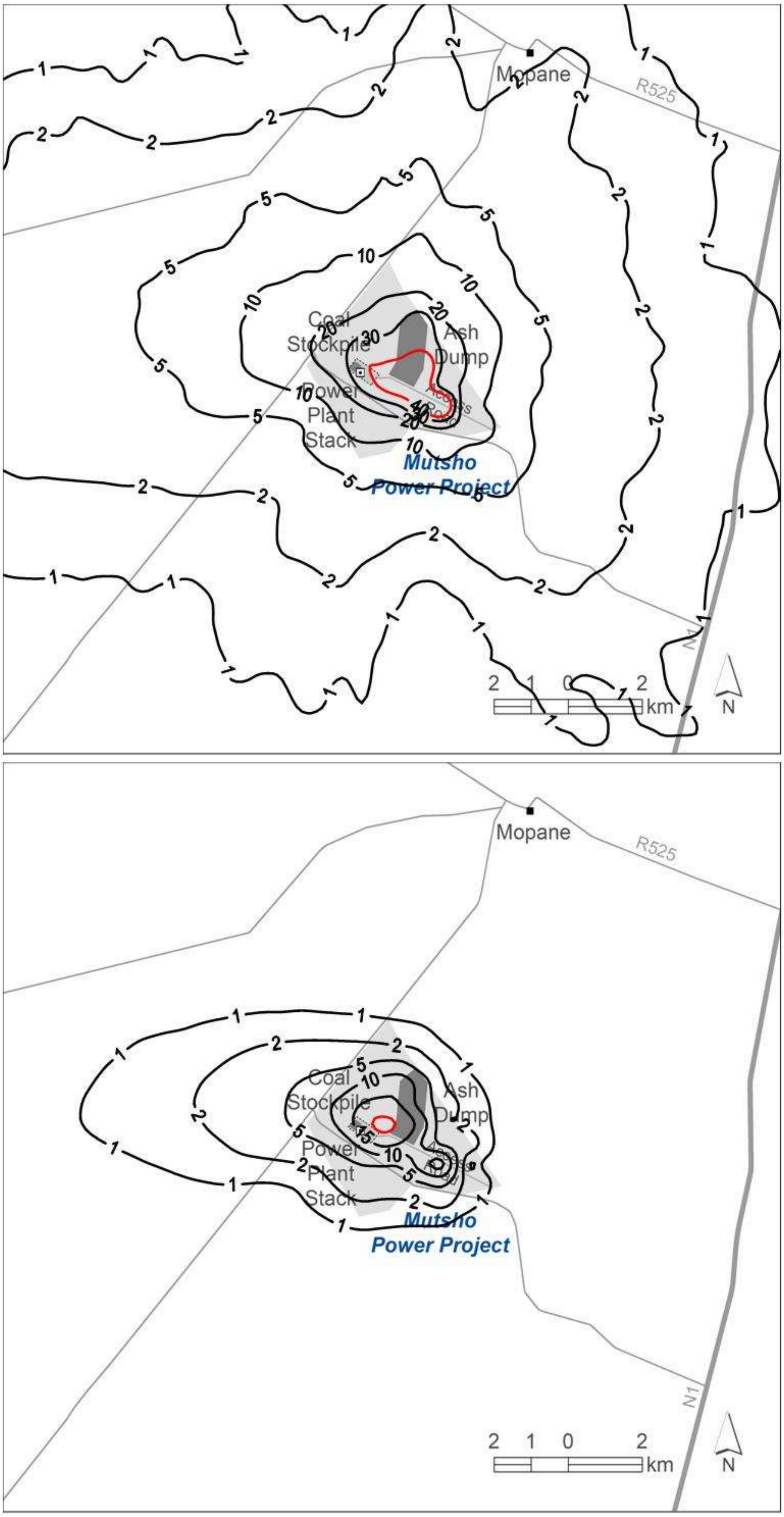



**Figure 13: Predicted 24-hour average (top) and annual average (bottom) $PM_{2.5}$ ambient concentrations in µg/m³ resulting from emissions from the proposed Mutsho Power Project coal stockpile and ash dump for the preferred site layout**

## Sulphur Dioxide ($SO_2$)

The source of $SO_2$ from the proposed Mutsho Power Project includes the Boiler Stack only. Predicted $SO_2$ concentrations are compared with the 1-hour, 24-hour and annual NAAQS.

**Scenario 1: Boiler Stack in Isolation**

**99th percentile 1-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 1-hour $SO_2$ concentration is 33 µg/m$^3$ for the Boiler Stack in isolation (Figure 12 and Table 20). The highest concentrations are predicted about 3.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 350 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

**99th percentile 24-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 24-hour $SO_2$ concentration is 15 µg/m$^3$ for the Boiler Stack in isolation (Figure 13 and Table 20). The highest concentrations are predicted about 1.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 125 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

**Annual average**

At the point of maximum ground-level impact, the highest predicted annual average $SO_2$ concentration is 1.3 µg/m$^3$ for the Boiler Stack in isolation (Figure 14 and Table 20). The highest concentrations are predicted about 1.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 50 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

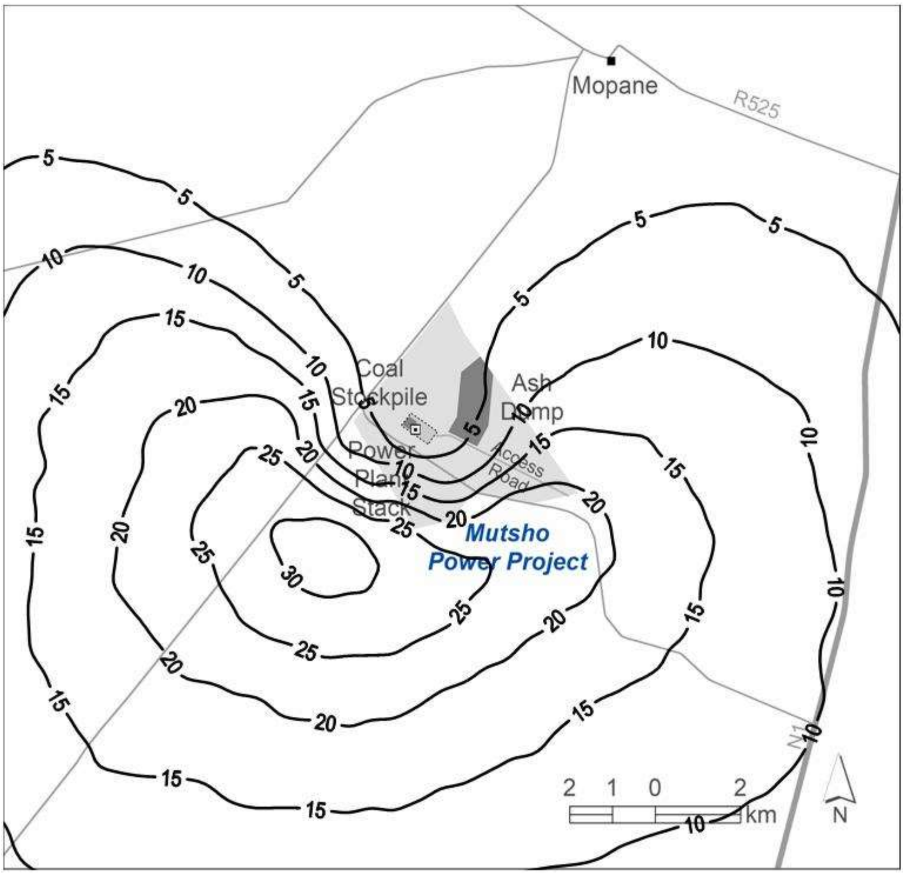



**Figure 14: Predicted 1-hour average $SO_2$ ambient concentrations in µg/m$^3$ resulting from emissions from the proposed Mutsho Power Project Boiler Stack in Isolation for the preferred site layout**

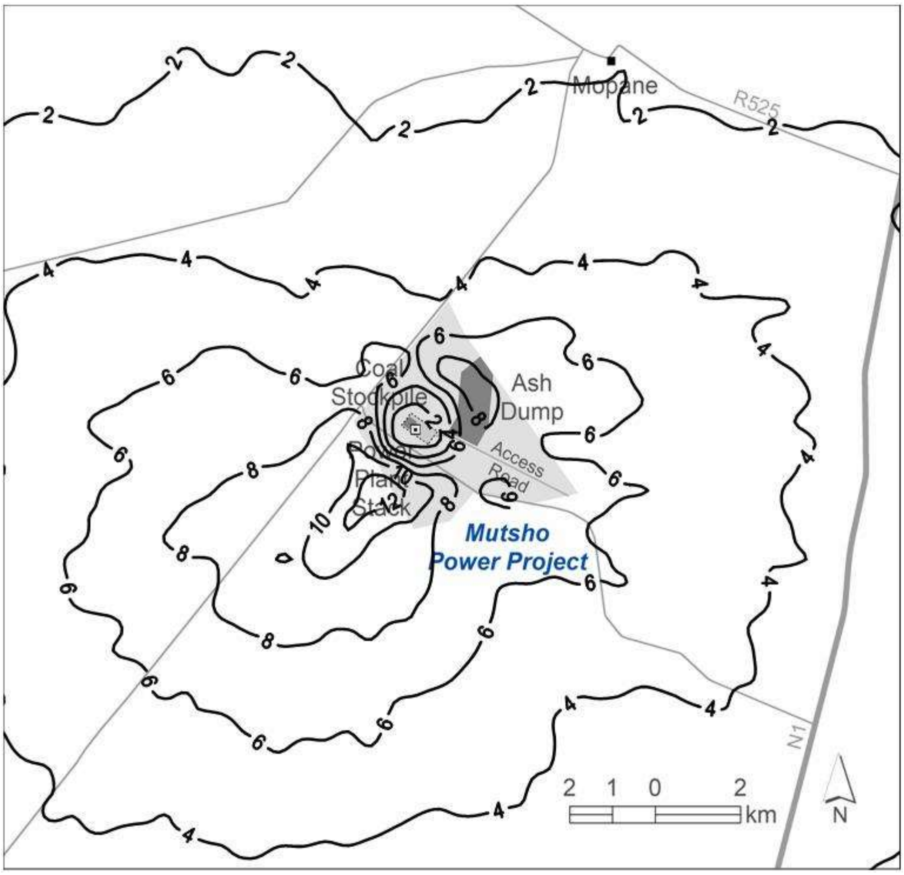



**Figure 15: Predicted 24-hour average $SO_2$ ambient concentrations in µg/m$^3$ resulting from emissions from the proposed Mutsho Power Project Boiler Stack in Isolation for the preferred site layout**

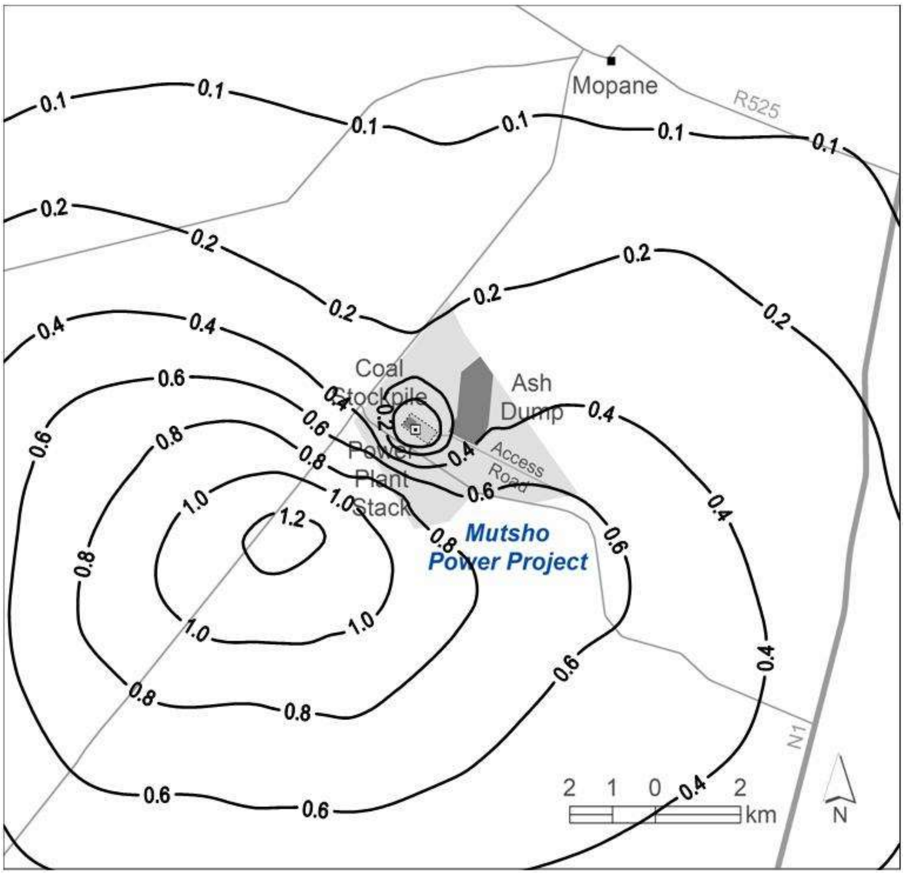



**Figure 16: Predicted annual average $SO_2$ ambient concentrations in µg/m$^3$ resulting from emissions from the proposed Mutsho Power Project Boiler Stack in Isolation for the preferred site layout**

## Nitrogen Dioxide ($NO_2$)

The source of $NO_2$ from the proposed Mutsho Power Project includes the Boiler Stack only. Predicted $NO_2$ concentrations are compared with the 1-hour and annual NAAQS. Since not all NO converts to $NO_2$, this approach is conservative and should be recognised when comparison is made against the NAAQS (Table 20). In addition, a default $NO_2$ conversion factor of 0.8 is applied (DEA, 2014).

**Scenario 1: Boiler Stack in Isolation**

**99$^{th}$ percentile 1-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 1-hour $NO_2$ concentration is 21 µg/m$^3$ for the Boiler Stack in isolation (Figure 15 and Table 20). The highest concentrations are predicted about 3.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 200 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

**Annual average**

At the point of maximum ground-level impact, the highest predicted annual average $NO_2$ concentration is 0.8 μg/$m^3$ for the Boiler Stack in isolation (Figure 15 and Table 20). The highest concentrations are predicted about 4 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 40 μg/$m^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project 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.

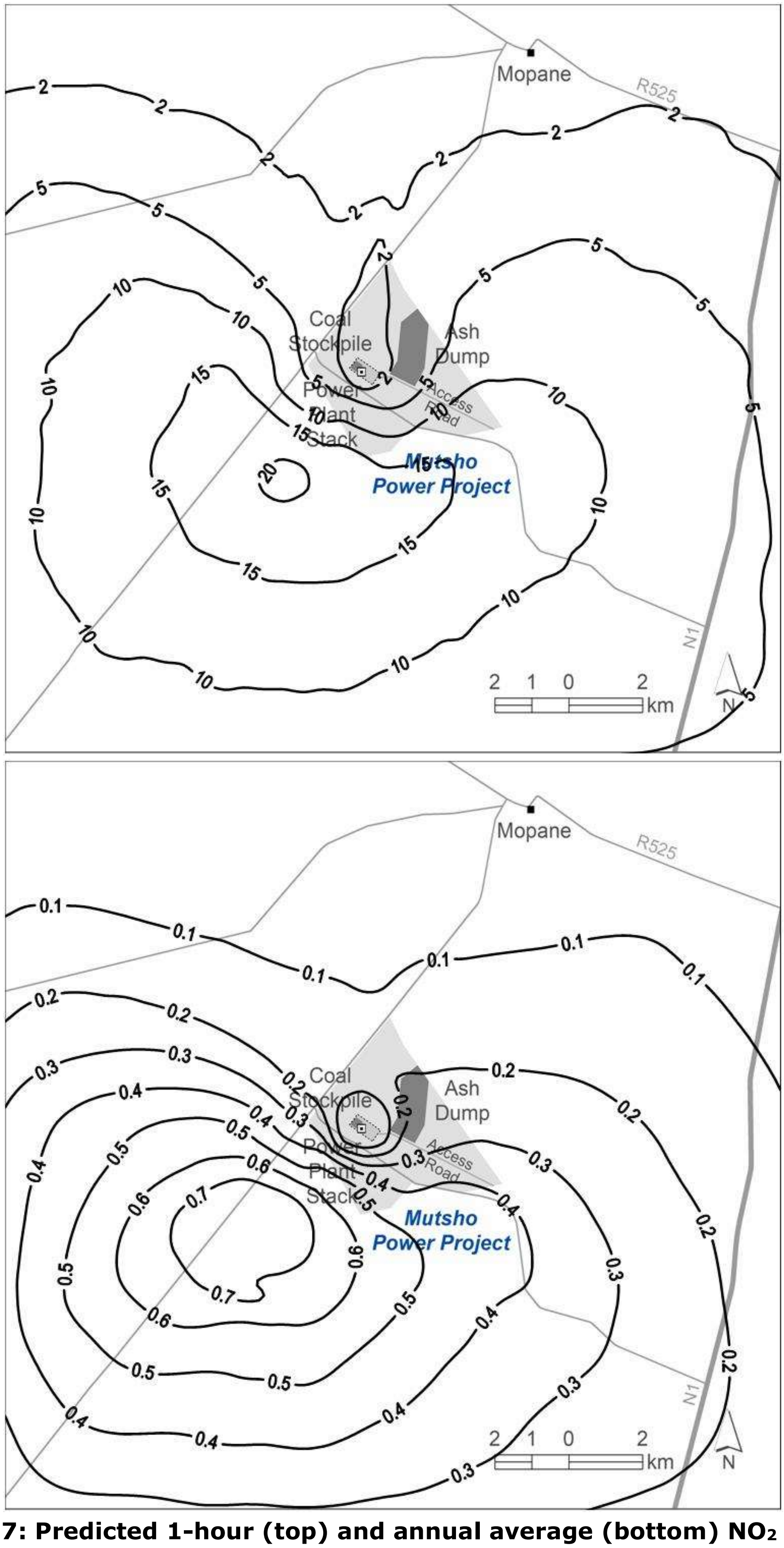



**Figure 17: Predicted 1-hour (top) and annual average (bottom) $NO_2$ ambient concentrations in μg/m³ resulting from emissions from the proposed Mutsho Power Project Boiler Stack in Isolation for the preferred site layout**

## Carbon Monoxide (CO)

The source of CO from the proposed Mutsho Power Project includes the Boiler Stack only. Predicted CO concentrations are compared with the 1-hour and 8-hour NAAQS.

**Scenario 1: Boiler Stack in Isolation**

**99$^{th}$ percentile 1-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 1-hour CO concentration is 94 µg/m$^3$ for the Boiler Stack in isolation (Figure 16 and Table 20). The highest concentrations are predicted about 3.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 30 000 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project site or in residential and sensitive receptor areas around the site. The predicted CO concentrations therefore comply with the NAAQS in the ambient environment.

**99$^{th}$ percentile 8-hour concentrations**

At the point of maximum ground-level impact, the predicted 99th percentile 8-hour CO concentration is 72 µg/m$^3$ for the Boiler Stack in isolation (Figure 16 and Table 20). The highest concentrations are predicted about 1.5 km to the southwest of the Boiler Stack. The predicted ambient concentrations are well below the NAAQS of 10 000 µg/m$^3$; and no exceedance of the NAAQS is predicted within the proposed Mutsho Power Project site or in residential and sensitive receptor areas around the site. The predicted CO concentrations therefore comply with the NAAQS in the ambient environment.

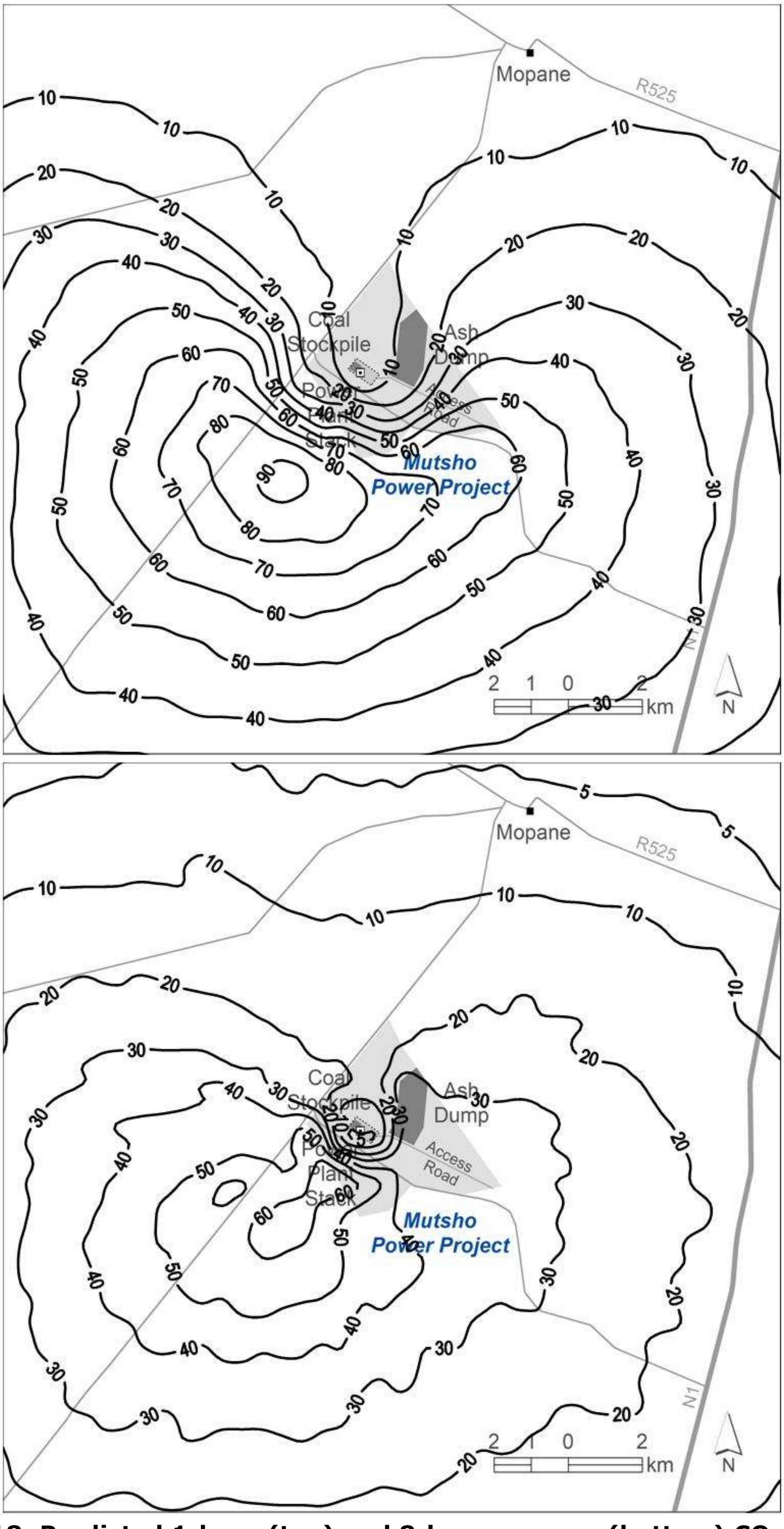



**Figure 18: Predicted 1-hour (top) and 8-hour average (bottom) CO ambient concentrations in µg/m³ resulting from emissions from the proposed Mutsho Power Project Boiler Stack in Isolation for the preferred site layout**

## Construction and Decommissioning

Construction work will entail building of new infrastructure and heavy construction work with concrete, steel, piping, etc. Dust emissions during construction result mainly from earth moving activities (scraping, compacting, excavation, grading), movement of construction vehicles and back-fill operations. Dust emissions during decommissioning result from the demolition of structures, earth moving activities (scraping, compacting, excavation, grading), movement of construction vehicles and back-fill operations. All aspects of the construction inherently generate dust, but the movement of construction vehicles on paved and unpaved surfaces at the construction site are generally the largest source of dust. Construction vehicles will be in operation for the duration of the construction and decommissioning. Dust is also easily entrained from exposed areas by the wind.

## Impact Assessment

The potential impact of emissions of dust, $PM_{10}$, $PM_{2.5}$, $NO_X$, $SO_2$ and CO resulting from the proposed Mutsho Power Project during normal operations is assessed according to the following criteria are applied:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).
- The **duration**, wherein it will be indicated whether:
  - The lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1.
  - The lifetime of the impact will be of a short duration (2 – 5 years) - assigned a score of 2.
  - Medium-term (5 – 15 years) – assigned a score of 3.
  - Long term (> 15 years) - assigned a score of 4.
  - Permanent - assigned a score of 5.
- The consequences (magnitude), quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1 – 5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; **and**
- The **status**, which will be described as either positive, negative or neutral.
  - The degree to which the impact can be reversed
  - The degree to which the impact may cause irreplaceable loss of resources.

- The degree to which the impact can be mitigated

The significance is calculated by combining the criteria in the following formula:
S = (E + D + M)*P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area)
- 30 – 60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated)
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

The air quality impacts of the proposed Mutsho Power Project are described according to the defined criteria for construction and decommissioning, the operational phase and the cumulative assessment in the tables below. The associated impact assessment scores are also provided

**Table 21: Description of air quality impacts associated with construction and decommissioning of Mutsho Power Project**

| Criteria | Assessment |
|---|---|
| **Nature** | The impact of dust associated with construction and decommissioning activities is more of a nuisance nature and does not typically pose a health risk due to its typically coarse size |
| **Extent** | ***Limited to the immediate area of the site***<br>Nuisance impacts of dust generated during construction and decommissioning are likely to be limited to the project site |
| **Duration** | ***Short duration***<br>Nuisance impacts of dust generated during construction and decommissioning are possible for the duration of these activities only. |
| **Consequence (Magnitude)** | **Small**<br>Dust generated during construction and decommissioning are likely to have a small and temporary effect on environmental functions and processes, possibly through dust accumulation on surfaces. |
| **Probability** | **Improbable**<br>There is some possibility of impacts from dust during construction and decommissioning, but the likelihood is low |
| **Status** | **Negative**<br>Nuisance impacts are regarded as negative but can be reversed once the activity stops. |

**Table 22: Impact assessment for construction and decommissioning of the Mutsho Power Project for site layout Option 1, 2 and 3**

| **Nature:** The nature of the impact of dust associated with construction and decommissioning activities is of a nuisance nature | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| **Extent** | **1** | **1** |
| **Duration** | **2** | **2** |
| **Magnitude** | **2** | **1** |
| **Probability** | **2** | **1** |
| **Significance** | **10** | **4** |
| **Status (positive or negative** | **Negative** | **Negative** |
| **Reversibility** | **Yes** | **Yes** |
| **Irreplaceable loss of resource** | **No** | **No** |
| **Can impact be mitigated?** | **Yes** | |
| **Mitigation:** On-site dust generation can be mitigated by limiting vehicle assess to the site, imposing vehicle speed restrictions and routine wetting of site roads and other exposed areas | | |
| **Residual risks:** Despite the implementation of dust control measures, some dust will be generated during construction and decommissioning. The residual risk is however low. | | |

**Table 23: Description of air quality impacts associated with the boiler during the operational phase of the Mutsho Power Project**

| Criteria | Assessment |
|---|---|
| **Nature** | Emissions from operations as the proposed Mutsho Power Project will result in an increase in ambient concentrations of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO in the surrounding ambient environment. The relative difference in the location of emission sources in three layout options is small and will have little effect on the spatial distribution of predicted ambient concentrations of air pollutants. The nature of the impact will be the same for the three site layout options. |
| **Extent** | ***Local and limited to the immediate area of the site*** Predicted dustfall and ambient $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO concentrations are well below the respective national dust regulations and NAAQS in the ambient environment throughout the modelling domain for the preferred site layout, Option 1. This will be the same for site layout Option 2 and Option 3, i.e. no predicted exceedances of the NAAQS. |
| **Duration** | ***Long term*** The impact will endure for as long as the proposed plant is in operation and is the same for all three site layout options |
| **Consequence (Magnitude)** | **Minor** For site layout Option 1, predicted dustfall and ambient $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO concentrations are relatively low in the ambient environment and a slight impact on |

| Criteria | Assessment |
|---|---|
| | environmental functions and processes is possible. This will be the same for site layout Option 2 and Option 3. |
| **Probability** | **Improbable**<br>For site layout Option 1, predicted dustfall and ambient $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO concentrations are relatively low and impacts are improbable in the ambient environment, i.e. beyond the boundary of the proposed Mutsho Power Project site there is some possibility but likelihood is low due to low predicted concentrations and the sparsely populated receiving environment. This will be the same for site layout Option 2 and Option 3. |
| **Status** | **Negative**<br>Air pollution impacts on human health may be negative despite the low predicted dustfall and ambient $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO concentrations in the ambient environment, i.e. beyond the boundary of the proposed Mutsho Power Project site. This applied to all three site layout options.<br>The impacts can be reversed if the emission of air pollutants stops. |

**Table 24: Impact assessment for the boiler stack during the operational phase of the proposed Mutsho Power Project for site layout Option 1, 2 and 3**

| **Nature:** increase in ambient concentrations of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO in the surrounding ambient environment | | |
|---|---|---|
| | **Without mitigation** | **With mitigation[1]** |
| **Extent** | **2** | **2** |
| **Duration** | **4** | **4** |
| **Magnitude** | **2** | **2** |
| **Probability** | **2** | **2** |
| **Significance** | **16** | **16** |
| **Status (positive or negative** | **Negative** | **Negative** |
| **Reversibility** | **Yes** | **Yes** |
| **Irreplaceable loss of resource** | **No** | **No** |
| **Can impact be mitigated?** | **Yes** | |
| **Mitigation:** The Mutsho Power Project proposes to implement Circulating Fluidized Bed (CFB) technology with the ability to achieve lower emission of pollutants. In addition, a Cottrell ESP will be fitted to each boiler to remove particulates from the flue gas. The design efficiency is 99.92%. Each boiler unit is fitted with flue gas desulphirisation to remove $SO_2$. Collectively these technologies reduce emissions so predicted ambient air pollution concentrations are very low. | | |
| **Residual risks:** Despite the proposed generation and emission abatement technology, there are residual effects, i.e. while emissions are low they are not zero. The predicted ambient air pollution concentrations are very low, and the residual risk is therefore low. | | |

1: For power generation, mitigation is affected through the CFB technology and the emission abatement technology, and no other mitigation applies to the boiler emissions

**Table 25: Description of air quality impacts associated with the coal stock pile, ash dump and site roads during the operational phase of the Mutsho Power Project**

| Criteria | Assessment |
|---|---|
| **Nature** | Emissions from the coal stockpile, the ash dump and the site roads during operations of the proposed Mutsho Power Project will result in an increase in ambient concentrations of $PM_{10}$ and $PM_{2.5}$ and dust fallout in the surrounding ambient environment. The relative difference in the location of emission sources in three layout options is small and will have little effect on the spatial distribution of predicted ambient concentrations of air pollutants. The nature of the impact will be the same for the three site layout options. |
| **Extent** | ***Local and limited to the immediate area of the site***<br>Exceedance of the dust standard for the residential area category, $PM_{10}$ and $PM_{2.5}$ are predicted over a very small area within the boundary of the proposed Mutsho Power Project site for the preferred site layout, Option 1. This will be the same for site layout Option 2 and Option 3, i.e. no predicted exceedances of the NAAQS. |
| **Duration** | ***Long term***<br>The impact will endure for as long as the proposed plant is in operation and is the same for all three site layout options |
| **Consequence (Magnitude)** | **Minor**<br>Exceedance of the dust standard for the residential area category, $PM_{10}$ and $PM_{2.5}$ are all predicted over a very small area within the boundary of the proposed Mutsho Power Project siteand a slight impact on environmental functions and processes is possible. This will be the same for site layout Option 2 and Option 3. |
| **Probability** | **Improbable**<br>For site layout Option 1, predicted dustfall and ambient $PM_{10}$ and $PM_{2.5}$ concentrations are relatively low and impacts are improbable in the ambient environment, i.e. beyond the boundary of the proposed Mutsho Power Project site there is some possibility but likelihood is low due to low predicted concentrations and the sparsely populated receiving environment. This will be the same for site layout Option 2 and Option 3. |
| **Status** | **Negative**<br>Air pollution impacts on human health may be negative despite the low predicted dustfall and ambient $PM_{10}$, $PM_{2.5}$ concentrations in the ambient environment, i.e. beyond the boundary of the proposed Mutsho Power Project site. This applied to all three site layout options.<br>The impacts can be reversed if the emission of air pollutants stops. |

**Table 26: Impact assessment impacts associated with the coal stock pile, ash dump and site roads during the operational phase of the Mutsho Power Project for site layout Option 1, 2 and 3**

| **Nature:** Increase in ambient concentrations of $PM_{10}$ and $PM_{2.5}$ and dust fallout in the surrounding ambient environment | | |
|---|---|---|
| | **Without mitigation** | **With mitigation** |
| **Extent** | **2** | **2** |
| **Duration** | **4** | **4** |
| **Magnitude** | **2** | **1** |
| **Probability** | **2** | **1** |
| **Significance** | **16** | **7** |
| **Status (positive or negative** | **Negative** | **Negative** |
| **Reversibility** | **Yes** | **Yes** |
| **Irreplaceable loss of resource** | **No** | **No** |
| **Can impact be mitigated?** | **Yes** | |
| **Mitigation:** The impact of dust generated at the coal stockpile, the ash dump and from site roads can be mitigated by the implementation of dust control technologies and measures, include dust suppression on conveyor transfer points, vegetating of the ash dump and wetting of site roads, amongst others. | | |
| **Residual risks:** Despite implementing dust control measures, emissions will be reduced but will not be zero. The residual risk is therefore low. | | |

**Table 27: Description of cumulative air quality impacts associated with the Mutsho Power Project**

| Criteria | Assessment |
|---|---|
| **Nature** | There are no significant sources of air pollutants in the area where the Mutsho Power Project will be developed. The air shed is therefore not degraded and emissions from the Mutsho Power Project will not add to an existing air pollution loading. There is therefore no cumulative impact associated with the Mutsho Power Project and other sources. The cumulative assessment here therefore refers the combination of sources at the Mutsho Power Project. |

**Table 28: Cumulative impact assessment resulting from all sources (boiler stack, the coal stockpile, ash dump and site access roads for at the proposed Mutsho Power Project during normal operations for site layout Option 1, 2 and 3**

| **Nature:** Increase in ambient concentrations of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO and dust fallout in the surrounding ambient environment | | |
|---|---|---|
| | **Without mitigation** | **With mitigation**[1] |
| **Extent** | **2** | **2** |
| **Duration** | **4** | **4** |
| **Magnitude** | **2** | **2** |
| **Probability** | **2** | **2** |
| **Significance** | **16** | **16** |
| **Status (positive or negative** | **Negative** | **Negative** |
| **Reversibility** | **Yes** | **Yes** |

| | | |
|---|---|---|
| **Irreplaceable loss of resource** | **No** | **No** |
| **Can impact be mitigated?** | **Yes** | |
| **Mitigation:** The Mutsho Power Project proposes to implement Circulating Fluidized Bed (CFB) technology with the ability to achieve lower emission of pollutants. In addition, a Cottrell ESP will be fitted to each boiler to remove particulates from the flue gas. The design efficiency is 99.92%. Each boiler unit is fitted with flue gas desulphurisation to remove $SO_2$. Collectively these technologies reduce emissions so predicted ambient air pollution concentrations are very low.<br>The impact of dust generated at the coal stockpile, the ash dump and from site roads can be mitigated by the implementation of dust control technologies and measures, include dust suppression on conveyor transfer points, vegetating of the ash dump and wetting of site roads, amongst others. | | |
| **Residual risks:** Despite the proposed generation and emission abatement technology, there are residual effects, i.e. while emissions are low they are not zero. The predicted ambient air pollution concentrations are very low, and the residual risk is therefore low. | | |

## 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. COMPLAINTS

The proposed Mutsho Power Project has not received complaints in respect of air pollution in the last 2 years, as it is a proposed facility.

# 7. CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

Air quality management interventions that can be included in the EMP for the proposed Mutsho Power Project during construction, operations and decommissioning are included in in Table 29.

**Table 29: Recommended air quality management interventions for the EMP for the Mutsho Power Project**

| | | |
|---|---|---|
| **Objective:** To reduce dust generation | | |
| **Project Component/s** | Construction and decommissioning | |
| **Potential Impact** | Limit the spatial extend and magnitude of nuisance dust impacts | |
| **Activities/Risk Sources** | Unpaved site roads and vehicle movement | |
| **Mitigation: Target/Objective** | | |
| **Mitigation: Action/Control** | **Responsibility** | **Timeframe** |
| Watering site roads | Site manager | Twice daily for the duration of construction and decommissioning |
| Restricting vehicle access to the site | Site manager | On-going for the duration of construction and decommissioning |
| Imposing on-site speed restrictions | Site manager | On-going for the duration of construction and decommissioning |
| | | |
| **Objective:** To minimise emissions of particulates and $SO_2$ from the boiler stack | | |
| **Project Component/s** | Power generation – boiler stack | |
| **Potential Impact** | Limit the spatial extend and magnitude of ambient concentrations on $SO_2$ and $PM_{10}$ | |
| **Activities/Risk Sources** | Maintenance of boiler stack emission control technologies, i.e. Cottrell ESP and flue gas desulphurisation (FGD) | |
| **Mitigation: Target/Objective** | | |
| **Mitigation: Action/Control** | **Responsibility** | **Timeframe** |
| Develop and implement maintenance plan for ESP and FGD | General manager | On-going during operational phase |

| | | |
|---|---|---|
| Conduct routine stack emission testing to ensure design performance is maintained and compliance with minimum emission standards | General manager | Annually during operational phase |
| Register and report emissions according to requirements of the emission reporting regulations | General manager | As required by the emission reporting regulations |
| | | |
| **Objective:** Reduce the emission of dust during operations | | |
| **Project Component/s** | Coal storage and handling, ash disposal and unpaved site roads | |
| **Potential Impact** | Limit the spatial extend and magnitude of particulate impacts | |
| **Activities/Risk Sources** | Reduce dust emissions through the implementation of a fugitive dust management plan (FDMP) | |
| **Mitigation: Target/Objective** | | |
| **Mitigation: Action/Control** | **Responsibility** | **Timeframe** |
| Develop and implement a FDMP for the Mutsho site to address dust from coal storage and handling, ash disposal and unpaved site roads | General manager | On-going during operational phase |
| Establish and operate a dust fallout monitoring network in terms of the dust control regulations | General manager | Annually during operational phase |

# 8. COMPLIANCE AND ENFORCEMENT ACTIONS

The proposed Mutsho Power Project does not have any air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years, as it is a proposed facility.

# 9. SUMMARY AND CONCLUSION

The main source of emissions from the proposed Mutsho Power Project includes the Boiler Stack, the coal stockpile, ash dump and the unpaved site access road. Two Scenarios are considered in this assessment: Scenario 1 - Boiler Stack in Isolation and Scenario 2 - All Sources (which include the Boiler Stack, coal stockpile, ash dump and unpaved site access road).

In Scenario 1, the predicted dustfall and ambient concentrations of $PM_{10}$, $SO_2$, $NO_X$ and CO are considerably less than the respective national dust standard and NAAQS for all averaging periods throughout the modelling domain. There are no predicted exceedances of the national dust standard or NAAQS within the proposed Mutsho Power Project site or in residential and sensitive receptor areas around the site. The predicted dustfall and ambient concentrations are therefore compliant in the ambient environment.

In Scenario 2, exceedance of the dust standard for the residential area category, $PM_{10}$ and $PM_{2.5}$ resulting from all sources at the Mutsho Power Project are predicted over a very small area along the unpaved site access road, which is within the boundary of the proposed Mutsho Power Project site. Predicted dustfall and ambient $PM_{10}$ and $PM_{2.5}$ concentrations are well below the respective national dust standard and NAAQS beyond the Mutsho Power Project site and are therefore compliant in the ambient environment.

According to the dispersion modelling results and air quality impact assessment, emissions from the Mutsho Power Project site operations are expected to result in dustfall and ambient concentrations of air pollutants that are well below the respective national dust standard and NAAQS in the ambient environment. Air quality impacts are therefore considered to have a low significance regardless of the site configuration. From an air quality perspective, it is therefore a reasonable opinion that the project should be authorised considering the outcomes of this study for the preferred site layout option.

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# 11. FORMAL DECLARATIONS

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

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

**DETAILS OF SPECIALIST AND DECLARATION OF INTEREST**

| | (For official use only) |
|---|---|
| File Reference Number: | 12/12/20/ or 12/9/11/L |
| NEAS Reference Number: | DEAT/EIA |
| Date Received: | |

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 718, 2009

**PROJECT TITLE**

Development of the Mutsho Power Project and associated infrastructure near Makhado (Louis Trichardt), Limpopo Province.

| | | | |
|---|---|---|---|
| Specialist: | uMoya-NILU Consulting (Pty) Ltd | | |
| Contact person: | Dr Mark Zunckel | | |
| Postal address: | P O Box 20622, Durban North | | |
| Postal code: | 4016 | Cell: | 083 690 2728 |
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| Professional affiliation(s) (if any) | South African Council for Natural Scientific Professionals (400449/04) | | |

| | | | |
|---|---|---|---|
| Project Consultant: | Savannah Environmental (Pty) Ltd | | |
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| E-mail: | joanne@savannahsa.com | | |

4.2 The specialist appointed in terms of the Regulations_

I, MARK ZUNCKEL, declare that -- General declaration:

I act as the independent specialist in this application;

I 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 declare that there are no circumstances that may compromise my objectivity in performing such work;

I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;

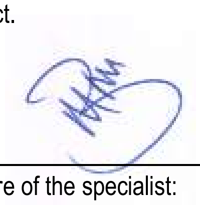
I will comply with the Act, Regulations and all other applicable legislation;

I have no, and will not engage in, conflicting interests in the undertaking of the activity;

I undertake to disclose to the applicant and the competent authority 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 competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;

all the particulars furnished by me in this form are true and correct; and

I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.



Signature of the specialist:

uMoya-NILU Consulting (Pty) Ltd

Name of company (if applicable):

5 April 2018

Date: