ANNEXURE C

ATMOSPHERIC IMPACT REPORT
In support of

Eskom's application for postponement of the Minimum Emission Standards compliance timeframes for the Port Rex Power Station

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EXECUTIVE SUMMARY

Eskom's liquid fuel-fired Port Rex Power Station in East London in the Eastern Cape Province is a peaking plant with a generation capacity of 171 MW. Power generation is a Listed Activity in terms of Section 21 of the NEM:AQA and as a result Port Rex is required to comply with the prescribed MES for existing plants by 2015 and for new plants by 2020. SO_2 and PM emissions from Port Rex already comply with the MES for both existing and new plants, but NO_x emissions will not comply with the new plant MES. Eskom has therefore applied for postponement of the new plant NO_x MES for Port Rex and proposed an alternative emissions limit. The purpose of this AIR has been to assess the likely implications of that postponement and the requested alternative emissions limit for human health and the environment.

An analysis of measured ambient NO_2 concentrations indicates full compliance with the NAAQS for both the hourly and the annual averaging periods. Predicted ambient NO_2 concentrations (using a dispersion model) were also seen to be compliant with the NO_2 NAAQS for current emissions, but potentially non-compliant for Eskom's requested emissions. The potential non-compliance derives from the fact that Port Rex was modelled as if it operated permanently, whereas in actual fact the station operates for less than 1% of the time. It is also clear from the modelling that the NAAQS hourly limit value is not exceeded every time Port Rex operates even under maximum emissions and, given that Port Rex operates for less than 60 hours a year and that the NAAQS allows 88 hourly exceedances of the limit value in a year, the risk of non-compliance with the NAAQS is very low indeed, and the associated risk to human health and the environment, negligible.

LIST OF ACRONYMS

µm	1 µm = 10^{-6} m
AEL	Atmospheric Emission License
AIR	Atmospheric Impact Report
APPA	Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965)
AQMP	Air Quality Management Plan
BID	Background Information Document
DEA	Department of Environmental Affairs
DoE	Department of Energy
ESP	Electrostatic precipitator
FFP	Fabric Filter Plant
FGD	Flue gas desulphurisation
IRP	Integrated Resource Plan
LNB	Low NO_x Burner
LPG	Liquid Petroleum Gas
NAAQS	National Ambient Air Quality Standards
NEMAQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen (NO_X = NO + NO_2)
OFA	Overfire Air
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with a diameter of less than 2.5 µm
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulates
WHO	World Health Organisation

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1. Enterprise Details

1.1 Enterprise Details

Entity details for Eskom's Port Rex Power Station are listed in Table 1.

Table 1: Enterprise details

Enterprise Name:	Eskom Holdings SOC Limited
Trading as:	Port Rex Power Station
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	State owned company
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):	2002/015527/06
Registered Address:	Megawatt Park, Maxwell Drive, Sunninghill, Sandton
Postal Address:	PO Box 1281 East London 5200
Telephone Number (General):	(021) 558 7266
Fax Number (General):	08666 50995
Company Website:	www.eskom.co.za
Industry Type/Nature of Trade:	Liquid-fired power stations that generate electricity. Listed activity (Sub-category 1.2) in terms of the NEM:AQA (Section 21), i.e. combustion installations using liquid fuels primarily for steam raising or electricity generation (DEA, 2010).
Land Use Zoning as per Town Planning Scheme:	Industrial
Land Use Rights if outside Town Planning Scheme:	-
Responsible Person:	Abedah Wilson
Emission Control Officer:	Abedah Wilson
Telephone Number:	+27 21 914 3111
Cell Phone Number:	+27 83 769 4447
Fax Number:	n/a
E-mail Address:	WilsonA@eskom.co.za
After Hours Contact Details:	+27 83 769 4447

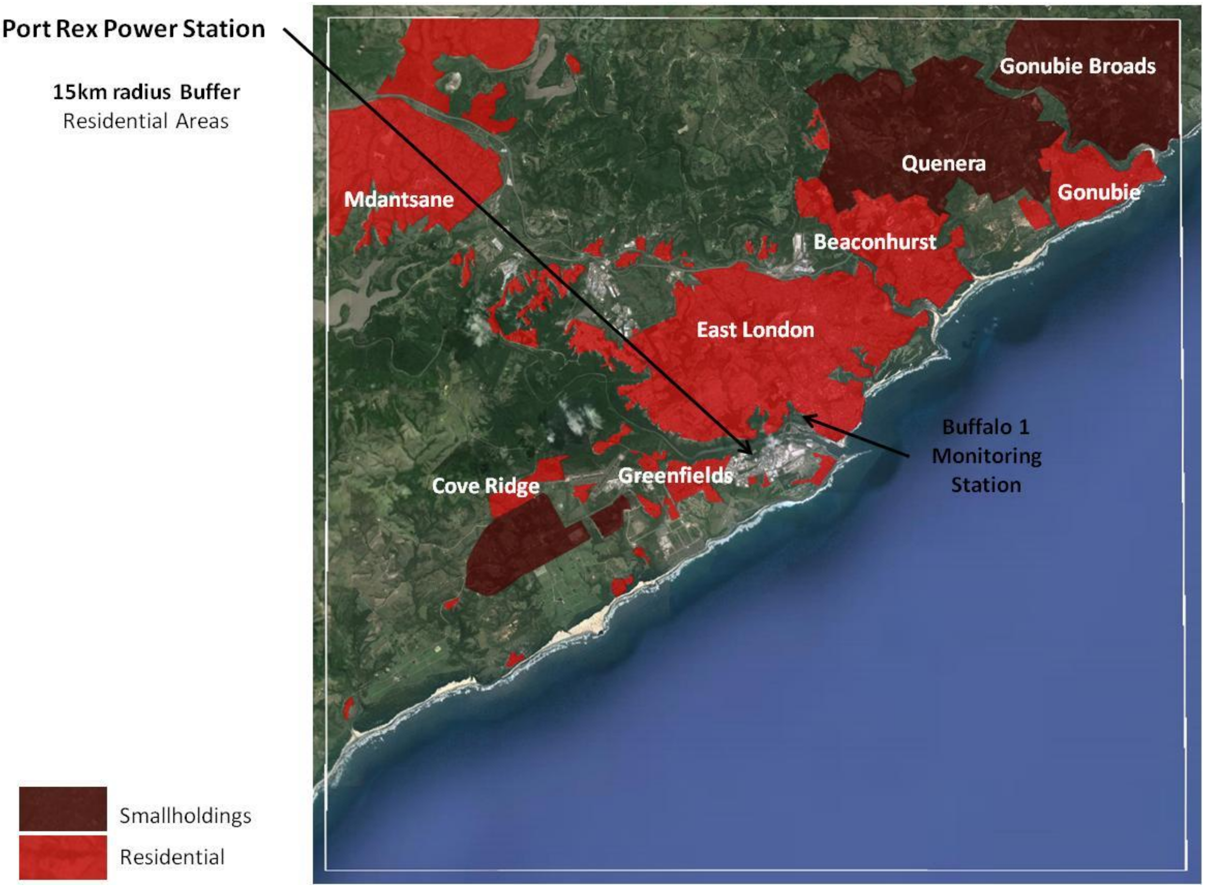
1.2 Location and Extent of the Plant

Port Rex Power Station is located approximately 2.5 km from the East London CBD in the Eastern Cape Province. Site information is provided in Table 2 and the relative location to key landmarks is shown in Figure 1.

Figure 1: Relative location of the Port Rex Power Station (Google Earth, 2013)

Table 2: Site information

Physical Address of the Plant (Licensed Premises)	9 Wells Road, Woodbrook, East London
Description of Site (Where No Street Address):	N/A
Coordinates (latitude, longitude) of Approximate Centre of Operations (Decimal Degrees):	Latitude: 33.028614° S Longitude: 27.881106° E
Coordinates (UTM) of Approximate Centre of Operations:	582284.00 m E 6345196.00 m S
Extent (km²):	0.02
Elevation Above Mean Sea Level (m)	70
Province:	Eastern Cape Province
District/Metropolitan Municipality:	Buffalo City Metropolitan Municipality
Local Municipality:	Buffalo City
Designated Priority Area (if applicable):	N/A



Receptor	Distance(m)	Direction
Buffalo Flats	0.5	N and NW
Greenfields	0.9	E
East London CBD	2	ENE
Industry	Immediate	Surrounding

Figure 2: Land use and sensitive receptors within a 30 km x 30km block of the Port Rex Power Station shown by the white square

1.3 Atmospheric Emission License and Other Authorisations

An APPA Registration Certificate (No. 2092) was issued to Port Rex Power Station by the Chief Air Pollution Control Officer (CAPCO) on 18 February 1997, in terms of Section 10 of the APPA, in respect of Scheduled Process No.29 (Power Generation). The Registration Certificate is valid until 1 April 2014 and has not been converted to an AEL yet. The Port Rex APPA Registration Certificate (number 2092) does not stipulate any emission limits, but instead stipulates the fuel which is to be used, and the height of the stacks. The current governmental authorisations, permits and licenses related to air quality management are provided in Table 3.

Table 3: Current government authorisations related to air quality

APPA Registration Certificate Number:	Date of Registration Certificate:	Scheduled Process Number:	Scheduled Process Description:
2092	18/02/1997	No. 29	Power Generation

1.3.1 Minimum Emission Standards

All of Eskom's coal- and liquid fuel-fired power stations are required to meet the Minimum Emission Standards (MES) promulgated in terms of Section 21(3)(a) of the NEMAQA under GNR 893 on 22 November 2013 ("GNR 893"). GNR 893 does provide for transitional arrangements in respect of the requirement for existing plants to meet the MES and provides that less stringent limits must be achieved by existing plants by 1 April 2015, and the more stringent 'new plant' limits must be achieved by existing plants by 1 April 2020. The MES are listed in Table 4.

Table 4: Minimum Emission Standards for combustion installations (Category 1) using liquid fuel for electricity generation (Sub-category 1.2) with a design capacity equal or greater to 50 MW heat input per unit

Substance	Plant status	MES mg/Nm^3 under normal conditions of 10% O_2, 273 K and 101.3 kPa
Particulate Matter	New	50
	Existing	75
Sulphur dioxide	New	500
	Existing	3 500
Oxides of nitrogen	New	250
	Existing	1 100

1.3.2 National Ambient Air Quality Standards (NAAQS)

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 (e.g. WHO, 1999; 2003; 2005). South Africa has accordingly established National Ambient Air Quality Standards (NAAQS) for the criteria pollutants, i.e. sulpur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), respirable particulate matter (PM_{10}), ozone (O_3), lead (Pb) and benzene (C_6H_6) (DEA, 2009) and $PM_{2.5}$ (DEA, 2012a). The NAAQS for SO_2, NO_2, PM_{10} and $PM_{2.5}$ are listed in Table 5.

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

Table 5: National Ambient Air Quality Standards for SO_2, NO_2 and PM_{10} (DEA, 2009) and $PM_{2.5}$ (DEA, 2012a). Because the applications apply to regulations that commence in 2015, the 2015 and 2016 standards are deemed to apply.

Pollutants	Averaging period	Limit value (µg/m³)	Number of permissible exceedances per annum
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
NO_2	1 hour	200	88
	1 year	40	0
PM_{10}	24-hour	120 (75[1])	4
	Calendar year	50 (40[1])	0
$PM_{2.5}$	24-hour	65 (40[2]) (25[3])	4
	Calendar year	25 (20[2]) (15[3])	0

1: Implementation date 1 January 2015
2: Implementation date 1 January 2016
3: Implementation date 1 January 2030

2. Nature of the Process

2.1 Listed Activity or Activities

Table 6: Activities listed in GNR 893 which are 'triggered' by the Port Rex Power Station.

Category of Listed Activities	Sub-category of the Listed Activity	Description and Application of the Listed Activity
1: Combustion Installations	1.2: Liquid Fuel Combustion Installations	Liquid fuels combustion installations used primarily for steam raising or electricity generation. All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.
2: Petroleum Industry, the production of gaseous and liquid fuels as well as petrochemicals from crude oil, coal, gas or biomass	2.4: Storage and Handling of Petroleum Products	All permanent immobile liquid storage facilities at a single site with a combined storage capacity of greater than 1000 cubic meters.

2.2 Process Description

Eskom Holdings SOC (Ltd) is a South African utility that generates, transmits and distributes electricity. The bulk of that electricity is generated in large coal-fired power stations that are situated close to the sources of coal, with most of the stations occurring on the Mpumalanga Highveld. In addition to the large coal-fired power plants that provide so-called 'baseload', the utility also has a series of 'peaking stations' that can be started and stopped quickly to respond to peak electricity demand. One such peaking station is the Port Rex Power Station (hereafter referred to as 'Port Rex') which is a liquid fuel-fired power station located in East London in the Eastern Cape Province (Figure 1). Port Rex has a generation capacity of 171 MW, which derives from three gas turbines, each of which is driven by two engines.

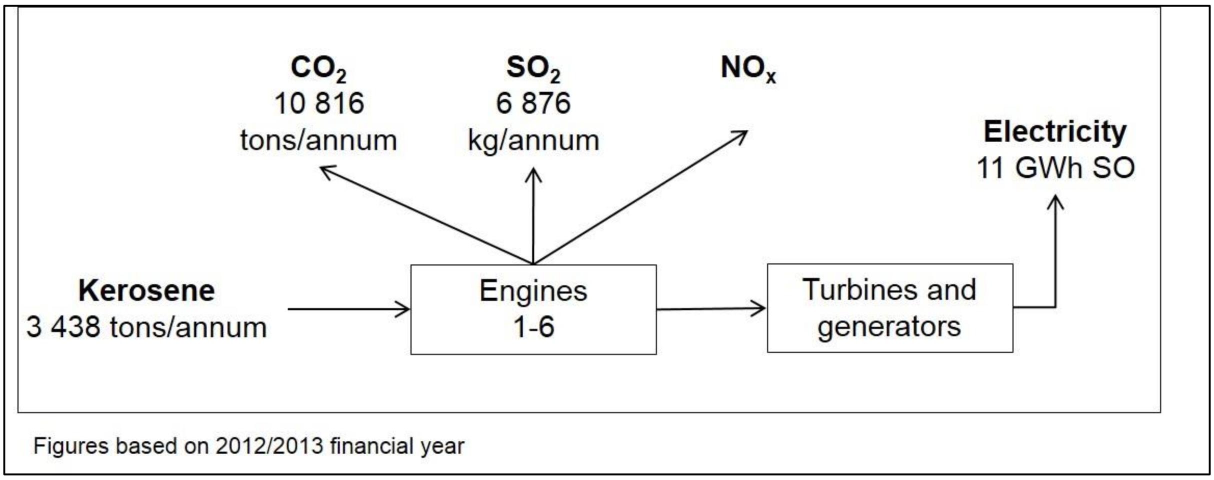


Figure 3: A basic atmospheric emissions mass balance for Port Rex Power Station showing the key inputs and outputs. Note that all quantities are expressed in tonnes per annum unless otherwise stated.

2.2.1 Atmospheric emissions resulting from power generation

The main product of combustion from a liquid-fuel fired power station such as Port Rex, is CO_2 which is produced from the oxidation of carbon in the fuel. However, incomplete combustion results in the formation of CO, albeit in much smaller quantities than CO_2. SO_2 is produced from the combustion of sulphur bound in fuel but the sulphur content of the fuel (kerosene) used at Port Rex is relatively low at 0.56%. NO_X is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the fuel. 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 station stacks. The non-combustible portion of the fuel remains as solid waste and is released as PM but again in very small quantities. A summary of the different unit process is provided in Table 7. The relative location of these is shown in Figure 4 and the process flow is illustrated in Figure 3.

2.3 Unit Processes

Table 7: Unit processes at Port Rex Power Station

Unit Process	Function of Unit Process	Batch or Continuous Process
Unit 1	Power generation process	Batch
Unit 2	Power generation process	Batch
Unit 3	Power generation process	Batch
Fuel storage	Fuel storage tanks	Continuous

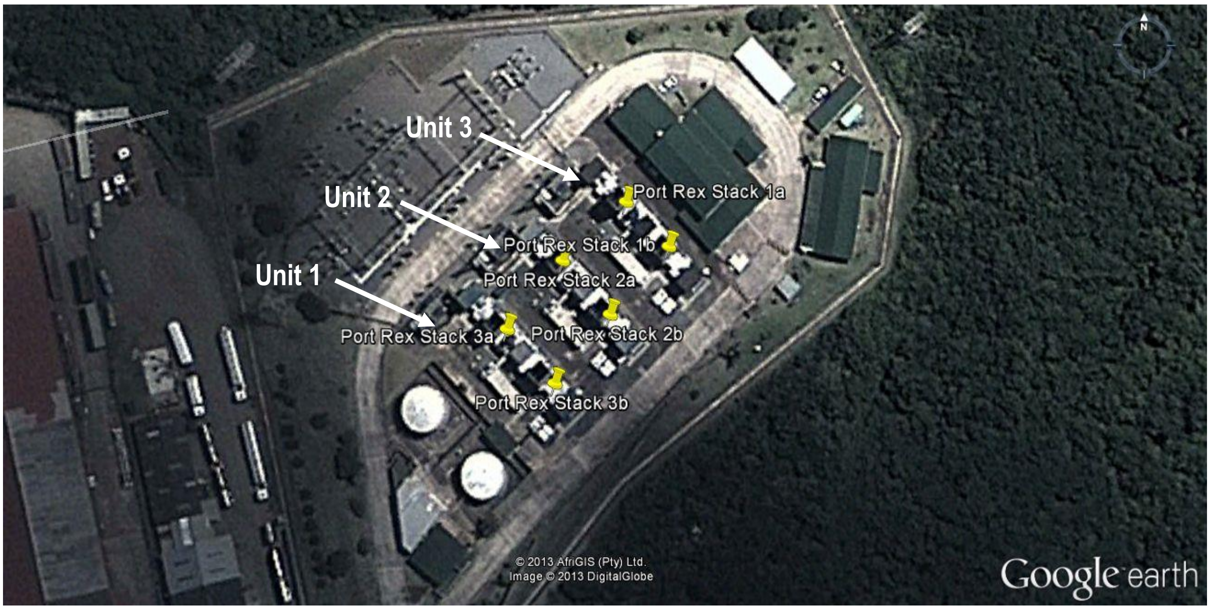


Figure 4: Relative location of the different process units at Port Rex Power Station

3. Technical Information

3.1 Raw Materials Used

The permitted raw materials consumption rate, the permitted production rates and the energy sources at Port Rex Power Station are listed in Tables 8 and 9 according to the Registration Certificate.

Table 8: Raw material used at Port Rex Power Station

Raw material	Maximum permitted consumption rate (Volume)	Units (quantity / period)
Diesel	Not specified	Not specified

Table 9: Production rates at Port Rex Power Station

Product/by-product	Maximum Production capacity permitted (Volume)	Units (quantity / period)
Electricity	171	MW

3.2 Appliances and Abatement Equipment Control Technology

No abatement equipment control technology has been installed at Port Rex Power Station.

4. Atmospheric Emissions

4.1 Point source parameters

The physical data for the stacks at Port Rex Power Station are listed in Table 10.

Table 10: Point sources at Port Rex Power Station

Source Description	Latitude of centre (UTM)	Longitude of centre (UTM)	Height of Release Above Ground (m)	Height above nearby building (m)	Diameter at Stack Tip / Vent Exit (m)*	Actual Gas Exit Temp (^0C)	Normal Gas volumetric flow per stack (Nm^3/s)	Actual Gas Exit Velocity (m/s)	Type of emission (continuous/ batch)
Stack 1a	6345.227	582.307	14	8	3.9	540	105.2	26.1	Batch
Stack 1b	6345.217	582.317	14	8	3.9	540	105.2	26.1	Batch
Stack 2a	6345.214	582.292	14	8	3.9	540	105.2	26.1	Batch
Stack 2b	6345.202	582.303	14	8	3.9	540	105.2	26.1	Batch
Stack 3a	6345.199	582.279	14	8	3.9	540	105.2	26.1	Batch
Stack 3b	6345.187	582.290	14	8	3.9	540	105.2	26.1	Batch

** Effective stack diameter. Individual flue dimensions are 3mx4m*

4.2 Point source maximum emission rates (normal operating conditions)

Emissions at Port Rex have not been measured, but can only be calculated based on EPA emission factors. Arrangements are being made to monitor emissions at Port Rex.

4.3 Point source maximum emission rates (start-up, shut-down, upset and maintenance conditions)

The Port Rex Power Station starts up very quickly. There is thus no prolonged period with elevated emission levels, as is the case for coal-fired power stations. Emissions during start-up, shut-down, upset and maintenance conditions have not been measured at Port Rex.

4.4 Fugitive emissions (area and or line sources)

Fugitive emissions at Port Rex Power Station result from fuel storage and handling. Fugitive emissions are not assessed in this AIR.

4.5 Emergency Incidents

A record is maintained of all emergency incidents occurring at Eskom Power Stations reported in terms of Section 30 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). There have been no emergency incidents at Acacia Power Station

5. Impact of Enterprise on the Receiving Environment

5.1 Analysis of emissions

5.1.1 Overview

The application for postponement means that Port Rex's emissions will remain unchanged from what they are currently. In addition the requested interim emissions have been expressed as a ceiling limit to ensure that Eskom can comply with the same under all normal operating circumstances given the variability of emissions from day to day. As such, assessing the impact of Port Rex on the receiving environment requires that:

- The existing state of the environment must be assessed in terms of prevailing climate and air quality, including those areas where there are no direct measurements of air quality;
- The air quality that could prevail if the ceiling limits are approved must also be assessed; and,
- The air quality state must then be assessed in terms of the risks to human health and the environment.

This assessment is then based on a detailed analysis of the prevailing climate together with an analysis of air quality monitoring data. Thereafter dispersion modelling has been used to predict ambient air pollution concentrations in the areas where there are no physical measurements and the worst case scenario under the requested emission limits. This analysis is presented in the following section.

5.1.2 Prevailing climatic conditions

Temperature and rainfall

Port Rex is in the Buffalo City Metropolitan Municipality which lies in the southern path of South Africa's sub-tropical climate region and experiences a combination of a moderate coastal climate and a warmer sub-tropical climate. Rainfall occurs throughout the year (Figure 5) with an annual average rainfall of 920 mm, but most of the rain occurs in summer from August to February. Rains occur mostly as a result of convective summer rain and winter rain associated with the passage of frontal systems. Summers are warm and humid although high temperatures can occur, whereas winters are mild. Monthly average rainfall data for East London for the climatologically representative period 1961 – 1990 (SAWS, 1998) is presented in Figure 5.

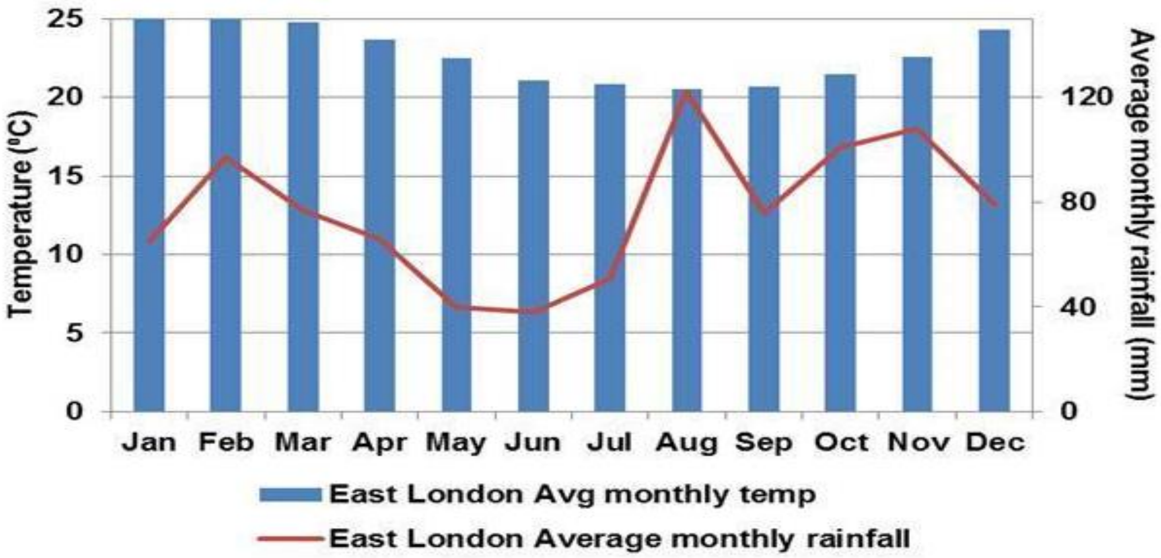


Figure 5: Average monthly maximum and minimum temperature, and average monthly rainfall at East London from 1982 to 1990 (SAWS, 1992)

5.1.3 Wind

The prevailing winds in East London are westerly to southwesterly and easterly to northeasterly, illustrated by the annual windrose in Figure 6. The windrose illustrates the frequency of hourly wind from the 16 cardinal wind directions, with wind indicated from the direction it blows, i.e. easterly winds blow from the east. A wind rose also illustrates the frequency of average hourly wind speed in six wind speed classes. The strongest winds in East London occur from the west to southwest exceeding 11 m/s. These typically occur with the passage of coastal lows ahead of frontal systems.

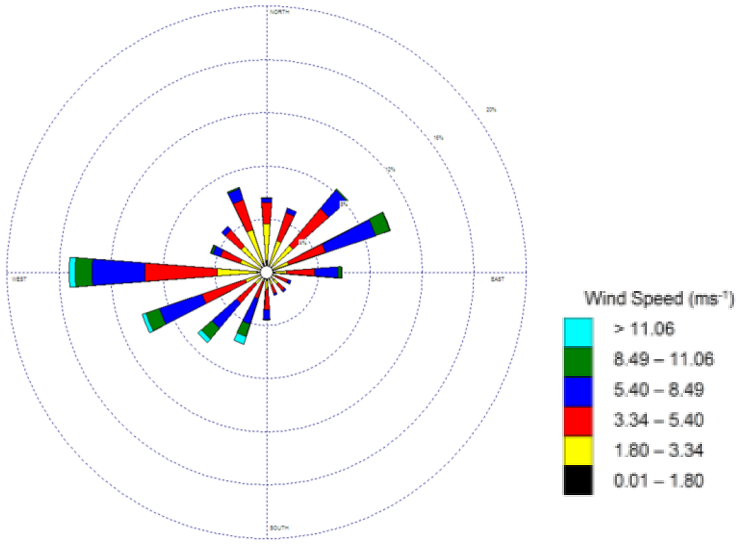


Figure 6: Annual wind rose for East London

5.2 Current status of ambient air quality

5.2.1 Ambient air quality monitoring

Sources of air pollution in East London in the vicinity of Port Rex include industry, motor vehicle traffic, the harbour, and waste burning (uMoya-NILU, 2013). A comprehensive description of air quality in the Buffalo City Metropolitan Municipality is included in the Air Quality Management Plan for the Eastern Cape Province (DEDEA&T, 2013). For the purpose of this assessment, ambient air quality monitoring data was sourced from the Buffalo 1 monitoring station in the East London CBD. As the application pertains only to NO_x, it is only that pollutant that is further assessed in this AIR.

Nitrogen dioxide

Frequency distributions of ambient hourly average concentrations of NO_2 from the Buffalo 1 monitoring station are shown in Figure 7 for 2010 and 2012. It can be seen from the graph that the limit value is exceeded during 2012 but only a few occasions and well less than the 1% exceedance tolerance that is provided for in the NAAQS. No exceedances are evident in the 2010 data and there is thus full compliance with the standard. It can also be seen from the data that NO_2 concentrations are maintained at well below 50 μg/m^3 for more than 95% of the year (the limit value is 200 μg/m^3). Annual average NO_2 concentrations of 6 and 4 μg/m^3 are evident for 2010, and 2012, which complies with the NAAQS of 40 μg/m^3 and is less than 15% of the limit value.

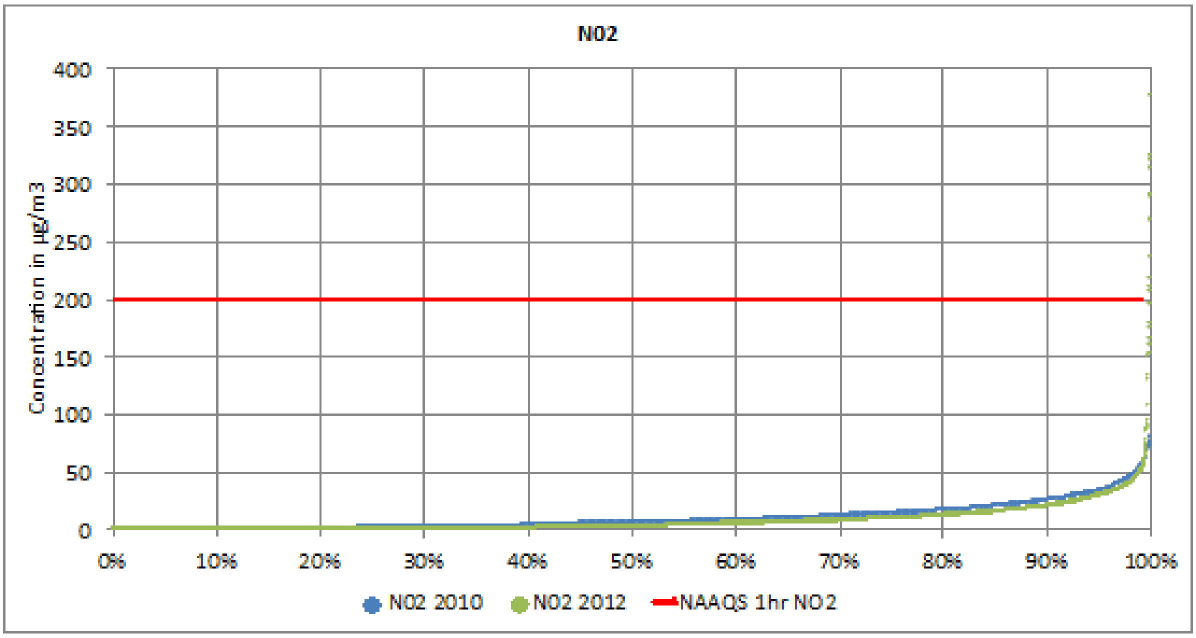


Figure 7: Frequency distribution of hourly average ambient NO_2 concentrations (µg/m^3) measured at the Buffalo 1 monitoring station in 2010 and 2012. The NAAQS limit value of 200 µg/m^3 is shown by the red horizontal line.

5.3 Dispersion Modelling

The approach to the dispersion modelling in this assessment is based on the requirements of the DEA guideline for dispersion modelling (DEA, 2012c) and is described in detail in the Plan of Study report (uMoya-NILU, 2013), made available during the public consultation process. An overview of the dispersion modelling approach for Port Rex Power Station is provided here.

5.3.1 Models used

A number of models with different features are available for air dispersion studies. The selection of the most appropriate model for an air quality assessment needs to consider the complexity of the problem and factors such as the nature of the development and its sources, the physical and chemical characteristics of the emitted pollutants and the location of the sources. This assessment is considered to be a level 2 assessment, according to the definition on the dispersion modelling guideline (DEA, 2012c). The CALPUFF suite of models (http://www.src.com/calpuff/calpuff1.htm) was therefore used. The U.S. EPA Guideline of Air Quality Models also provides for the use of CALPUFF on a case-by-case basis for air quality estimates involving complex meteorological flow conditions, where steady-state straight-line transport assumptions are inappropriate.

CALPUFF 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).

The Air Pollution Model (TAPM) (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002) is used to model surface and upper air metrological data for the study domain. TAPM uses global gridded synoptic-scale meteorological data with observed surface data to simulate surface and upper air meteorology at given locations in the domain, taking the underlying topography and land cover into account. The global gridded data sets that are used are developed from surface and upper air data that are submitted routinely by all meteorological observing stations to the Global Telecommunication System of the World Meteorological Organisation. TAPM has been used successfully in Australia where it was developed (Hurley, 2000; Hurley et al., 2001; Hurley et al., 2002), and in South Africa (Raghunandan et al., 2007). It is considered to be an ideal tool for modelling applications where meteorological data does not adequately meet requirements for dispersion modelling. TAPM modelled output data is therefore used to augment the site-specific surface meteorological data for upper air data for input to CALPUFF.

5.3.2 Model parameterisation

TAPM

In East London, TAPM is set-up in a nested configuration of three domains centred on Port Rex Power Station. The outer domain is 420 km by 420 km with a 21 km grid resolution, the middle domain is 240 km by 240 km with a 12 km grid resolution and the inner domain is 60 km by 60 km with a 3 km grid resolution (Figure 8). One year (2012) of hourly observed meteorological data from the SAWS station at East London are input to TAPM to 'nudge' the modelled meteorology towards the observations. The nesting configuration ensures that topographical effects on meteorology are captured and that meteorology is well resolved and characterised across the boundaries of the inner domain. Twenty-seven vertical levels are modelled in each nest from 10 m to 5 000 m, with a finer resolution in the lowest 1 000 m. The vertical levels are 10, 25, 50, 75, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 3000, 3500, 4000, 4500 and 5000 m.

The 3-dimensional TAPM meteorological output on the inner grid 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. The spatially and temporally resolved TAPM surface and upper air meteorological data is used as input to CALPUFF's meteorological pre-processor, CALMET.

CALPUFF

The CALMET grid (light blue square in Figure 8), which is 900 km^2 is 30 km (west-east) by 30 km (north-south). It is a subdomain of the TAPM inner grid and is centred on Port Rex Power Station. It consists of a uniformly spaced receptor grid with 500 m spacing, giving 3 600 grid cells (60 X 60 grid cells). The CALPUFF modelling domain is the same as the CALMET modelling domain and is based on a similar grid structure.

The topographical and land use for the respective modelling domains is obtained from the dataset accompanying the CSIRO's The Air Pollution Model (TAPM) modelling package. This dataset includes global terrain elevation and land use classification data on a longitude/latitude grid at 30-second grid spacing from the US Geological Survey, Earth Resources Observation Systems (EROS) Data Centre Distributed Active Archive Centre (EDC DAAC).

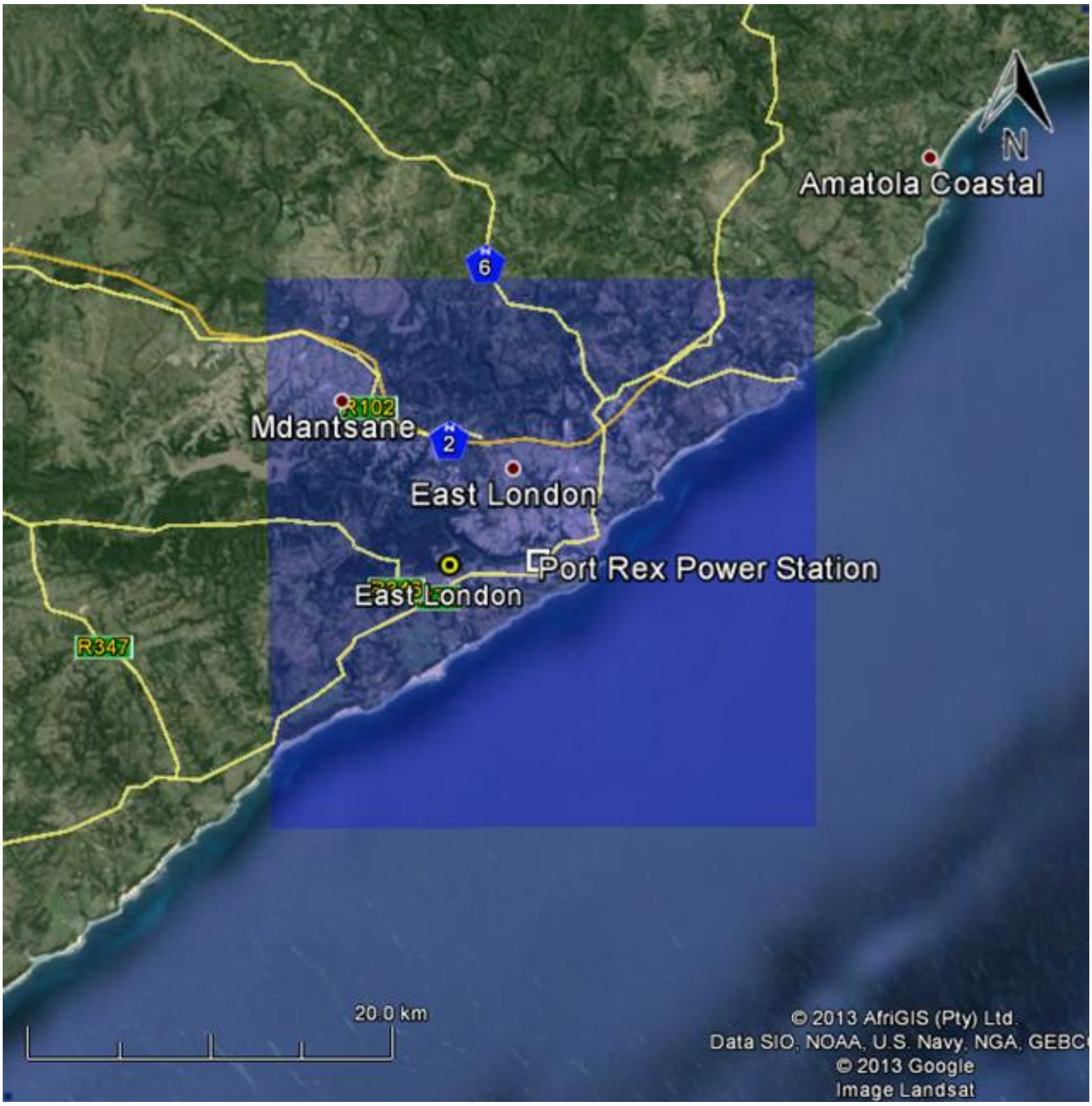


Figure 8: TAPM and CALPUFF modelling domains for Port Rex, showing the relative locations of the meteorological stations

The parameterisation of key variables that are applied in CALMET and CALPUFF are indicated in Table 11 and Table 12.

Table 11: 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 Convective: 0.15 Stable: 2400 Overwater, mechanical: 0.12
Minimum potential temperature lapse rate (K/m)	0.001
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)	Not used as continuous surface data field is applied
Conversion of NO_x to NO_2	75%

Table 12: Parameterisation of key variables for CALPUFF

Parameter	Model value
Chemical transformation	Default NO_2 conversion factor of 0.75 is applied (DEA, 2012c).
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	Dispersion coefficients use turbulence computed from micrometeorology
Terrain adjustment method	Partial plume path adjustment

5.3.3 Model accuracy

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

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

Models recommended in the DEA dispersion modelling guideline (DEA, 2012b) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). It is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

For Port Rex Power Station the reducible uncertainty in CALMET and CALPUFF is minimised by:

- Using representative quality controlled observed hourly meteorological data to nudge the meteorological processor to the actual values;
- Using 3-years of spatially and temporally continuous surface and upper air meteorological data field for the modelling domain;
- Appropriate parameterisation of both models (Tables 11 and 12);
- Using representative emission data;
- Applying representative background concentrations to include the contribution of other sources; and
- Using a competent modelling team with considerable experience using CALPUFF.

5.4 Modelled ambient concentrations

Emissions for two operational scenarios are calculated for Port Rex Power Station:

Scenario 1: Actual emissions for 2012. The units operate in batch mode in response to demand. Emissions were calculated from the total operational time of 9.7 hours and total fuel consumption of 817 kl in 2012. Average operational time in 2012 was 0.8 hours per month.

Scenario 2: Requested emission limits: NO_x emission limits that Eskom believes are achievable at Port Rex Power Station. All units are assumed to operate continuously over a full year so as to assess the worst-case ambient air quality situation that could occur under the requested emissions limits.

Emission concentrations and rates for NO_2, SO_2 and PM_{10} are listed in Table 13.

Table 13: Current actual emissions and Eskom's requested emission limits for Port Rex Power Station

Pollutant	Source	Scenario 1: Current actual emissions	Scenario 2: Requested emission limits
		Rate (g/s)	Concentration (mg/Nm^3)
NO_x	Stacks 1-6	42.85	750
SO_2	Stacks 1-6	28.42	500
PM_{10}	Stacks 1-6	0.58	50

Port Rex complies with the MES for existing and new plants (Table 4) for SO_2 and PM_{10} and as such these pollutants have not been assessed in the AIR.

5.4.1 Modelled operational scenarios

As Port Rex is a peaking station, it operates in batch mode (viz. only started and operated for short 'batch' periods). In 2012 it operated at an average of 0.8 hours per month and this operational scenario has then been modelled as Scenario 1. For the requested emission limits, the power station was assumed to operate continuously so as to model a worst-case scenario (Scenario 2). The DEA (2012) recommends that for short-term assessment, only the 99th percentile predicted concentrations be compared to the NAAQS. The use of the 99th percentile is because the highest predicted ground-level concentrations are typically outliers, generated by the model spuriously in response to the variability and complexity of meteorological processes. The predicted concentrations are presented as isopleth maps in the following sections. It should be noted though that the predicted concentrations under Scenario 1 are so low, that the maximum predicted values were used rather than the 99th percentile.

The predicted annual average and maximum 1-hour concentrations at the point of maximum ground-level impact are presented in Table 14, for the two scenarios.

Table 14: Predicted annual average and predicted maximum 1-hour concentration at the points of maximum ground-level impact for Actual Emissions and the predicted annual average and the 99th percentile concentration at the points of maximum ground-level impact for the Requested Limits Scenario.

	NO_2 (µg/m^3)		
	Scenario 1: Current Actual Emissions (based on maximum concentrations)	**Scenario 2: Requested Emission Limits (based on 99th percentile concentrations)**	**NAAQS Limit Values (µg/m^3)**
1-hour	46	211	200
Annual	0.009	21	40

5.5 Scenario 1: Current actual emissions

5.5.1 Nitrogen dioxide

For current emissions from Port Rex, the predicted annual average NO_2 concentration (which is 0.009 µg/m^3 at the point of highest impact in the domain) is significantly less than the NO_2 NAAQS of 40 µg/m^3 (Figure 9 and Table 14). At the point of maximum ground-level impact, the predicted maximum 1-hour NO_2 concentration is 46 µg/m^3, which is well below the NAAQS of 200 µg/m^3 (Figure 10 and Table 14).

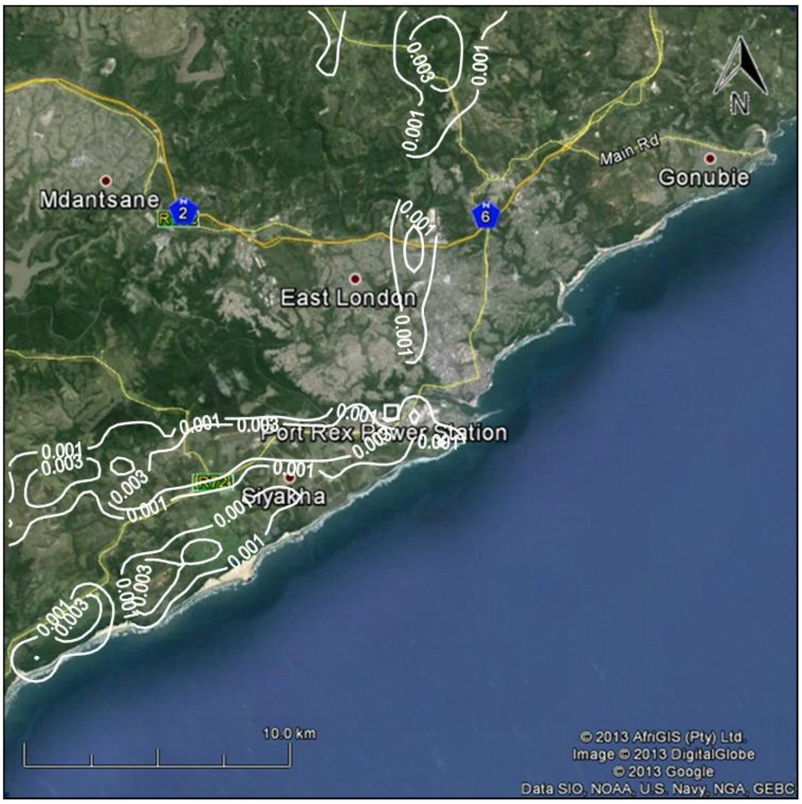


Figure 9: Annual average NO_2 concentrations (µg/m^3) resulting from current actual emissions for Port Rex Power Station

Figure 10: Maximum concentration of the predicted hourly NO_2 concentrations (µg/m^3) resulting from current actual emissions for Port Rex Power Station

5.6 Requested NO_x emission limit: Annual and 99th percentile concentrations

The predicted annual average NO_2 concentration does not exceed the NAAQS of 40 µg/m^3 for the requested emissions anywhere in the study domain (Figure 11 and Table 14). The 99th percentile of the predicted 1-hour NO_2 concentrations exceeds the limit value of the NAAQS of 200 µg/m^3) in a small area immediately at the power station (Figure 12 and Table 14).

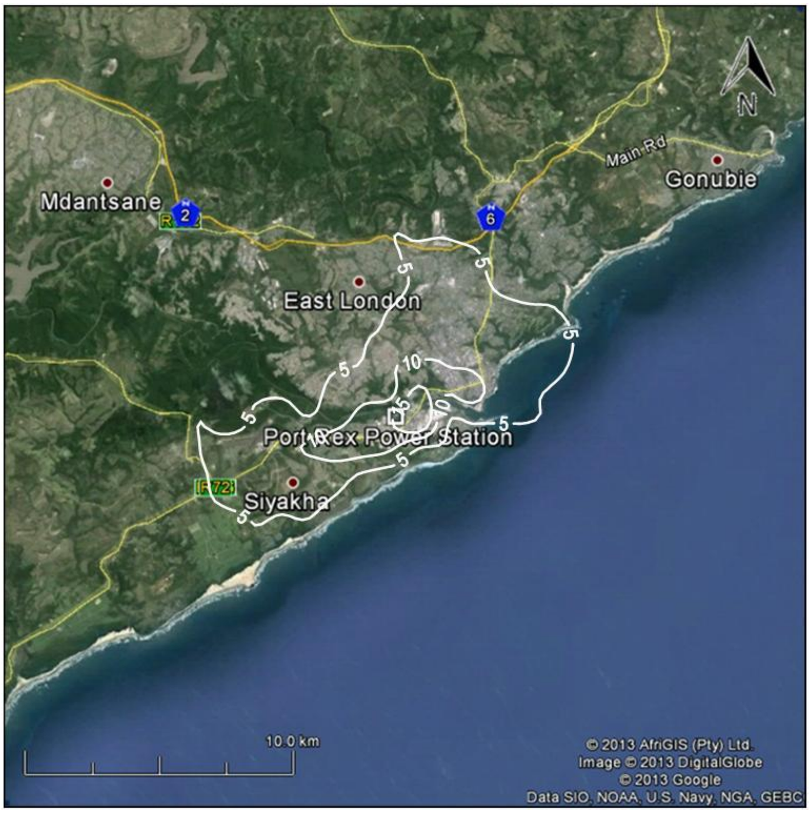


Figure 11: Annual average NO_2 concentrations (µg/m^3) resulting from the requested NO_x emission limit for Port Rex Power Station

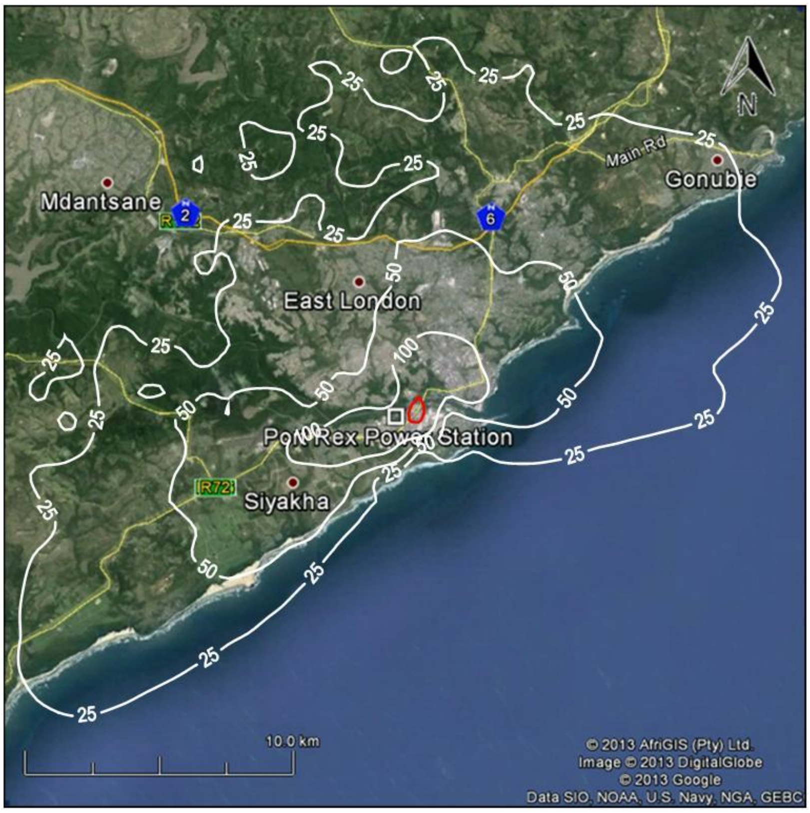


Figure 12: 99th percentile concentration (µg/m³) of the predicted hourly NO_2 concentrations resulting from requested NO_x emission limit for Port Rex Power Station. The red line is the limit value of the National Ambient Standard (200 µg/m³) inside of which exceedance are predicted.

5.7 Analysis of Emissions' Impact on Human Health

5.7.1 Potential health effects

As previously described, although atmospheric emissions from Port Rex include SO_2 and PM, the application for postponement of the MES at Port Rex is only for NO_X. As such only NO_2 is considered here in terms of its potential impact on human health and the environment.

Nitrogen dioxide (NO_2)

Exposure to NO_2 is typically 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 caused decrements in lung function, particularly increased airway resistance. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure (EAE, 2006).

5.7.2 Analysis

The potential impacts on human health have been assessed in this report only by comparing the measured and predicted ambient air quality with the published NAAQS. It can be seen from the measured ambient air quality measurements that NO_2 concentrations comply with the NAAQS for the various averaging periods. Ambient air quality concentrations predicted using a dispersion model are seen to comply with the NAAQS for NO_2 for current emissions, but to potentially not comply with the 1 hour NO_2 NAAQS for the requested emissions. Drawing conclusions about the potential human health effects of these concentrations is not straight forward but the following can be stated with a reasonable degree of confidence:

Nitrogen oxides

Both measured and predicted ambient NO_2 concentrations for current emissions from Port Rex are seen to be fully compliant with the NAAQS and so while it cannot be argued that there is no health risk, the health risk posed by NO_x emissions must be considered permissible. For the requested emissions limits, where a small area of potential non-compliance is predicted for 1-hour NO_2 concentrations, the concentrations are simply exaggerated. The load factor on Port Rex (number of hours operated) is simply too low to result in non-compliance. The NAAQS allows some 88 hourly exceedances of the limit value year per annum, but Port Rex has never yet operated for 88 hours in a year neither is it likely to do so. In addition, the predicted concentrations indicate that if the power station operates continuously for the entire year at the requested (maximum) emissions, then there will be more than 88 hours when the NAAQS limit value could be exceeded but for no more than 400 hours (out of 8 760 hours in a year). As a result, the predicted ambient concentrations for the requested emissions should not be interpreted to mean that every time Port Rex operates that the hourly NO_2 NAAQS limit value will be exceeded. The risk to human health posed by emissions from Port Rex is thus considered negligible and, as importantly, compliance with the MES will not make a material difference to that risk.

5.8 Analysis of Emissions' Impact on the Environment

In terms of impact on the environment, NO_2 does pose the risk of a variety of potential non-health impacts. Of these impacts dry and wet acid deposition is considered to be the most significant but there are also concerns around potential impacts on vegetation and fauna. The most challenging part of assessing such impacts is the absence of defined damage thresholds (i.e. defined concentrations at which damage is known to occur) especially in a regulatory sense. As a result the assumption that is made here is that if there is compliance with the NAAQS that the damage risk will be considered permissible. The NO_x emissions from Port Rex and the predicted ambient concentrations of NO_2 are so low that the risk of non-health related impacts on the environment is negligible.

6. Complaints

Acacia Power Stations does maintain a Complaints register. Any complaints that are received by the power station are recorded in this register. No complaints have been received and recorded.

7. Current or planned air quality management interventions

Not applicable.

8. Compliance and Enforcement History

No compliance and enforcement actions have been undertaken against Eskom's Port Rex Power Station within the last five years.

9. Additional Information

No additional information is necessary.

10. Summary and Conclusion

Eskom's liquid fuel-fired Port Rex Power Station in East London in the Eastern Cape Province is a peaking plant with a generation capacity of 171 MW. Power generation is a Listed Activity in terms of Section 21 of the NEM:AQA and as a result Port Rex is required to comply with the prescribed MES for existing plants by 2015 and for new plants by 2020. SO_2 and PM emissions from Port Rex already comply with the MES for both existing and new plants, but NO_x emissions will not comply with the new plant MES. Eskom has therefore applied for postponement of the new plant NO_x MES for Port Rex and proposed an alternative emissions limit. The purpose of this AIR has been to assess the likely implications of that postponement and the requested alternative emissions limit for human health and the environment.

An analysis of measured ambient NO_2 concentrations indicates full compliance with the NAAQS for both the hourly and the annual averaging periods. Predicted ambient NO_2 concentrations (using a dispersion model) were also seen to be compliant with the NO_2 NAAQS for current emissions, but potentially non-compliant for Eskom's requested emissions. The potential non-compliance derives from the fact that Port Rex was modelled as if it operated permanently, whereas in actual fact the station operates for less than 1% of the time. It is also clear from the modelling that the NAAQS hourly limit value is not exceeded every time Port Rex operates even under maximum emissions and, given that Port Rex operates for less than 60 hours a year and that the NAAQS allows 88 hourly exceedances of the limit value in a year, the risk of non-compliance with the NAAQS is very low indeed, and the associated risk to human health and the environment, negligible.

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12. Formal Declarations