AIR QUALITY IMPACT ASSESSMENT

PROPOSED HIGH-SPEED PROVING GROUND

Mercedes Benz SA Ltd

DECEMBER 2015

WSP | PARSONS BRINCKERHOFF

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Draft Report (version 1)

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ACRONYMS AND ABBREVIATIONS

APPA	Atmospheric Pollution Prevention Act
AQIA	Air Quality Impact Assessment
CO	Carbon monoxide
CO_2	Carbon dioxide
DPF	Diesel Particulate Filter
EIA	Environmental Impact Assessment
GNR	Government Notice Regulations
MBSA	Mercedes-Benz South Africa (Pty) Ltd
MM5	Fifth-Generation Penn State/NCAR Mesoscale Model
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
NPI	National Pollutant Inventory
P99	99^{th} percentile
PM	Particulate matter
PM_{10}	Particulate matter with a diameter less than 10 µm
$PM_{2.5}$	Particulate matter with a diameter less than 2.5 µm
SO_2	Sulphur dioxide
SANS	South African National Standards
S&EIR	Scoping and Environmental Impact Reporting
US EPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
VKT	Vehicles kilometres travelled
WHO	World Health Organisation

EXECUTIVE SUMMARY

Mercedes-Benz South Africa (Pty) Ltd (MBSA) proposes to develop a High-Speed Proving Ground for vehicle testing for the Mercedes-Benz Research and Development Team, in the Northern Cape Province of South Africa. WSP Environmental (Pty) Ltd has been appointed by MBSA to conduct the Scoping and Environmental Impact Reporting (S&EIR) process for the project. As part of this process an Air Quality Impact Assessment (AQIA) is not required, but at the Client's request, such a study has been included. This report details the findings of the air quality impact assessment.

This air quality impact assessment investigated emissions associated with the construction and operation of the Proposed High-Speed Proving Ground near Upington in the Northern Cape. The assessment consisted of the development of a comprehensive emissions inventory accounting for all construction and operational sources, as well as dispersion modelling to determine the dispersion of pollutants from the proposed site.

During the construction phase, particulate matter (PM_{10} and $PM_{2.5}$) concentrations at the three nearest farm house receptor locations are predicted to be low, with no exceedences of the relevant National Ambient Air Quality Standards predicted. Concentrations within the site boundary are predicted to exceed the relevant standards, with the highest concentrations predicted along the high-speed oval where cut-to-fill and general construction activities will occur.

During the operational phase, PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and VOC concentrations at the nearest farm house receptor locations are predicted to be low, with no exceedences of the relevant national ambient air quality standards predicted. Exceedences of PM_{10} concentrations are predicted along the off-site access road. Since this access road is unpaved, such concentrations can be attributed to the movement of vehicles along this road, to and from the site. The highest concentrations of SO_2, NO_x, CO and VOC are predicted along the high-speed oval, however, concentrations remain well below the relevant standards with no exceedences predicted. The test car tailpipes are the main source of such emissions.

The air quality impacts of the Proposed High-Speed Proving Ground were evaluated using a risk matrix which assessed the severity, extent, duration, probability and confidence of potentially significant impacts. Based on this rating system, it was calculated that the air quality impacts of the proposed project are expected to be "Low".

AIR QUALITY CONSULTANT

Kirsten Collett is an air quality specialist with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed by WSP and has worked on air quality impact assessments, monitoring and modelling for a variety clients over the past four years. She has provided consulting support to various client industries including mining, petrochemical, power generation, metallurgical and local government bodies.

DECLARATION OF INDEPENDENCE

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act 2006 EIA Regulations and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultants fees.

Name: Kirsten Collett

Company: WSP Environmental (Pty) Ltd

Signature: 

1 INTRODUCTION

Mercedes-Benz South Africa (Pty) Ltd (MBSA) proposes to develop a High-Speed Proving Ground for vehicle testing for the Mercedes-Benz Research and Development Team, in the Northern Cape Province of South Africa. WSP Environmental (Pty) Ltd has been appointed by MBSA to conduct the Scoping and Environmental Impact Reporting (S&EIR) process for the project. As part of this process an Air Quality Impact Assessment (AQIA) is not required, but at the Client's request, such a study has been included.

This report details the findings of the AQIA conducted by WSP. Included in this report is background to the project; a discussion on the associated atmospheric emissions and relevant air quality legislation; a description of the methodology utilised in the study; identification of sensitive receptors; dispersion modelling results; as well as an assessment of the related impacts.

1.1 SCOPE OF WORK

Below is a summary of the scope of work performed by WSP in fulfilment of the requirements of the air quality specialist study:

- Description of the receiving environment, specifically relating to sensitive receptors;
- Development of a comprehensive emissions inventory detailing all proposed emission sources at the facility during both the construction and operational phases;
- Evaluation of the proposed air quality impacts during the construction and operational phase, as well as the atmospheric dispersion potential of pollutants using the AERMOD dispersion modelling software;
- An assessment of the air quality impacts of the construction and operation of the proposed project on the surrounding receptors; and
- Compilation of an AQIA report, inclusive of all information listed above.

1.2 RATIONALE FOR THE STUDY

An AQIA for the Proposed High-Speed Proving Ground is not required in terms of the S&EIR process. However, based on previous experience with High-Speed Proving Grounds in other parts of the world, the Client has requested this air quality study be included in the larger assessment.

2 PROJECT BACKGROUND

2.1 LOCALITY AND STUDY AREA

The Proposed High-Speed Proving Ground is located on property Steenkamps Pan, Farm 419/06 in the //Khara Hais Local Municipality, which falls within the ZF Mgcawu District Municipality, approximately 38 km northeast of Upington in the Northern Cape Province (**Figure 1**). The surrounding land use is limited to extensive and low-intensity livestock grazing with scattered agricultural smallholdings.

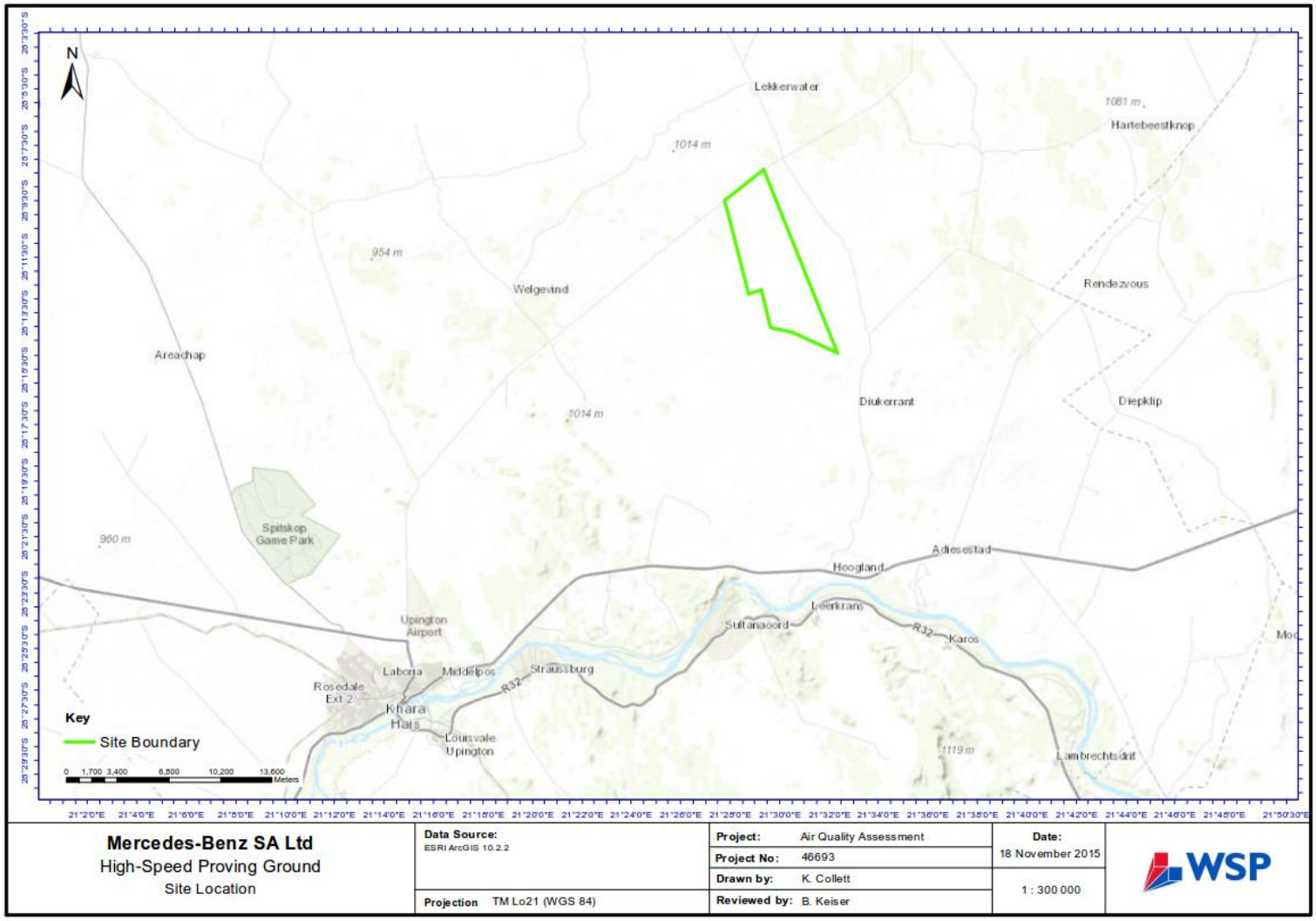

Figure 1: Location of the Proposed High-Speed Proving Ground in the Northern Cape Province

2.2 PROJECT DESCRIPTION

CONSTRUCTION PHASE

The construction phase of the Proposed High-Speed Proving Ground will take place over a two year period, with construction occurring in two phases. Phase one will include construction of the oval, lay-bys, bridge, slope hill, access roads (outside the oval) and buildings and is envisaged to have a duration of fourteen months. Phase two will commence after phase 1 and is anticipated to last eight months. This phase will include the construction of the handling track, multi-functional area, bad roads and access roads inside the oval.

A third "mining" phase may be introduced in order to abstract the material required for the construction and development of the High-Speed Proving Ground by means of one borrow pit (calcrete) and one quarry (granite) located within the boundary of Steenkamps Pan, Farm 419/06. Granite material may be mined from the quarry located west of the proving ground, while calcrete material may be mined from the borrow pit located southeast of the proving ground (**Figure 2**).

The construction phases (mining included) will be operational from 07:00 – 17:00 (Monday to Friday) and 07:00 – 14:00 (Saturdays).

OPERATIONAL PHASE

The operation of the Proposed High-Speed Proving Ground and associated infrastructure will enable Mercedes Benz to undertake testing of vehicles under hot climate conditions in parallel to the European winter season under specified technical conditions in terms of testing modules.

The test modules that will be designed and operated at the site include:

- High-Speed Oval – A 17 km long loop for performing acceleration tests (50 – 250 km/h);
- Handling Track – A 5.8 km long module designed for testing the handling characteristics of the test vehicles (50 – 230 km/h);
- Multi-Functional Area – A 0.8 km long module for testing the steering characteristics of the test vehicles (up to 120 km/h);
- DPF Road – A 0.8 km long module for testing the diesel particle filter applications of the test vehicles (10 – 30 km/h);
- Bad Roads – A 10 km long off-road module designed to conduct comfort and corrosion testing (40 – 80 km/h); and
- Access Roads (outside oval) – A 2.5 km test module designed for performing acceleration tests (0 – 100 km/h).

The test modules will be operational from 08:00 – 20:00 (Monday to Saturday) for six months of the year (October to April). The six month period will coincide with the European winter season testing. Ad hoc testing may be conducted at the site during the remainder of the year.

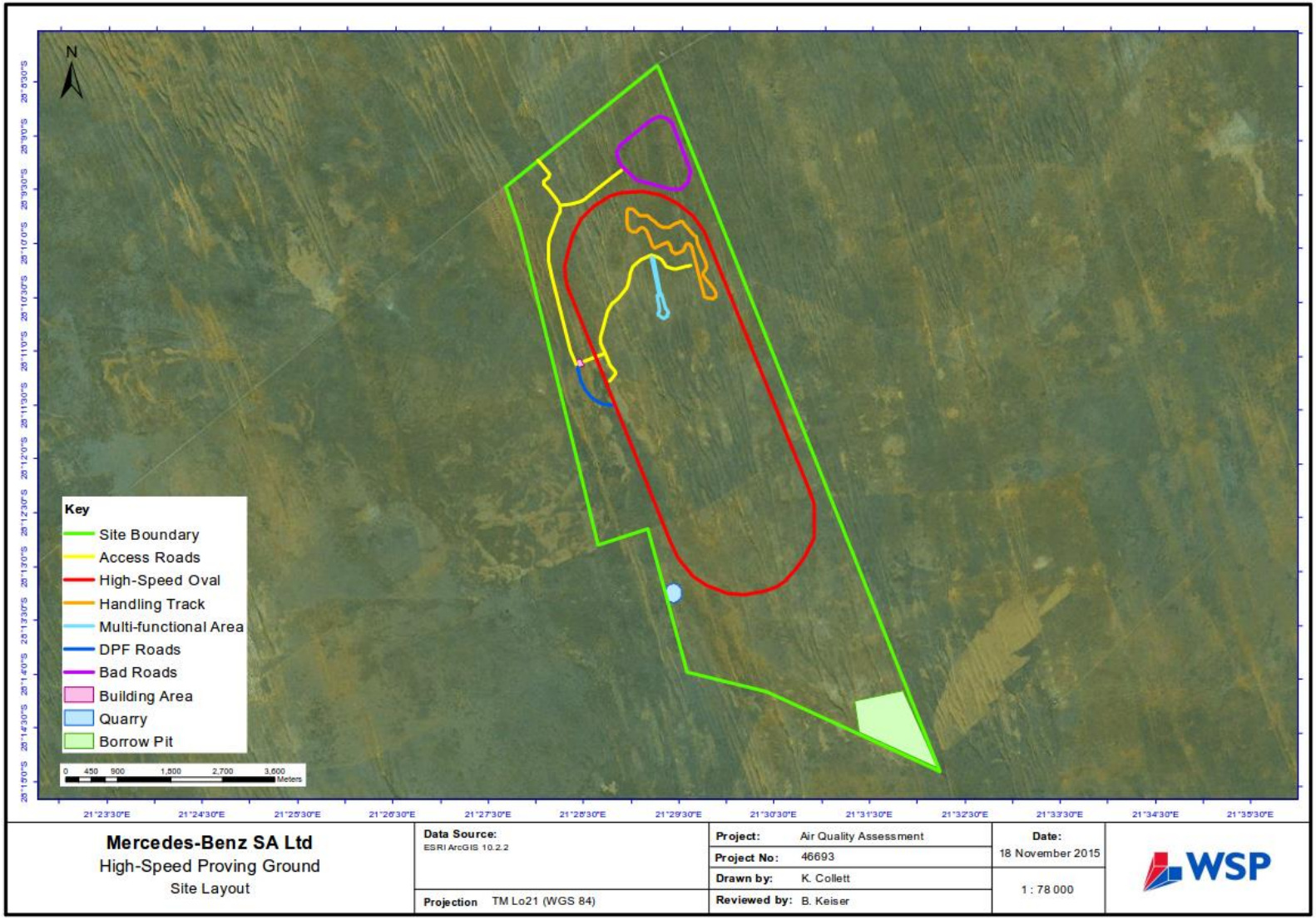

Figure 2: Site layout of the Proposed High-Speed Proving Ground

3 ATMOSPHERIC EMISSIONS AND IMPACTS

The pollutant of concern during the construction phase is dust in the form of particulate matter (PM). Activities during the construction phase that will contribute to the production of airborne particulates include:

- Blasting;
- Handling of materials (truck loading and unloading);
- Crushing;
- Vehicle movement on site; and
- General construction activities.

During the operational phase, the operation of test vehicles, trucks and other vehicles on site will be the main contributors to pollutant emissions at the site. Atmospheric pollutants emitted from vehicles include hydrocarbons, carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NO_x), sulphur dioxide (SO_2) and particulates. These pollutants are emitted from the vehicle tailpipe; engine and fuel supply system; and from brake linings, clutch plates and tyres. Hydrocarbon emissions, such as benzene, result from the incomplete combustion of fuel molecules in the engine. Carbon monoxide is a product of incomplete combustion and occurs when carbon in the fuel is only partially oxidized to carbon dioxide. Nitrogen oxides are formed by the reaction of nitrogen and oxygen under high pressure and temperature conditions in the engine. SO_2 is emitted due to the high sulphur content of the fuel. Particles such as lead originate from the combustion process, as well as from brake and clutch lining wear (Samaras and Sorensen, 1999).

Vehicle tailpipe emissions in the form of SO_2, NO_x, PM, CO and volatile organic compounds (VOCs) are assessed in this study as these are the pollutants for which South African legislated standards exist. Wheel-generated emissions of PM from the main access road (DR 3322) leading from Upington are also assessed, as this is a gravel road which has a large dust-generating potential, especially related to heavy duty truck operations.

3.1 HEALTH AND ENVIRONMENTAL IMPACTS

PARTICULATE MATTER (PM)

Particulate matter (PM) refers to solid or liquid particles suspended in the air. PM varies in size from particles that are only visible under an electron microscope to soot or smoke particles that are visible to the human eye. PM contributes greatly to deteriorations in visibility, as well as posing major health risks, as small particles (PM_{10}) can penetrate deep into lungs, while even smaller particle sizes ($PM_{2.5}$) can enter the bloodstream via capillaries in the lungs, with the potential to be laid down as plaques in the cardiovascular system or brain. Health effects include: respiratory problems, lung tissue damage, cardiovascular problems, cancer and premature death. Acidic particles may damage buildings, vegetation and acidify water sources (US EPA, 2011).

SULPHUR DIOXIDE

SO_2 is produced via the combustion of sulphur rich fuel. SO_2 is a major respiratory irritant, resulting in respiratory illnesses, alterations in pulmonary defences and aggravation of existing cardiovascular disease. SO_2 may also create sulphuric acid as a result of its water solubility,

producing acid rain. Once emitted, SO_2 may oxidize in the atmosphere to produce sulphate aerosols, which are harmful to human health, limit visibility and in the long term have an effect on global climate (Seinfeld and Pandis, 1998; Fenger, 2002; US EPA, 2011).

NITROGEN OXIDES

Under high temperature conditions nitrogen and oxygen atoms in the air react to form nitric oxide (NO). NO is a colourless gas that is non-toxic, but is transformed into NO_2 when it is oxidised in the atmosphere. Elevated NO_2 concentrations may lead to asthma, emphysema, bronchitis, damage to lung tissue and even premature death. NO_x may lead to biological imbalances and mutations in vegetation, limits visibility and contributes to the formation of acid rain via the production of nitric acid (HNO_3). Further oxidation of NO_2 may lead to the formation of nitrate aerosols, which further limit visibility and affect the natural environment. Most importantly, however, NO_x contributes to the formation of tropospheric O_3, an important atmospheric oxidant, a major air pollutant and a key greenhouse gas (Seinfeld and Pandis, 1998; Fenger, 2002; US EPA, 2011).

CARBON MONOXIDE

CO is a product of incomplete combustion of carbon in fuels and is a colourless, odourless, and toxic gas at high concentrations. When CO enters the bloodstream, it reduces the flow of oxygen to various organs and tissue, and is particularly dangerous to individuals who suffer from cardiovascular disease. Really high concentrations of CO may affect healthy individuals through impaired vision and a reduction in brain activity. These concentrations tend only to be reached in indoor environments (Fenger, 2002; US EPA, 2011).

VOLATILE ORGANIC COMPOUNDS

Volatile organic compounds (VOCs) are organic compounds that easily vaporize from the solid or liquid phase into a gas. VOCs are released during fuel combustion (wood, coal, petrol or natural gas) and are released from solvents, paints, glues and other chemicals. They consist of a variety of chemicals that have both long term and short term health effects. Many VOCs are hazardous air pollutants with their particular impacts determined by each compound's unique chemistry. Impacts from exposure to VOCs include eye, nose and throat irritation; headaches; nausea; dizziness; fatigue; skin allergies; damage to kidneys, liver and the nervous system; loss of coordination; and some VOCs are suspected to cause cancer. When combined with nitrogen oxides, VOCs react to form ground level ozone, which is a component of photochemical smog and can contributes to climate change (Seinfeld and Pandis, 1998; Colls, 2002; US EPA, 2011).

BENZENE

Benzene in its purest form is a colourless liquid with an aromatic odour. Crude oil is the largest natural source of benzene, with benzene being used in many products, including plastics, synthetic rubber, glues, paints, furniture wax, lubricants, dyes, detergents, pesticides and some pharmaceuticals (Government of South Australia, 2008). Inhaling very large amounts of benzene over a short period (5 – 10 min) can result in death. Exposure to lower concentrations can result in drowsiness, dizziness, headaches, tremors, confusion and unconsciousness. Long-term exposure can result in harmful effects of the tissues that form blood cells, especially bone marrow. Benzene has been identified as a human carcinogen (Government of South Australia, 2008).

4 AIR QUALITY LEGISLATION

The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA), which repeals the Atmospheric Pollution Prevention Act (APPA) of 1965, came into effect on 11 September 2005, with the promulgation of regulations in terms of certain sections resulting in the APPA being repealed entirely on 1 April 2010. Key features of the current legislation include:

- A decentralisation of air quality management responsibilities;
- The identification and quantification of significant emission sources that then need to be addressed;
- The development of ambient air quality targets as goals for driving emission reductions;
- The use of source-based (command-and-control) measures in addition to alternative measures, including market incentives and disincentives, voluntary programmes, and education and awareness;
- The promotion of cost-optimized mitigation and management measures;
- Stipulation of air quality management planning by authorities, and emission reduction and management planning by sources; and
- Access to information and public consultation.

The NEMAQA introduced a management system based on ambient air quality standards and corresponding emission limits to achieve them. Two significant regulations stemming from the NEMAQA have since been promulgates, namely:

- GNR 1210 on 24 December 2009 (Government Gazette 32816) National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) National Ambient Air Quality Standards; and
- GNR 248 on 31 June 2010 (Government Gazette 33064) National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) List of Activities Which Result in Atmospheric Emissions Which Have or May Have a Significant Detrimental Effect on the Environment, Including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage.

The new National ambient standards for air quality were based primarily on guidance offered by two standards set by the South African National Standards (SANS), namely:

- SANS 69:2004 Framework for implementing National ambient air quality standards; and
- SANS 1929:2005 Ambient air quality – Limits for common pollutants.

SANS 69:2004 makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values.

SANS1929:2005 uses the provisions in SANS 69 to establish air quality objectives for the protection of human health and the environment, and stipulates that limit values are initially set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve acceptable air quality nationally. The limit values presented in this standard are to be used in air quality management but have only become enforceable as revised under GNR 1210 since 24 December 2009. National ambient air quality standards for criteria pollutants generally have specific averaging periods; compliance timeframes, permissible frequencies of exceedence and reference methods.

4.1 AMBIENT AIR QUALITY STANDARDS

Ambient air quality standards and guidelines are specified in the NEMAQA, SANS 69:2004 as well as SANS 1929:2005.The priority pollutants as defined by the Act are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), ozone (O_3), benzene (C_6H_6), lead (Pb) and carbon monoxide (CO). The legislated standards for ambient air quality as it relates to the proposed High-Speed Proving Ground are presented in **Table 1.**

Table 1: National Ambient Air Quality Standards Applicable to this assessment

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)	Frequency of Exceedence	Compliance Date
Particulate Matter (PM_{10})	24 hours	120	4	Immediate – 31 Dec 2014
		75	4	01 Jan 2015
	1 year	50	0	Immediate – 31 Dec 2014
		40	0	01 Jan 2015
Particulate Matter ($PM_{2.5}$)	24 hours	65	4	Immediate – 31 Dec 2015
		40	4	01 Jan 2016 – 31 Dec 2029
		25	4	01 Jan 2030
	1 year	25	0	Immediate – 31 Dec 2015
		20	0	01 Jan 2016 – 31 Dec 2029
		15	0	01 Jan 2030
Benzene (C_6H_6)	1 year	10	0	Immediate – 31 Dec 2014
		5	0	01 Jan 2015
Sulphur Dioxide (SO_2)	10 minutes	500	526	Immediate
	1 hour	350	88	Immediate
	24 hours	125	4	Immediate
	1 year	50	0	Immediate
Nitrogen Dioxide (NO_2)	1 hour	200	88	Immediate
	1 year	40	0	Immediate
Carbon Monoxide (CO)	1 hour	30000	88	Immediate
	8 hour	10000	11	Immediate

5 AMBIENT CONDITIONS

5.1 REGIONAL AIR QUALITY

Regional air quality in the Upington area is generally good due to the limited number of air pollution sources. Potential air pollution sources within the ZF Mgcawu District Municipality, surrounding the Proposed High-Speed Proving Ground include agricultural activities, motor vehicles, small scale industries within the town of Upington and wind-blown dust from natural areas.

Due to the remote location of the proposed High-Speed Proving Ground, there are no ambient air quality monitoring stations within the vicinity and as such, baseline air quality data is not presented here and is not included in the dispersion model.

5.2 CLIMATE AND LOCAL METEOROLOGY

The ZF Mgcawu District Municipality as a whole has an arid climate that receives predominantly summer rainfall, although rainfall events are quite erratic and cannot be relied on for agricultural purposes. Temperatures in the region fluctuate seasonally with summer temperatures ranging from 20 °C to above 35°C, while winter temperatures can range between 4 and 21°C.

Atmospheric transport within the area occurs both vertically and horizontally. Vertical transport is primarily due to deep convection. This convection transports air and any air pollutants contained therein from the surface into the upper atmosphere. Vertical motion is eventually inhibited due to the absolutely stable layers found preferentially at ~700 hPa, ~500 hPa and ~300 hPa on no-rain days. These stable layers trap pollutants at lower atmospheric levels and so influence the transport of pollutants over the whole of southern Africa (Cosijn and Tyson, 1996; Garstang et al., 1996).

On a more local scale, like that of the Upington area and surroundings, vertical motion and hence dispersion of pollutants is inhibited by surface inversions that form during the night. These inversions are a result of radiational cooling at the surface and are most pronounced just before sunrise. In the presence of sunlight the inversions begin to break down through convective heating and the height of the mixed layer is increased (Cosijn and Tyson, 1996; Tyson and Preston-Whyte, 2000).

In terms of horizontal transport, local winds may transport pollutants within the vicinity of their source. These include: anabatic and katabatic winds, valley and mountain winds, and mountain-plain and plain-mountain winds (Tyson and Preston-Whyte, 2000). On a larger scale, various synoptic systems affect atmospheric circulation over the ZF Mgcawu District Municipality, as well as circulation over the whole of southern Africa. These systems include: continental highs, ridging highs, westerly lows, westerly waves and easterly waves, which transport air and any pollutants contained within over larger distances (Garstang et al., 1996; Tyson et al., 1996).

In the Upington region, transport associated with continental highs occurs all year round, but with greater frequency during winter. Easterly waves show an annual cycle, peaking in summer, with extremely seldom occurrences in winter. Transport associated with ridging highs and westerly waves dominates during winter (Garstang et al., 1996; Tyson and Preston-Whyte, 2000).

Recirculation is also important in the transport of pollutants and occurs frequently over southern Africa due to the high frequency of anticyclonic circulations (Garstang et al., 1996; Freiman and Piketh, 2003). Recirculation occurs when air is transported away from its source and returns in the opposite direction after rotating cyclonically or anticyclonically. Recirculation can occur at a number of scales from sub-continental to regional, and an interaction between different scales of

wind systems results in further recirculation (Tyson et al., 1996; Tyson and Preston-Whyte, 2000; Freiman and Piketh, 2003).

LOCAL WIND FIELD

Meteorological data was sourced from the nearest, most reliable meteorological station in the region, namely the South African Weather Service's (SAWS) Upington Weather Office (Station Code: 0317475A8). The station is located at the Upington Airport, ~28 km southwest of the Proposed High-Speed Proving Ground and is positioned at a similar altitude, thus providing a good comparative dataset for the proposed project.

Wind roses are a useful tool in illustrating prevailing meteorological conditions for an area, indicating wind speeds and frequency of distribution. In the following wind roses, the colour of the bar indicates the wind speed whilst the length of the bar represents the frequency of winds *blowing from* a certain direction (as a percentage).

In the Upington area, winds originate predominantly from the north (14.5% of the time), south-southwest (12.2% of the time) and southwest (11% of the time). Wind speeds are strongest from the north with wind speeds greater than 8 m/s occurring for 2% of the time from this direction. Calm conditions (wind speeds < 1 m/s) are experienced for 5.6% of the time.

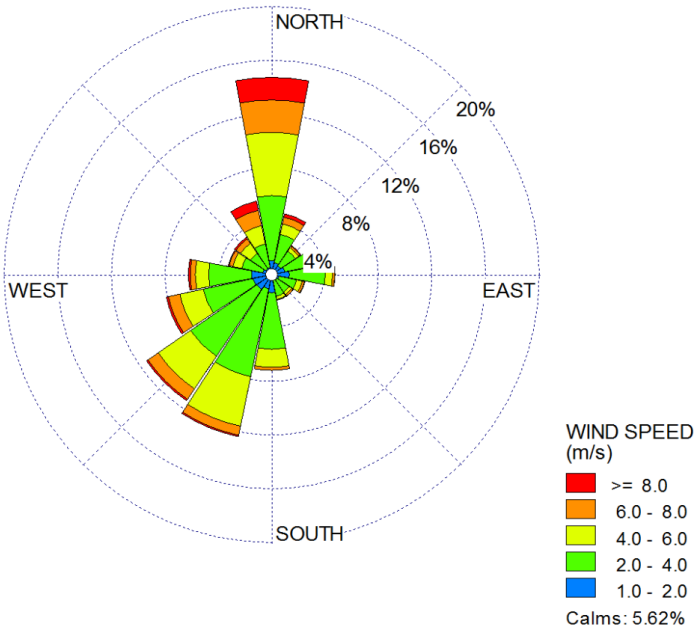

Figure 3: Surface wind rose plot for the Upington area for the 2012 to 2014 period

Seasonal variations in the wind field in the Upington area are depicted in **Figure 4**. During summer (December to February) winds originate predominantly from the south-southwest and southwest, with the strongest winds (> 8 m/s) experienced from a northerly direction. During autumn (March to May) and winter (June to August), there is a definite shift in wind direction. The south-westerly wind component diminishes and a definite strengthening in the northerly wind component is evident. The strongest winds (> 8 m/s) occur from this direction. During spring (September to November) the northerly wind component diminishes and winds originate predominantly from the south-westerly sector. The strongest winds, however, still originate from the north.

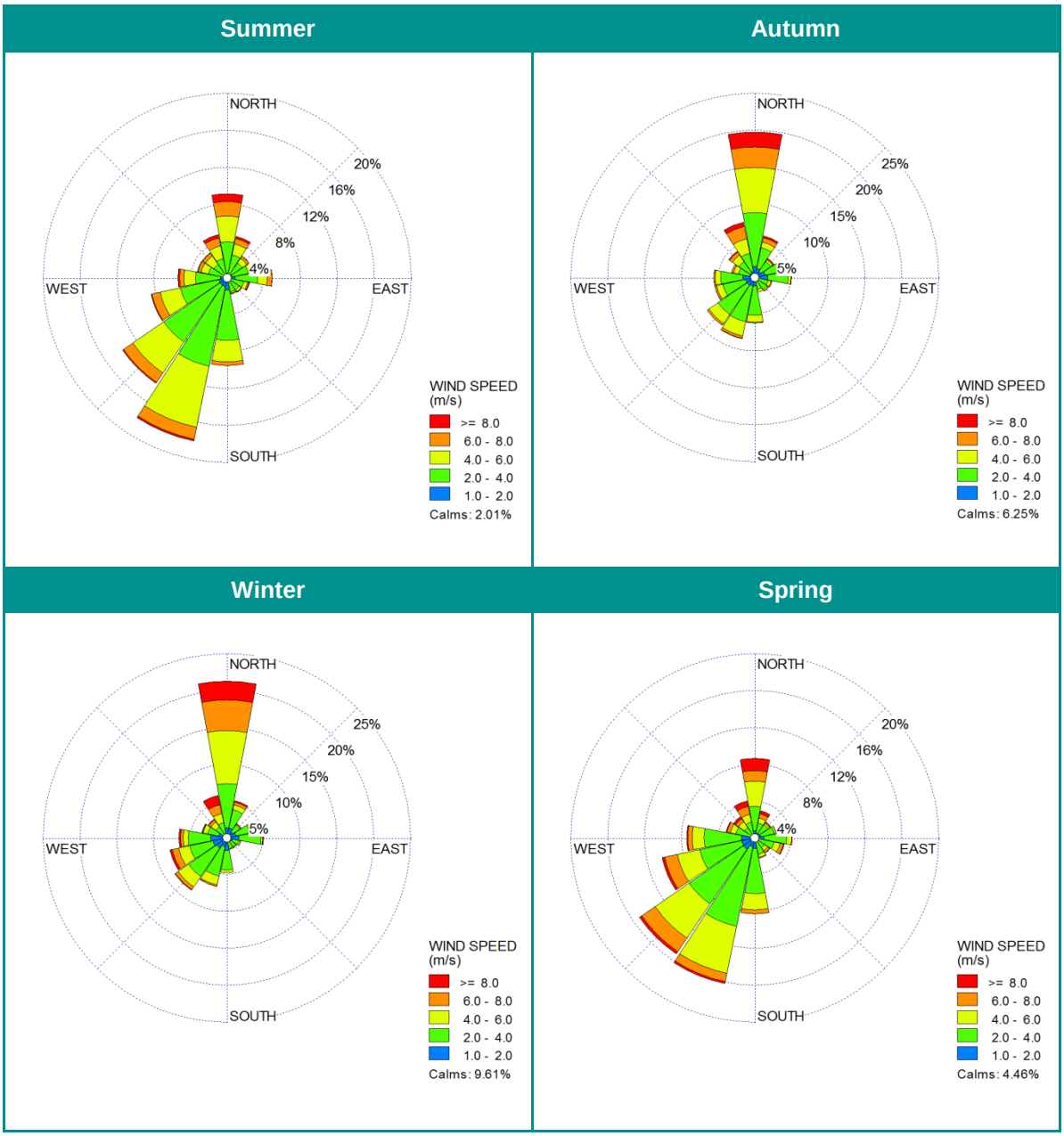

Figure 4: Average seasonal wind rose plots for the Upington area for the 2012 to 2014 period

Diurnal variations in the wind field in the Upington area are depicted in **Figure 5**. In the early morning and evening hours wind speeds are light to moderate with winds originating predominantly from the south-westerly and northerly sectors. After sunrise, when convective mixing is initiated, wind speeds strengthen, particularly from the north. During the afternoon, winds are at their strongest with winds originating from the northerly, westerly and southerly sectors.

The dispersion of emissions will be lower during the early morning hours as a result of calmer wind speeds. During winter the concentrations of pollutants experienced at the surface at this time, may also be augmented by the formation of surface inversions which trap pollutants and prevent them from being dispersed into the atmosphere. After sunrise, convective mixing is initiated and any pollutants that are trapped at ground level are dispersed into the atmosphere.

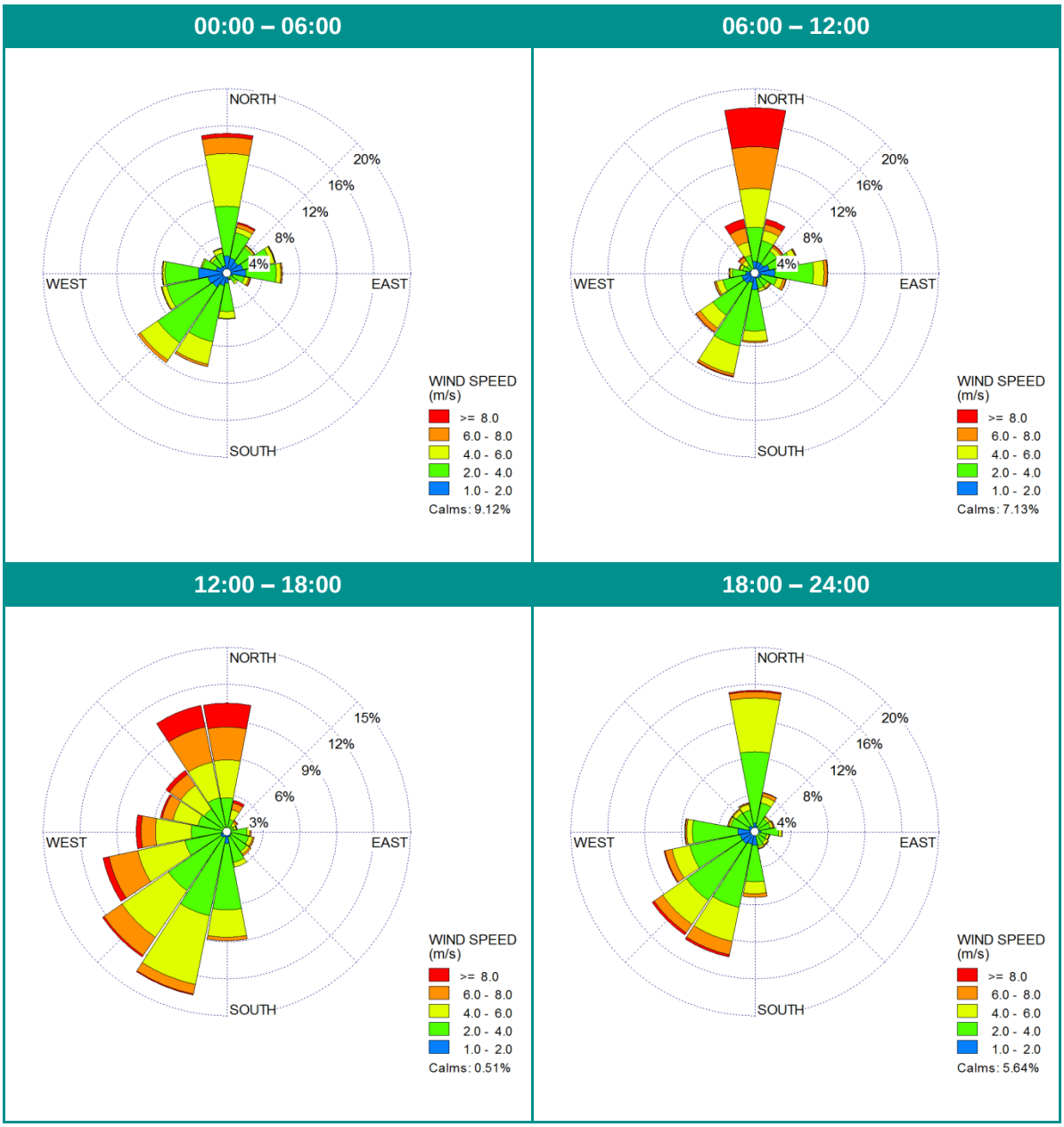

Figure 5: Diurnal wind rose plots for the Upington area for the 2012 to 2014 period

TEMPERATURE AND RAINFALL

Figure 6 represents the average temperatures for the Upington area, calculated from the hourly average temperature data from the SAWS Upington station for 2012 to 2014. Maximum temperatures occur during January (~30°C) whilst minimum temperatures are experienced during July (~-10°C). Average temperatures range quite considerably between the summer and winter months, with an average summer temperature of about 25°C and an average winter temperature of about 12°C.

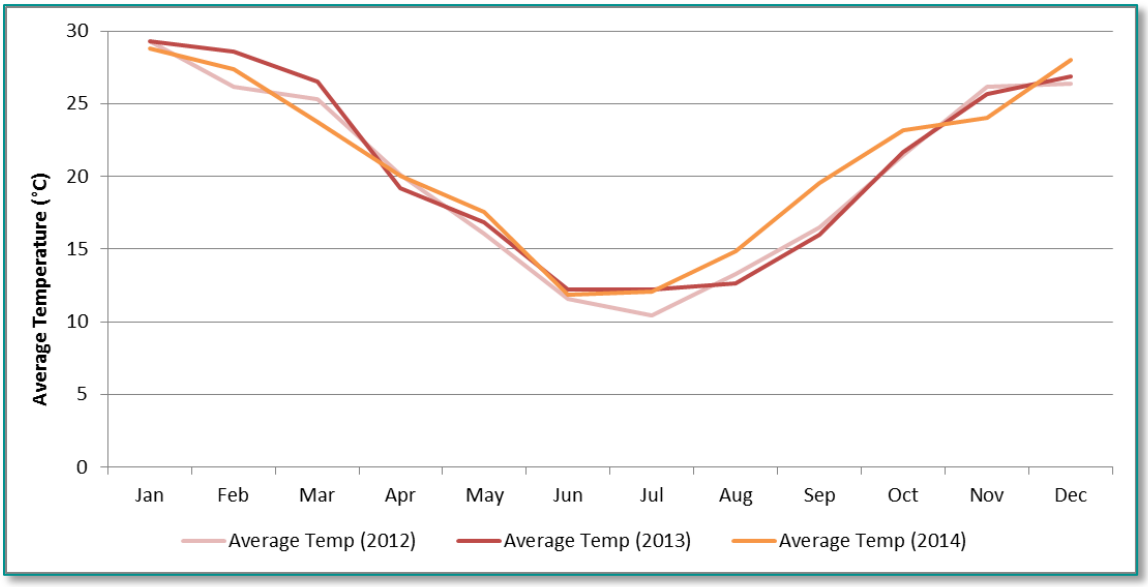

Figure 6: Average temperatures for the Upington area for the 2012 to 2014 period

Monthly average rainfall figures for the Upington area for 2012 to 2014 are plotted in **Figure 7**, together with the monthly average humidity. The highest rainfall is experienced during the summer and autumn months. The lowest rainfall occurs during late winter and early spring (July to September). Rainfall has the potential to remove pollutants from the air, especially particulates, thereby improving the air quality situation in high rainfall areas. During the summer months, air quality in the area may improve slightly due to the rainfall experienced at this time. Drier conditions coupled with other combustion sources in the area, may augment the concentration of ambient pollutants during winter and early spring.

Relative humidity in the region is generally low, with values ranging from 25% to 50%.

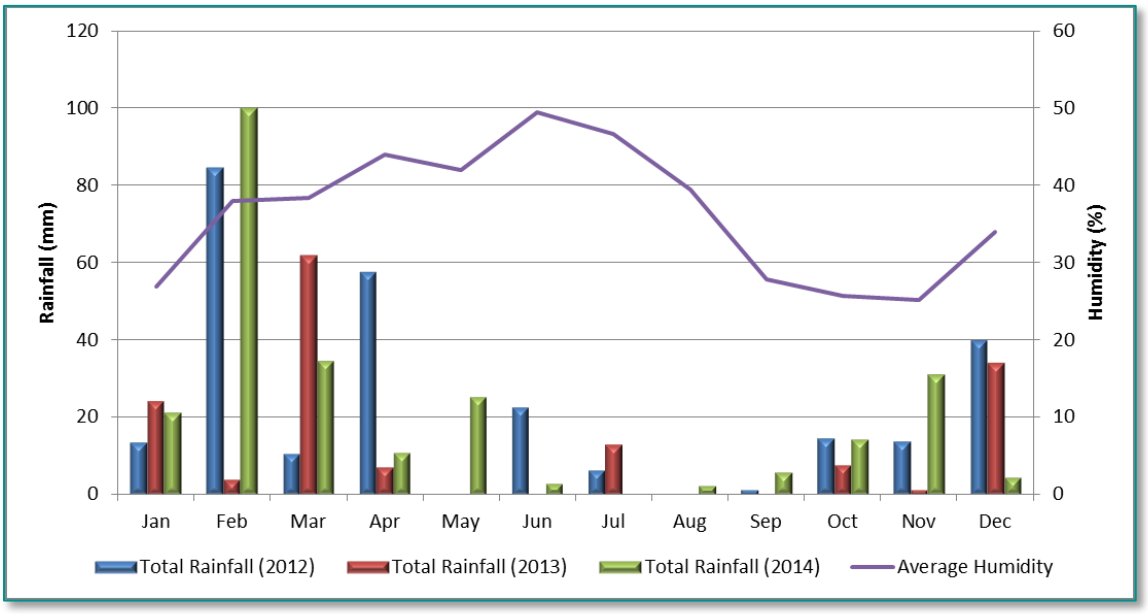

Figure 7: Total average monthly rainfall and average humidity for the Upington area for the 2012 to 2014 period

6 STUDY METHODOLOGY

6.1 EMISSION ESTIMATION

Emissions from the Proposed High-Speed Proving Ground were calculated using the United States Environmental Protection Agency's (US EPA) AP42 and Australian National Pollutant Inventory (NPI) emission factors. An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. The AP42 emission factors have been compiled since 1972 and contain emission factors and process information for over 200 air pollution source categories. These emission factors have been developed based on test data, material mass balance studies and engineering estimates.

CONSTRUCTION PHASE

GENERAL CONSTRUCTION

Total suspended particulate (TSP) emissions generated as a result of general construction activities, which includes land clearing, ground excavation, drilling, blasting, earth moving and construction itself, were calculated using the following equation:

$$E_{TSP} = 2.69\ tons/\text{ha/month of activity} \qquad (1)$$

The emission factor relates the tons of TSP emitted per hectare covered by construction activities per month of activity. Calculations were based on the statistics presented in **Table 2**. Based on the US EPA particle size distribution data, PM_{10} and $PM_{2.5}$ constitute 50% and 15% of TSP respectively.

Table 2: General construction statistics for the Proposed High-Speed Proving Ground

Location	Operational Times	Calculated PM_{10} emission rate ($g/m^2/s$)	Calculated $PM_{2.5}$ emission rate ($g/m^2/s$)
High-Speed Oval, Building Area, Access Roads (Outer) and Slope Hill	07:00 – 17:00	1.25E-04	3.74E-05

WIND EROSION

Particulate emissions from the wind erosion of exposed areas were calculated using the following equation:

$$E_{TSP} = 0.85\ \frac{Mg}{(ha)(yr)} \qquad (2)$$

The equation relates the amount of particulate matter (in Mg) emitted per hectare of exposed ground per year. The calculated emission rate was applied to the area of the active pits at the quarry and borrow pit, as well as to any stockpiles at these locations. In accordance with the US EPA particle size distribution data, PM_{10} was calculated as 50% of TSP and $PM_{2.5}$ was calculated as 10% of PM_{10}.Calculated emission rates are presented in **Table 3**.

Table 3: Wind erosion emission rates for the Proposed High-Speed Proving Ground

Location	Calculated PM_{10} emission rate ($g/m^2/s$)	Calculated $PM_{2.5}$ emission rate ($g/m^2/s$)
Borrow Pit and Quarry	1.35E-06	1.35E-07

CRUSHING

To determine the particulate emissions from the crushing of granite and calcrete material at the quarry and borrow pit respectively, the US EPA AP42 emission factors for crushed stone processing were utilised. Emissions were based on primary crushing. The following equations were used to calculate TSP and PM_{10} emissions from such activities:

$$E = 0.0027\ kg/ton \quad \text{(for TSP)} \quad (3)$$

$$E = 0.0012\ kg/ton \quad \text{(for } PM_{10}\text{)} \quad (4)$$

The resultant emission rates are based on the amount of particulates emitted (in kg) per ton of ore that is crushed. $PM_{2.5}$ emission rates were calculated by applying a factor of 15% to the TSP emission rates. The statistics used to calculate emissions from the Proposed High-Speed Proving Ground are presented in **Table 4**.

Table 4: Crushing statistics for the construction phase of the Proposed High-Speed Proving Ground

Location	m³ crushed per month	Material density (kg/m³)	Tons crushed per month	Calculated PM_{10} emission rate (g/s)	Calculated $PM_{2.5}$ emission rate (g/s)
Borrow Pit	5,400	1,442	7,787	8.65E-03	2.92E-03
Quarry	9,600	2,800	26,880	2.92E-03	1.01E-02

BLASTING

The emission factor utilised to estimate TSP emissions from blasting activities during the construction of the Proposed High-Speed Proving Ground, is presented below:

$$E = 0.00022(A)^{1.5}\ kg/blast \quad (5)$$

Where A represents the horizontal area (m^2) to be blasted (with a blasting depth of ≤ 21 m)

The emission factor relates the amount of particulate matter emitted (in kg) to the surface area that is blasted. The calculations were based on the blasting statistics presented in **Table 5**.

Table 5: Blasting statistics for the Proposed High-Speed Proving Ground

Location	Length of operation (months)	No. of blasts per month	Area (ha)	Calculated PM_{10} emission rate (g/s)	Calculated $PM_{2.5}$ emission rate (g/s)
Borrow Pit	6	4	15.25	25.23	1.46
Quarry	12	4	3.16	2.38	0.14

TRUCK LOADING

Particulate emissions generated from the loading of material onto trucks were estimated using the equations below:

$$E = 0.025\ kg/ton \quad \text{(for TSP)} \quad (6)$$

$$E = 0.012\ kg/ton \quad \text{(for } PM_{10}\text{)} \quad (7)$$

The emission factors relate the amount of particulate matter emitted (in kg) to the amount of material loaded during a specified timeframe. In accordance with the US EPA particle size distribution data, $PM_{2.5}$ emission rates were calculated by applying a factor of 10.5% to the TSP emission rate. The calculations were based on the statistics presented in **Table 6**.

Table 6: Truck loading statistics for the construction phase of the Proposed High-Speed Proving Ground

Location	Length of operation (months)	Tons loaded per month	Calculated PM_{10} emission rate (g/s)	Calculated $PM_{2.5}$ emission rate (g/s)
Borrow Pit	6	7,787	8.65E-02	1.89E-02
Quarry	12	26,880	2.99E-01	6.53E-02

OPERATIONAL PHASE

VEHICLES ON UNPAVED ROADS

Particulate emission estimates from vehicles travelling on the DR 3322 gravel road from Upington to the proposed site are presented here. The equation used to determine particulate emissions from vehicles travelling on unpaved roads is as follows:

$$E = \left(k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}\right)(281.9)\ \ g/VKT \qquad (8)$$

Where s is the surface material silt content (%), W is the mean vehicle weight; and a, b and k are empirical constants

This emission factor relates the amount of particulate emissions (in grams) to the number of kilometres travelled by all vehicles on site (VKT). **Table 7** presents the empirical constants used in the equation for different particle sizes, while the vehicle statistics used in this study are presented in **Table 8**.

Table 7: Empirical constants for different particle sizes

Constant	TSP	PM_{10}	$PM_{2.5}$
a	0.7	0.9	0.9
b	0.45	0.45	0.45
k	4.9	1.5	0.15

Table 8: Vehicular statistics of vehicles operating on unpaved roads at the Proposed-High Speed Proving Ground

Vehicle Type	Road Length (m)	No. of vehicle trips per month	Average vehicle weight (tons)	Road surface silt loading (%)	Calculated PM_{10} Emission rate (g/s)	Calculated $PM_{2.5}$ Emission rate (g/s)
Heavy Vehicles	6,200	42	39	6	1.86E-01	1.86E-02
Employee Vehicles	6,200	1,800	2.7	6	1.85E+00	1.85E-01

VEHICLE TAILPIPE EMISSIONS

Tailpipe emissions from test vehicles, heavy vehicles and other light duty vehicles travelling onsite were estimated using the NPI Emissions Estimation Technique Manual for Combustion Engines. The emission factor estimates pollutant emissions from vehicles in kilograms per year of activity onsite. The following equation was used to determine such emissions:

$$Ei = LY \times EFi \quad kg/y \qquad (9)$$

Where LY is the distance travelled in a reporting year, EFi is the emission factor of the substance and (i) is the substance.

Calculations were based on fuel consumption for a generic diesel truck of 0.25 l/km and 0.056 l/km for cars, as provided by the Client. The emission factors and calculated emission rates utilised in the dispersion model are presented in **Table 9**.

Table 9: Emissions factors and emission rates from vehicle tailpipes at the Proposed High-Speed Proving Ground

Pollutant	Emission Factor (kg/m³)	Calculated Emission Rate (g/s)
CO	10	3.55E-04
NO_x	6.7	2.38E-04
SO_2	0.017	6.03E-07
PM_{10}	2.1	7.45E-05
$PM_{2.5}$	2	7.09E-05
VOC	0.82	2.91E-05

6.2 DISPERSION MODELLING

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants emitted from a source into the atmosphere. Sophisticated software with algorithms that incorporate source quantification, surface contours and topography, as well as meteorology can reliably predict the downwind concentrations of these pollutants.

AERMOD is a new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes that uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour, that produces output maps of plume spread with key isopleths for visual interpretation and enables, through its statistical output, direct comparisons with the latest National and International ambient air quality standards for compliance testing.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources.
- A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.
- A terrain pre-processor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

MODELLING SCENARIOS

For the purposes of this investigation, various statistical outputs were generated, as described below:

- Long-term scenario

  The long-term scenario refers to an annual average concentration, which is calculated by averaging all hourly concentrations. The calculation is conducted for each grid point within the modelling domain. The long-term concentration for each receptor point is presented in a results table.

- Short-term scenario

  The short-term scenario refers to the 99th percentile (P99) concentration. The 99th percentile concentrations are recommended for short-term assessment with the available ambient air

quality standards since the highest predicted ground level concentrations can be considered outliers due to complex variability of meteorological processes. This might cause exceptionally high concentrations that the facility may never actually exceed in its lifetime.

MODELLING INPUT

Data input into the model includes modelled MM5 surface and upper air meteorological data with wind speed, wind direction, temperature, pressure, precipitation, cloud cover and ceiling height for January 2012 – December 2014 (**Figure 8**).

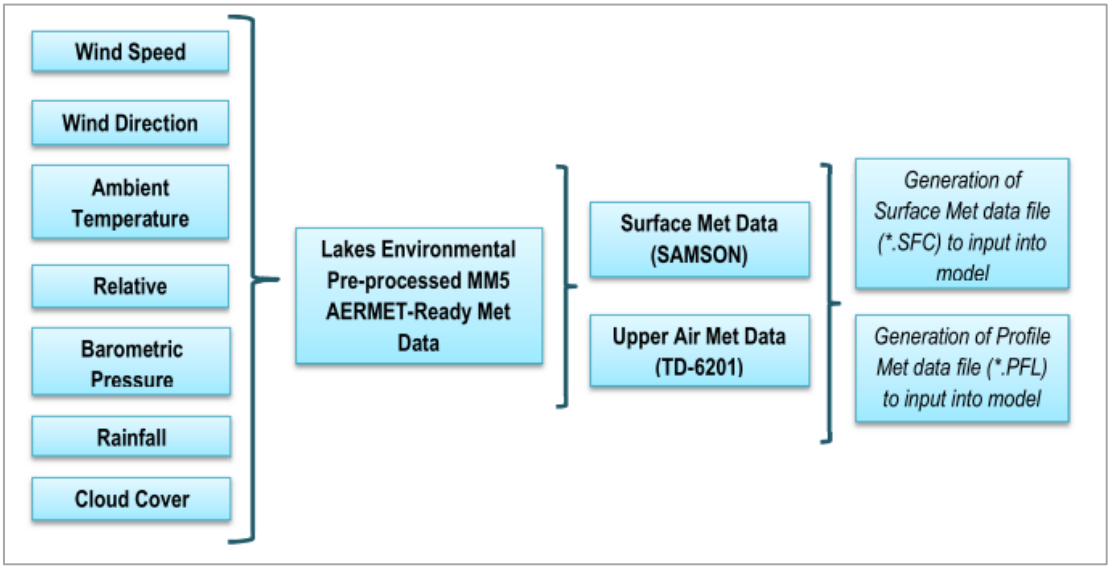

Figure 8: Meteorological data path

Table 10 presents the meteorological data used in the dispersion model for the period 2012 - 2014.

Table 10: Statistics regarding meteorological data used in the dispersion model

Total Met Lines	Met Lines Used	Calm Conditions	% Calms	% Met Lines Used
26,304	26,304	2,191	8.3%	100%

A modelling domain of 15 km × 15 km was used (**Table 11**), with multi-tier Cartesian grid receptor spacing's of 100 and 250 m. A receptor spacing of 50 m was also located along the site boundary. **Table 12** presents the model input parameters utilised in this assessment.

Table 11: Modelling Domain coordinates.

Domain Point	Latitude (°S)	Longitude (°E)
North-Western Point	28.127	21.417
North-Eastern Point	28.127	21.569
South-Western Point	28.262	21.417
South-Eastern Point	28.262	21.570

Table 12: Dispersion model input parameters

Parameter	Model Input
Model	
Assessment Level	Level 2
Dispersion Model	AERMOD
Supporting Models	AERMET and AERMAP
Emissions	
Pollutants modelled	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and VOCs
Scenarios	Construction and Operation
Chemical transformation	100% of NOx is NO_2
Exponential decay	None
Settings	
Terrain setting	Elevated
Terrain data	SRTM90
Terrain data resolution (m)	90
Land characteristics (bowen ratio, surface albedo, surface roughness)	Rural
Grid Receptors	
Modelling domain (km)	15 x 15
Property line resolution (m)	50
Fine grid resolution (m)	100
Medium grid resolution (m)	250

6.3 SENSITIVE RECEPTOR IDENTIFICATION

Sensitive receptors are identified as areas that may be negatively impacted on due to emissions from the Proposed High-Speed Proving Ground. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. The sensitive receptors identified in the area surrounding the Proposed High-Speed Proving Ground include: the town of Upington, located 30 km southwest of the proposed site and any surrounding farmhouses, within a 15 km radius of the proposed site (**Table 13** and **Figure 9**). It must be noted that the majority of these receptors are located too far from the proposed site to be impacted on and as such not all receptors were included in the dispersion model.

Table 13: Location and distances of sensitive receptors surrounding the Proposed High-Speed Proving Ground

Receiver	Distance from Nearest Site Boundary (m)	Latitude (°S)	Longitude (°E)
FH1	2,400	28.1657	21.4392
FH2	3,200	28.1791	21.5397
FH3	2,400	28.2369	21.5574
FH4	11,400	28.1535	21.6189
FH5	9,800	28.1856	21.6157
FH6	12,700	28.1930	21.6536
FH7	12,500	28.2249	21.6629
FH8	3,700	28.2811	21.5520
FH9	8,100	28.3199	21.5607
FH10	13,000	28.2751	21.3686
FH11	13,000	28.2283	21.3463
FH12	6,600	28.1316	21.4004
FH13	5,000	28.0945	21.4813
FH14	5,600	28.0887	21.4867
FH15	15,000	28.0381	21.5891
Upington	31,600	28.4249	21.2573

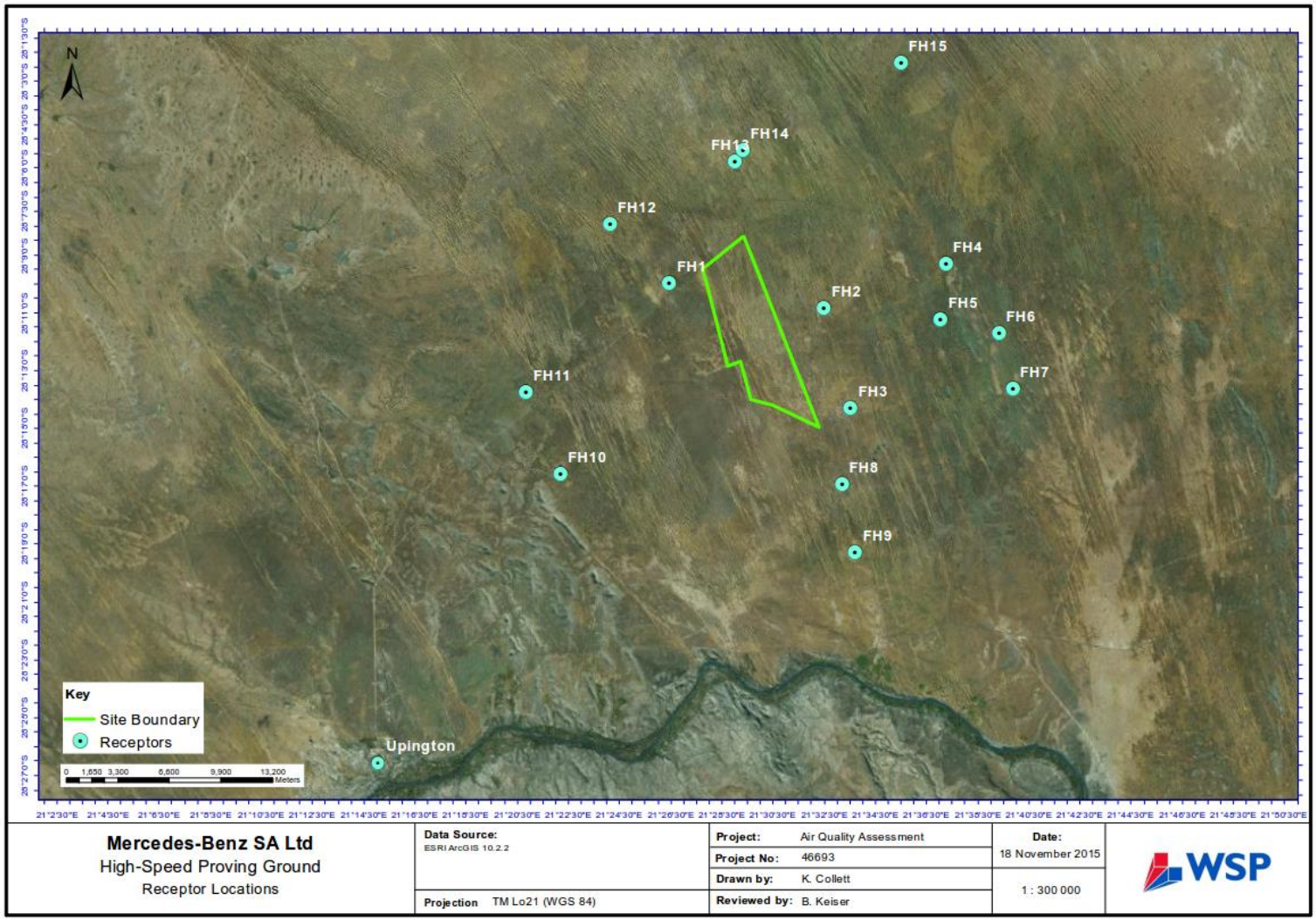

Figure 9: Location of sensitive receptors surrounding the Proposed High-Speed Proving Ground

7 ASSUMPTIONS

In this AQIA, various assumptions were made that may impact on the results obtained. These assumptions include:

- The information provided regarding the construction and operational activities is assumed to be representative of what will occur in reality;
- As a worst case, one blast will occur at the borrow pit and quarry a week respectively;
- The same amount of material that is crushed at the quarry and borrow pit is loaded to trucks;
- Unpaved road emissions from the road between the quarry/borrow pit and site are not included due to uncertainties with the number and frequency of vehicles in operation on these roads;
- Unpaved road emissions along the off-site access road during the operational phase are based on a return trip per vehicle;
- The length of the off-site road extends to the edge of the 15 km x 15 km modelling domain;
- Unpaved road emissions from the operation of test vehicles on the bad roads are excluded due to the uncertain nature of the routes, as well as slow speeds and resultant negligible emissions;
- The average fuel consumption of cars and heavy duty vehicles operating on the off-site road were utilised in the calculations;
- For the test modules, each car will do one round trip per hour; and
- For the test modules, all cars will be operational for the maximum time (08:00 – 20:00, 6 days a week).

8 RESULTS AND DISCUSSION

This section presents the results of the atmospheric dispersion modelling conducted for the Proposed High-Speed Proving Ground. Concentration results at specified sensitive receptors are presented in tabular format, while concentration isopleths are presented graphically to indicate the dispersion of pollutants from the site. It must be noted that concentration results are only presented for the nearest three farm house receptors, as the other identified receptors are too far from the proposed site, falling outside of the 15 km x 15 km modelling domain.

8.1 CONSTRUCTION PHASE

PARTICULATE MATTER (PM_{10})

The predicted PM_{10} concentrations at the three nearest farm house receptors during the construction phase are presented in **Table 14**. Predicted annual average concentrations at all three receptors are low and below the annual PM_{10} standard of 40 µg/m³. The P99 daily average concentrations are also low, with no exceedences of the daily standard (75 µg/m³) predicted at the receptor locations.

Graphical outputs of the PM_{10} model results are presented in **Figure 10** and **Figure 11**. Annual average PM_{10} concentrations will only exceed the standard within the site boundary, specifically along the high-speed oval. P99 daily concentrations are predicted to spread further from the site, although not exceeding the daily standard at any of the receptor locations. It must be noted that P99 concentrations are generated to present a worst-case situation and such concentrations may never actually occur.

It must be noted that the estimation of emissions from construction activities are highly uncertain due to the site specific and erratic nature of construction activities. The emission rate used to calculate such emissions is a gross overestimation at most construction sites and as such the results presented here may be slightly over predicted to those that will be experienced in reality.

Table 14: Predicted PM_{10} concentrations at receptor locations during the construction phase

Receptor	Annual Average PM_{10} (µg/m³)	Daily PM_{10} (µg/m³)
FH1	4.30	42.84
FH2	2.05	22.40
FH3	0.60	12.61

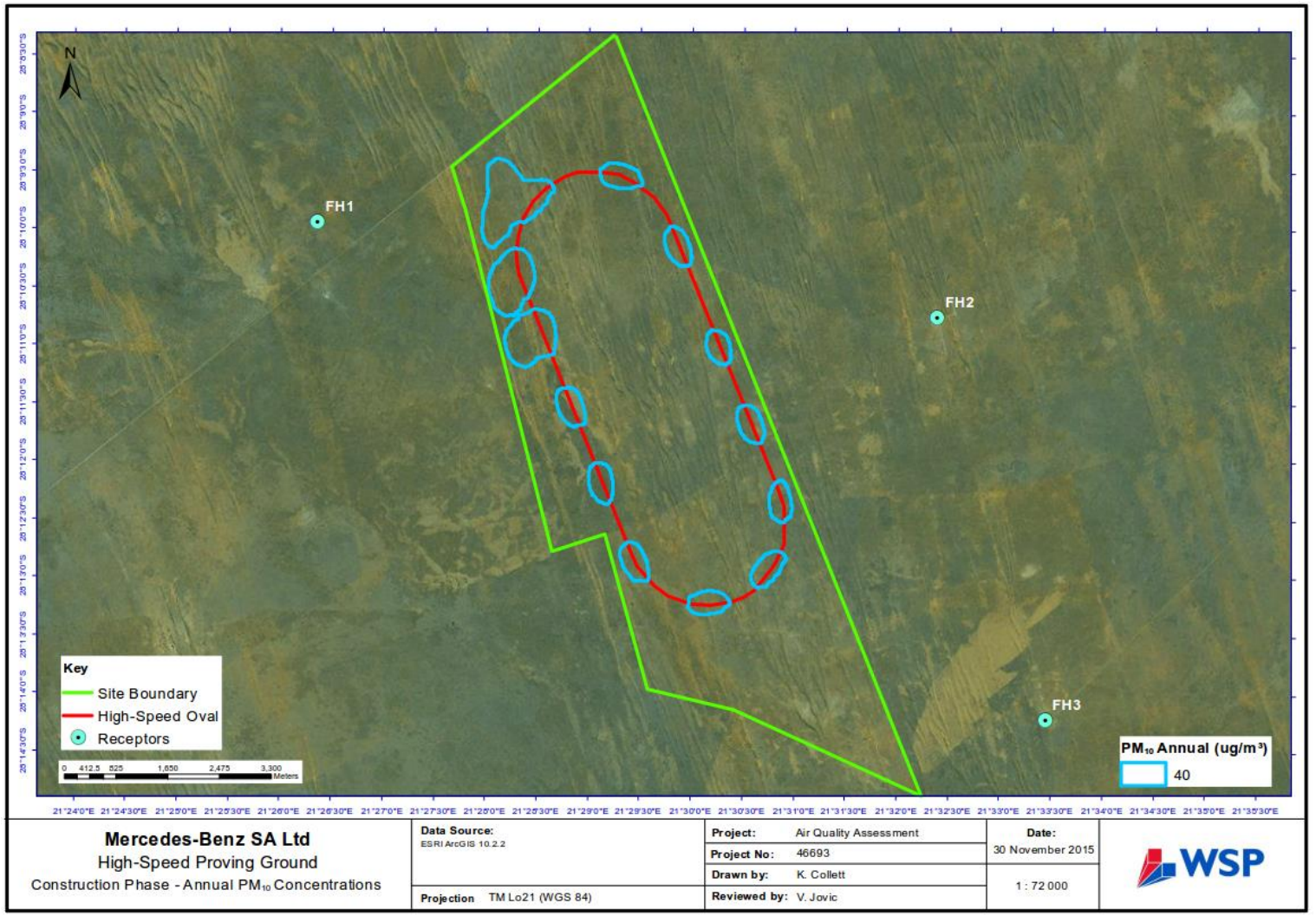

Figure 10: Predicted annual average PM_{10} concentrations associated with the construction phase of the Proposed High-Speed Proving Ground

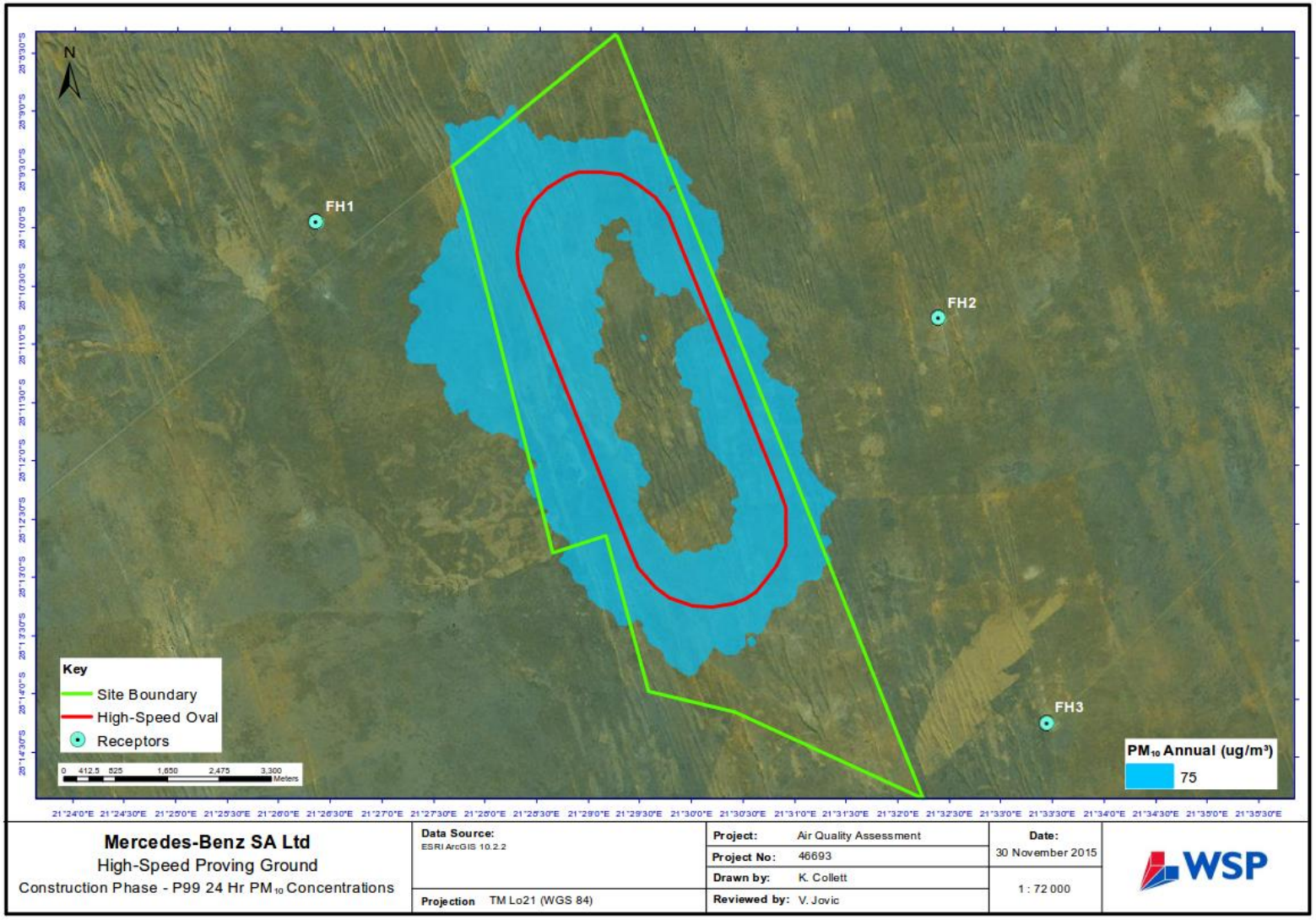

Figure 11: Predicted P99 daily PM_{10} concentrations associated with the construction phase of the Proposed High-Speed Proving Ground

PARTICULATE MATTER ($PM_{2.5}$)

The predicted $PM_{2.5}$ concentrations at the three nearest farm house receptors during the construction phase are presented in **Table 15**. Predicted annual average concentrations at all three receptors are low and well below the annual $PM_{2.5}$ standard of 20 µg/m³. The P99 daily average concentrations are also low, with no exceedences of the daily standard (40 µg/m³) predicted at any of the receptor locations.

Graphical outputs of the $PM_{2.5}$ model results are presented in **Figure 12** and **Figure 13**. Annual average $PM_{2.5}$ concentrations will only exceed the standard within the site boundary, specifically along the high-speed oval. P99 daily concentrations are predicted to spread slightly further from the site, extending past the site boundary to the west, although not exceeding the daily standard at any of the receptor locations. It must be noted that P99 concentrations are generated to present a worst-case situation and such concentrations may never actually occur.

It must be noted that the estimation of emissions from construction activities are highly uncertain due to the site specific and erratic nature of construction activities. The emission rate used to calculate such emissions is a gross overestimation at most construction sites and as such the results presented here may be slightly over predicted to those that will be experienced in reality.

Table 15: Predicted $PM_{2.5}$ concentrations at receptor locations during the construction phase

Receptor	Annual Average $PM_{2.5}$ (µg/m³)	Daily $PM_{2.5}$ (µg/m³)
FH1	1.28	12.80
FH2	0.61	6.70
FH3	0.17	3.71

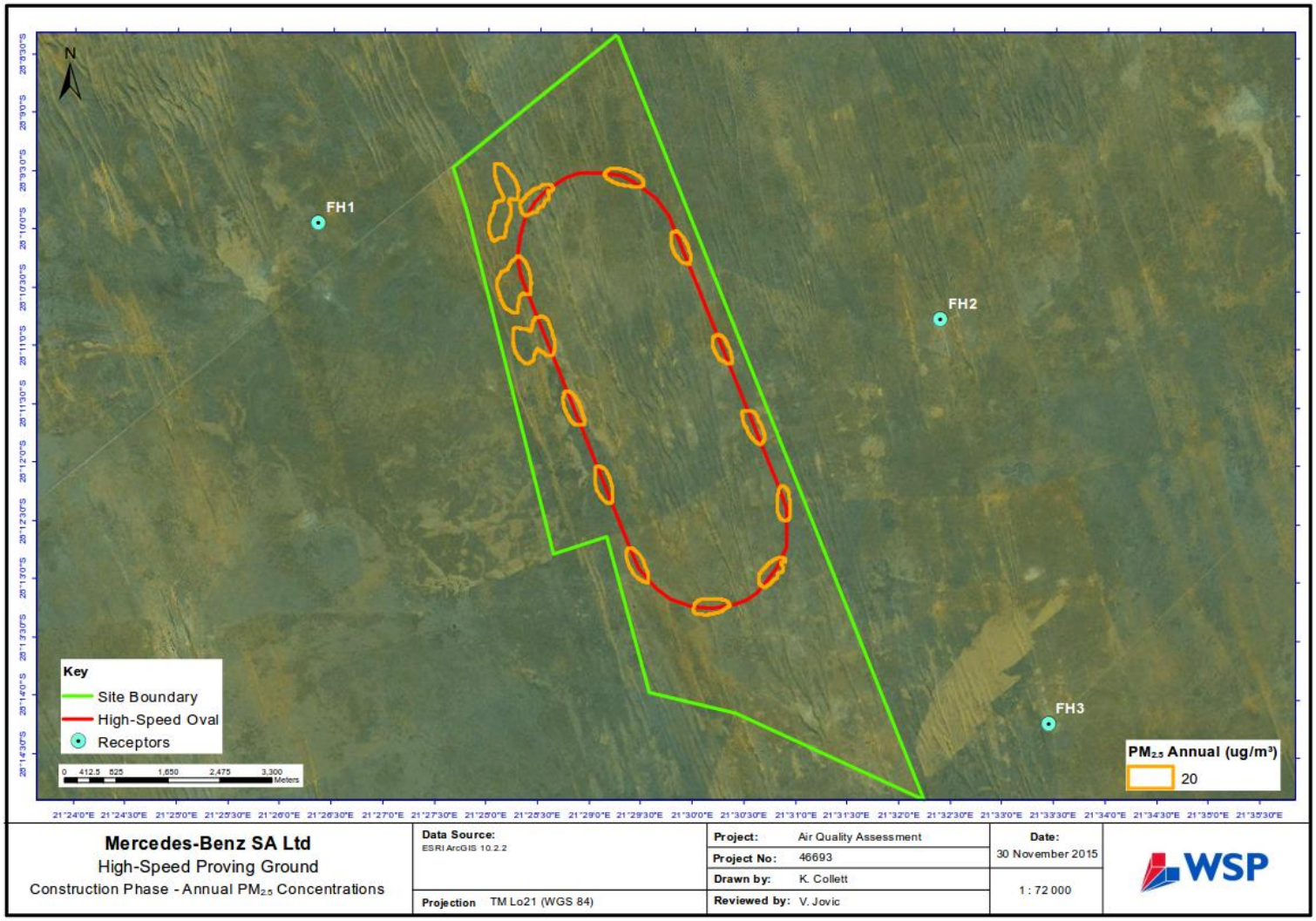

Figure 12: Predicted annual average $PM_{2.5}$ concentrations associated with the construction phase of the Proposed High-Speed Proving Ground

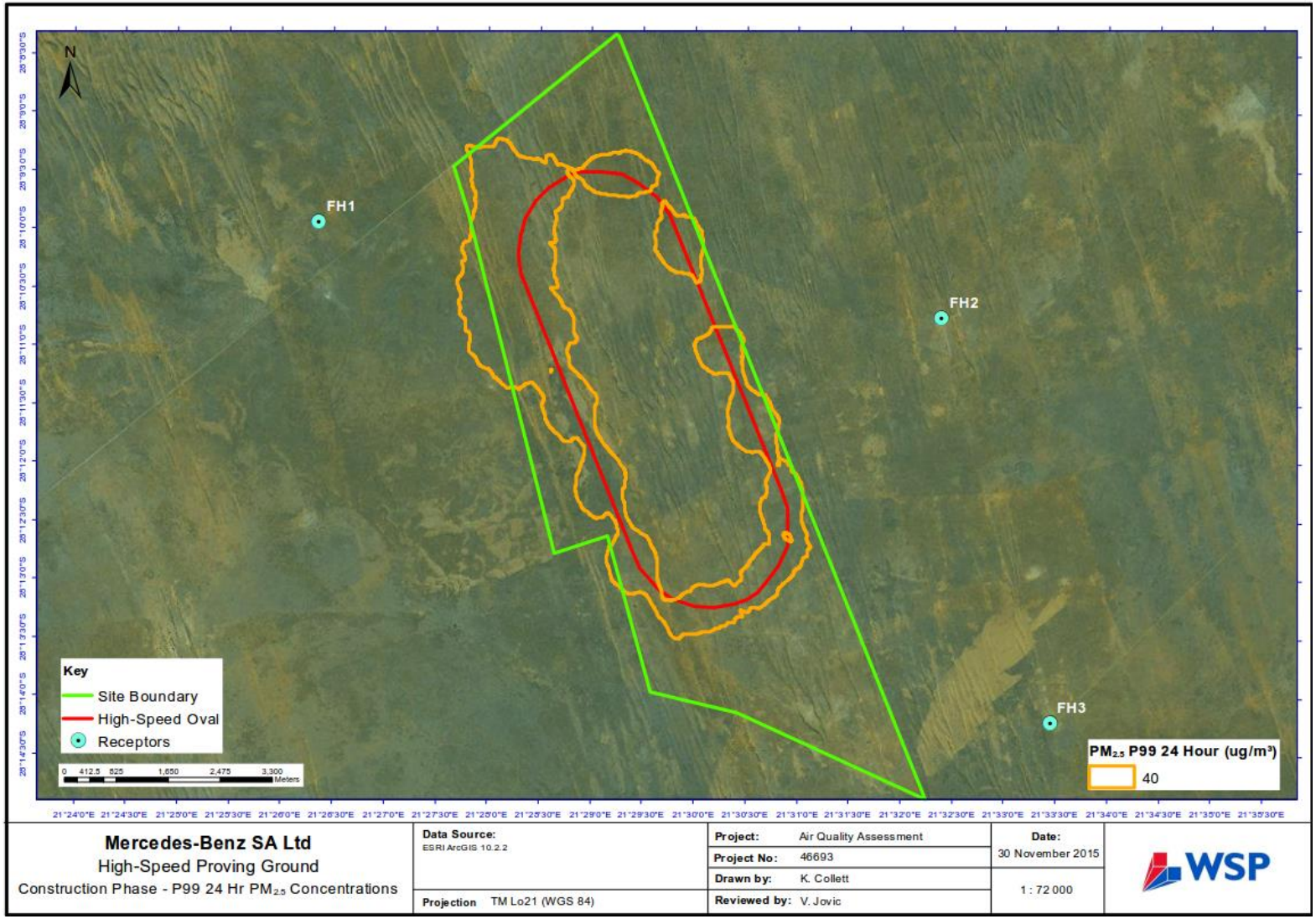

Figure 13: Predicted P99 daily $PM_{2.5}$ concentrations associated with the construction phase of the Proposed High-Speed Proving Ground

8.2 OPERATIONAL PHASE

PARTICULATE MATTER (PM_{10})

The predicted PM_{10} concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 16**. Predicted annual average concentrations at all three receptors are considerably low and well below the annual PM_{10} standard of 40 µg/m³. The P99 daily average concentrations also remain low, with no exceedences of the daily standard (75 µg/m³) predicted at any of the receptor locations.

Graphical outputs of the PM_{10} model results are presented in **Figure 14** and **Figure 15**. Both annual average and P99 daily concentrations are only predicted to exceed the relevant standards along the off-site access road. Since this access road is unpaved, such concentrations can be attributed to the movement of vehicles along this road, to and from the site. Particulate matter, however, is not predicted to disperse towards FH1, the receptor located in closest proximity to this access road.

Table 16: Predicted PM_{10} concentrations at receptor locations during the operational phase

Receptor	Annual Average PM_{10} (µg/m³)	Daily PM_{10} (µg/m³)
FH1	2.74	16.47
FH2	0.53	1.02
FH3	0.02	0.52

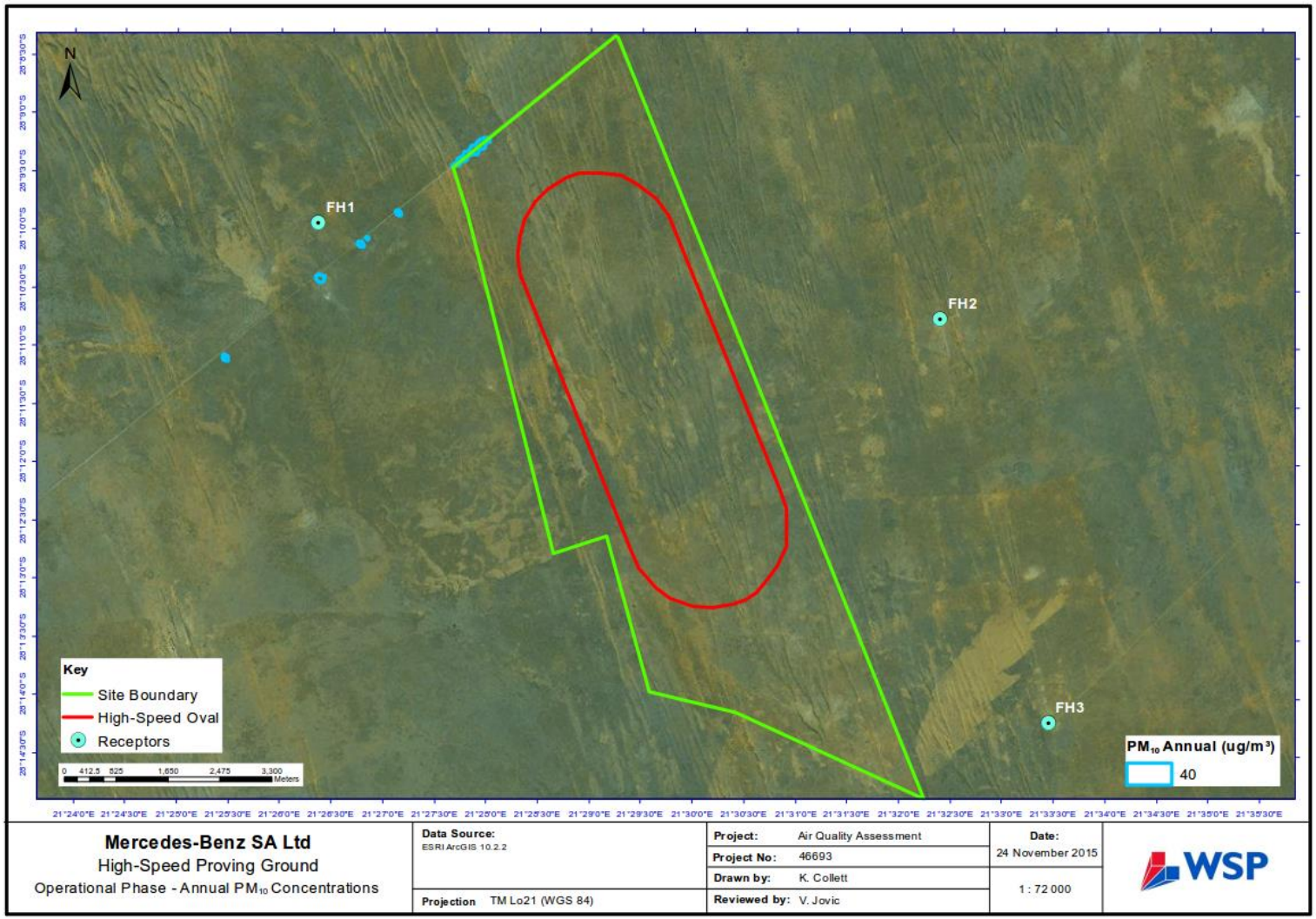

Figure 14: Predicted annual average PM_{10} concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

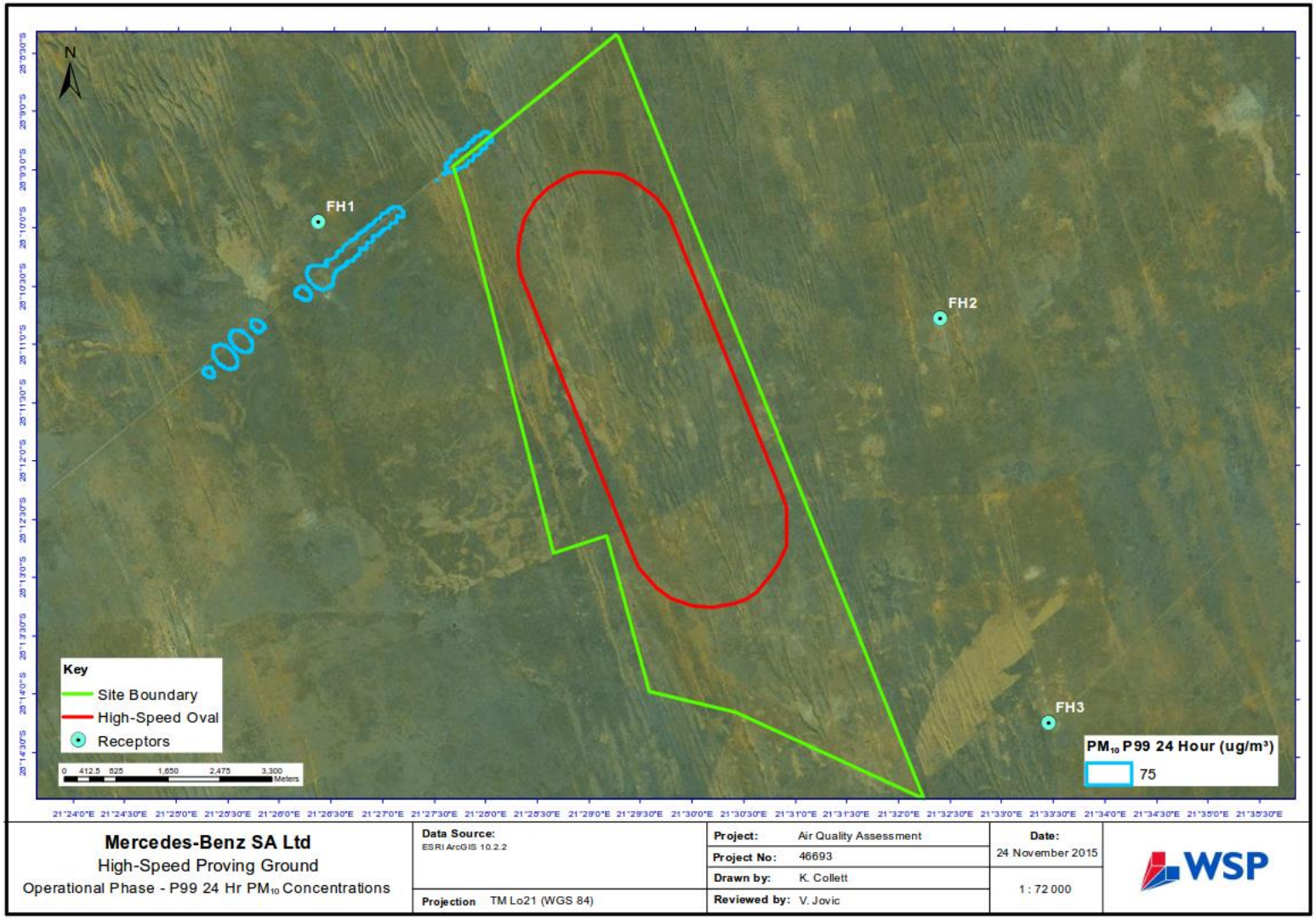

Figure 15: Predicted P99 daily PM_{10} concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

PARTICULATE MATTER ($PM_{2.5}$)

The predicted $PM_{2.5}$ concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 17**. Predicted annual average concentrations at all three receptors are considerably low and well below the annual $PM_{2.5}$ standard of 20 µg/m³. The P99 daily average concentrations also remain low, with no exceedences of the daily standard (40 µg/m³) predicted at any of the receptor locations.

Graphical outputs of the $PM_{2.5}$ model results are presented in **Figure 16** and **Figure 17**. The highest concentrations are predicted along the off-site access road, with only P99 daily concentrations exceeding the daily standard along this road. Vehicle-entrained dust from the unpaved access road is the main contributor to $PM_{2.5}$ emissions.

Table 17: Predicted $PM_{2.5}$ concentrations at receptor locations during the operational phase

Receptor	Annual Average $PM_{2.5}$ (µg/m³)	Daily $PM_{2.5}$ (µg/m³)
FH1	0.284	1.762
FH2	0.011	0.134
FH3	0.004	0.088

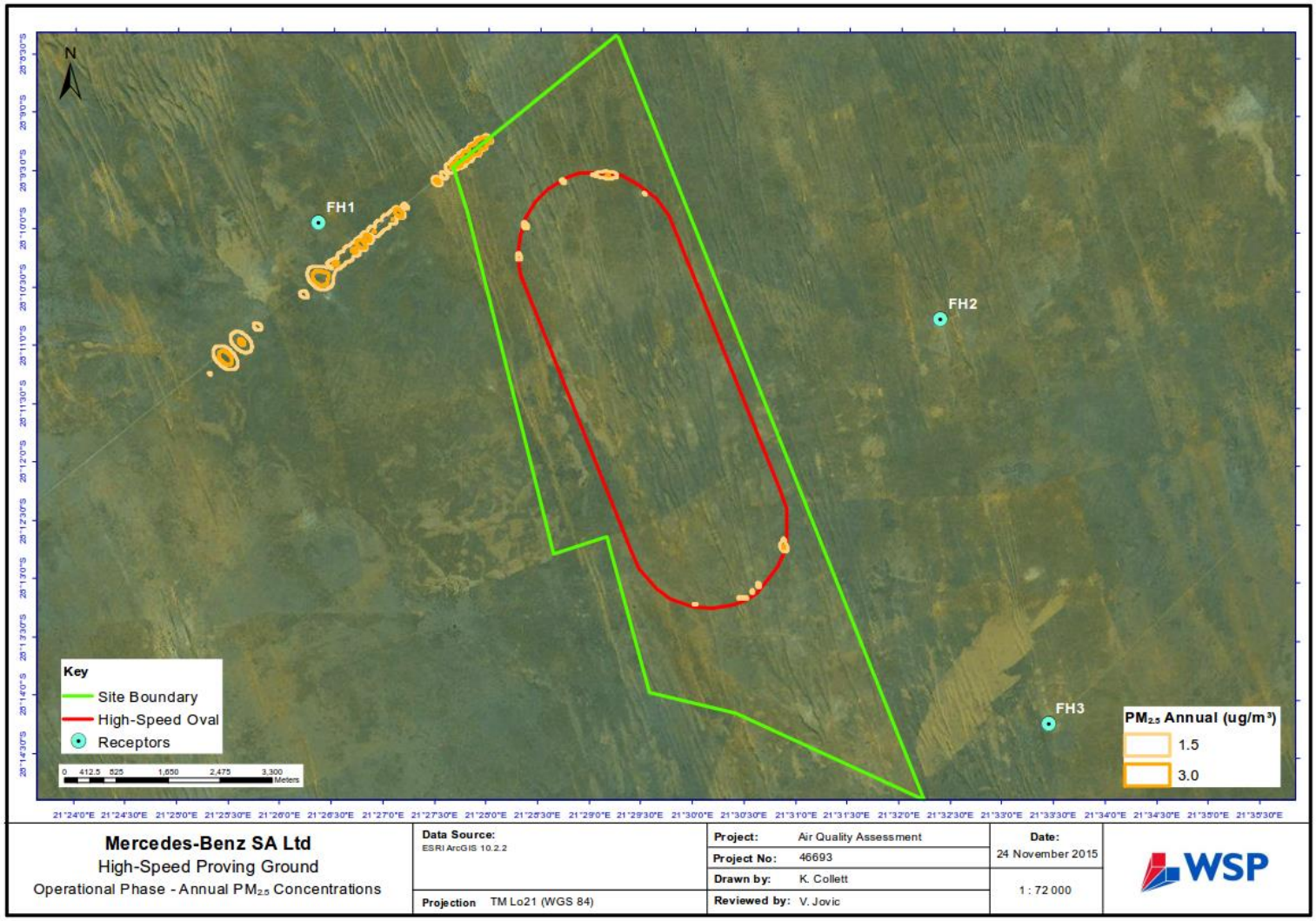

Figure 16: Predicted annual average $PM_{2.5}$ concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

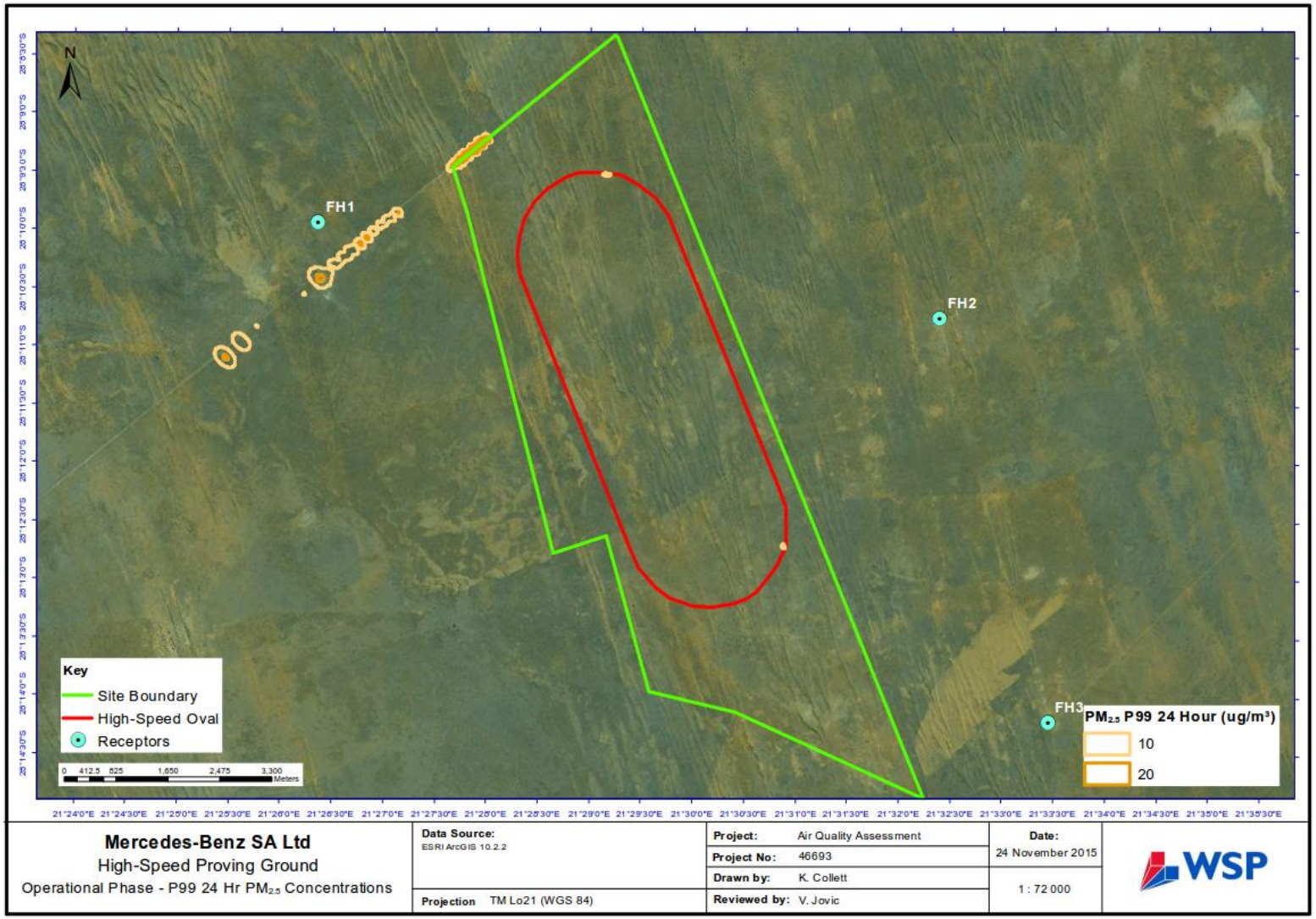

Figure 17: Predicted P99 daily $PM_{2.5}$ concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

SULPHUR DIOXIDE

The predicted SO_2 concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 18**. Predicted annual average, P99 daily and P99 hourly concentrations at all three receptors are considerably low and well below the annual (50 µg/m³), daily (125 µg/m³) and hourly (350 µg/m³) standards respectively.

Graphical outputs of the SO_2 model results are presented in **Figure 18** through **Figure 20**. The highest concentrations are predicted along the high-speed oval, however, concentrations remain well below the relevant standards with no exceedences predicted. The test car tailpipes are the main source of emissions.

Table 18: Predicted SO_2 concentrations at receptor locations during the operational phase

Receptor	Annual Average SO_2 (µg/m³)	Daily SO_2 (µg/m³)	Hourly SO_2 (µg/m³)
FH1	0.00010	0.00222	0.00126
FH2	0.00005	0.00108	0.00058
FH3	0.00002	0.00016	0.00036

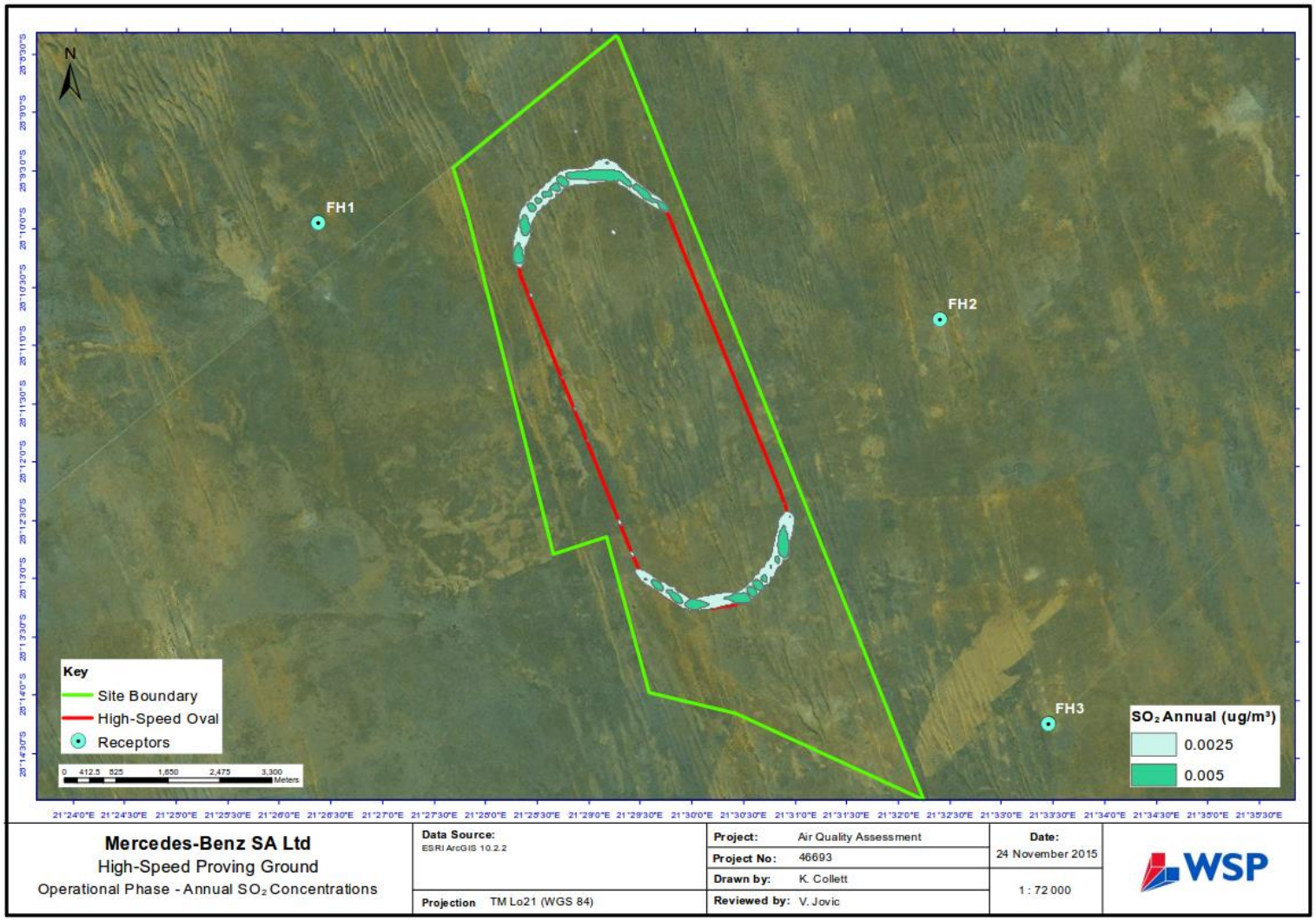

Figure 18: Predicted annual average SO_2 concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

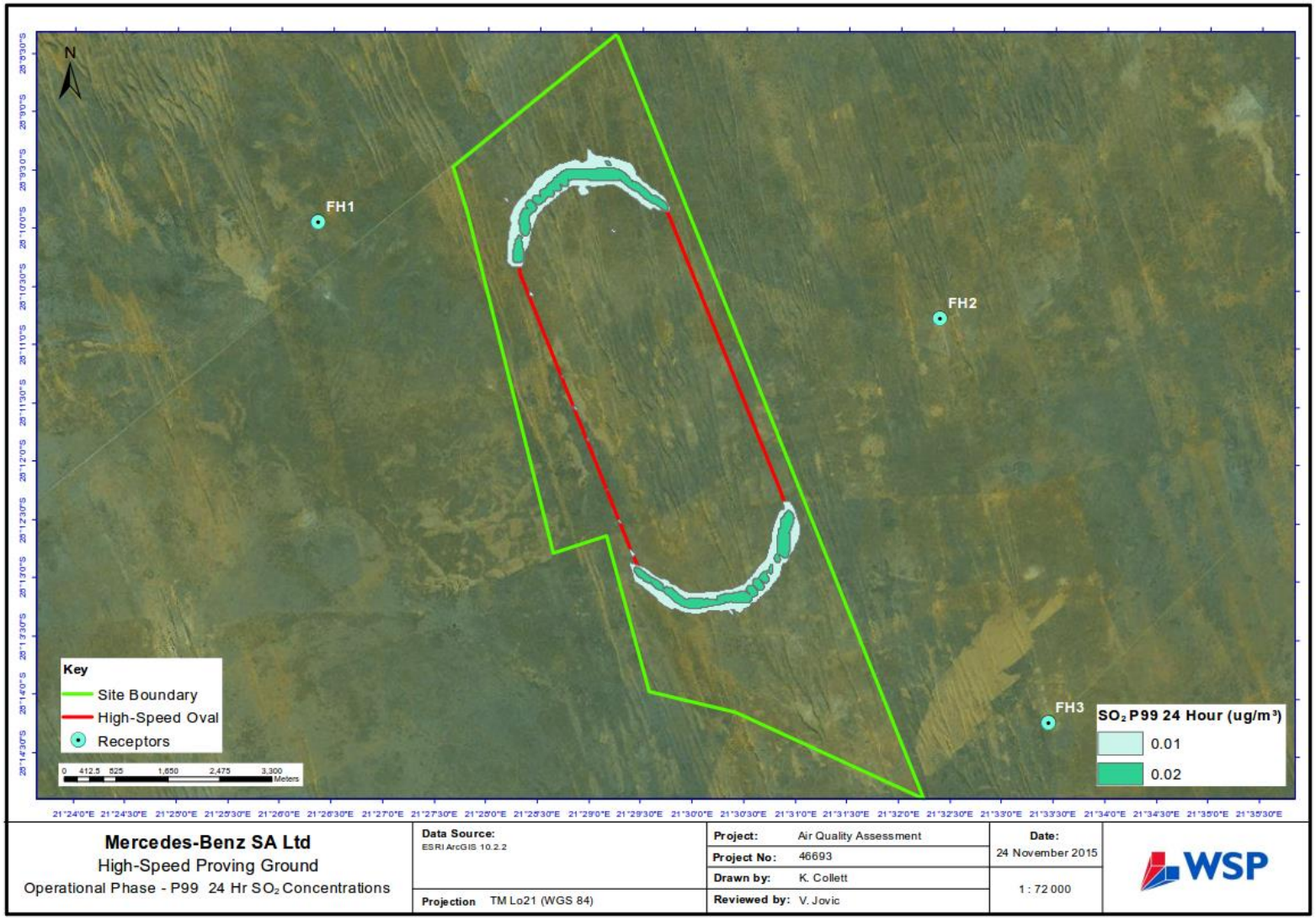

Figure 19: Predicted P99 daily SO_2 concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

Figure 20: Predicted P99 hourly SO_2 concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

NITROGEN OXIDES

The predicted NO_x concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 19**. Predicted annual average and P99 daily concentrations at all three receptors are considerably low and well below the annual (40 µg/m³) and daily (200 µg/m³) standards respectively.

Graphical outputs of the NO_x model results are presented in **Figure 21** and **Figure 22**. The highest concentrations are predicted along the high-speed oval, however, concentrations remain well below the relevant standards with no exceedences predicted. The test car tailpipes are the main source of emissions.

Table 19: Predicted NO_x concentrations at receptor locations during the operational phase

Receptor	Annual Average NO_x (µg/m³)	Daily NO_x (µg/m³)
FH1	0.04	0.87
FH2	0.02	0.42
FH3	0.01	0.06

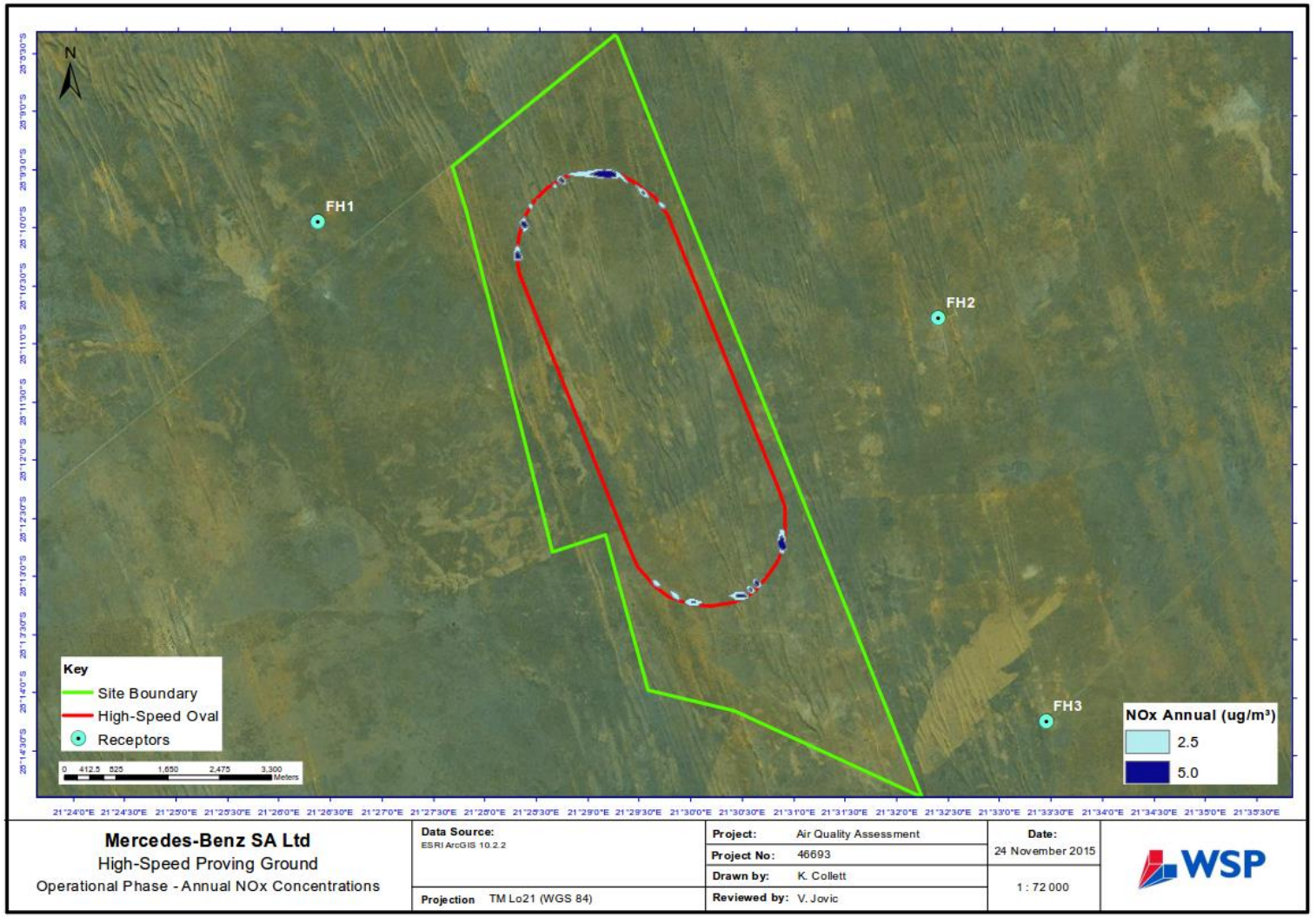

Figure 21: Predicted annual average NO_x concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

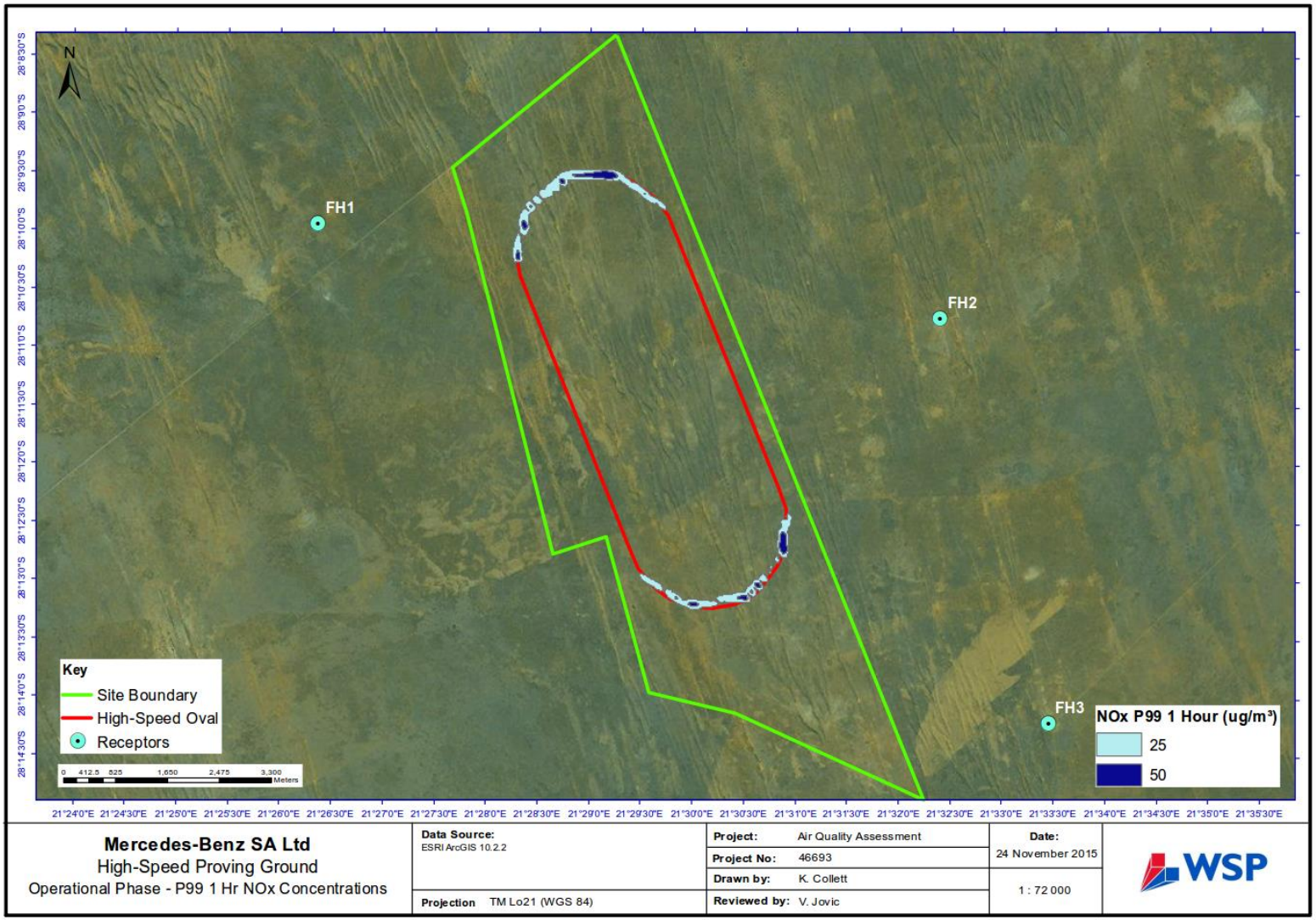

Figure 22: Predicted P99 daily NO_x concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

CARBON MONOXIDE

The predicted CO concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 20**. Predicted P99 hourly and P99 8-hourly (calculated on 1 hourly averages) concentrations at all three receptors are considerably low and well below the hourly (30,000 µg/m³) and 8-hourly (10,000 µg/m³) standards respectively.

Graphical outputs of the CO model results are presented in **Figure 23** and **Figure 24**. The highest concentrations are predicted along the high-speed oval, however, concentrations remain well below the relevant standards with no exceedences predicted. The test car tailpipes are the main source of emissions.

Table 20: Predicted CO concentrations at receptor locations during the operational phase

Receptor	Hourly CO (µg/m³)	8-hour CO (µg/m³)
FH1	1.31	1.05
FH2	0.63	0.58
FH3	0.09	0.33

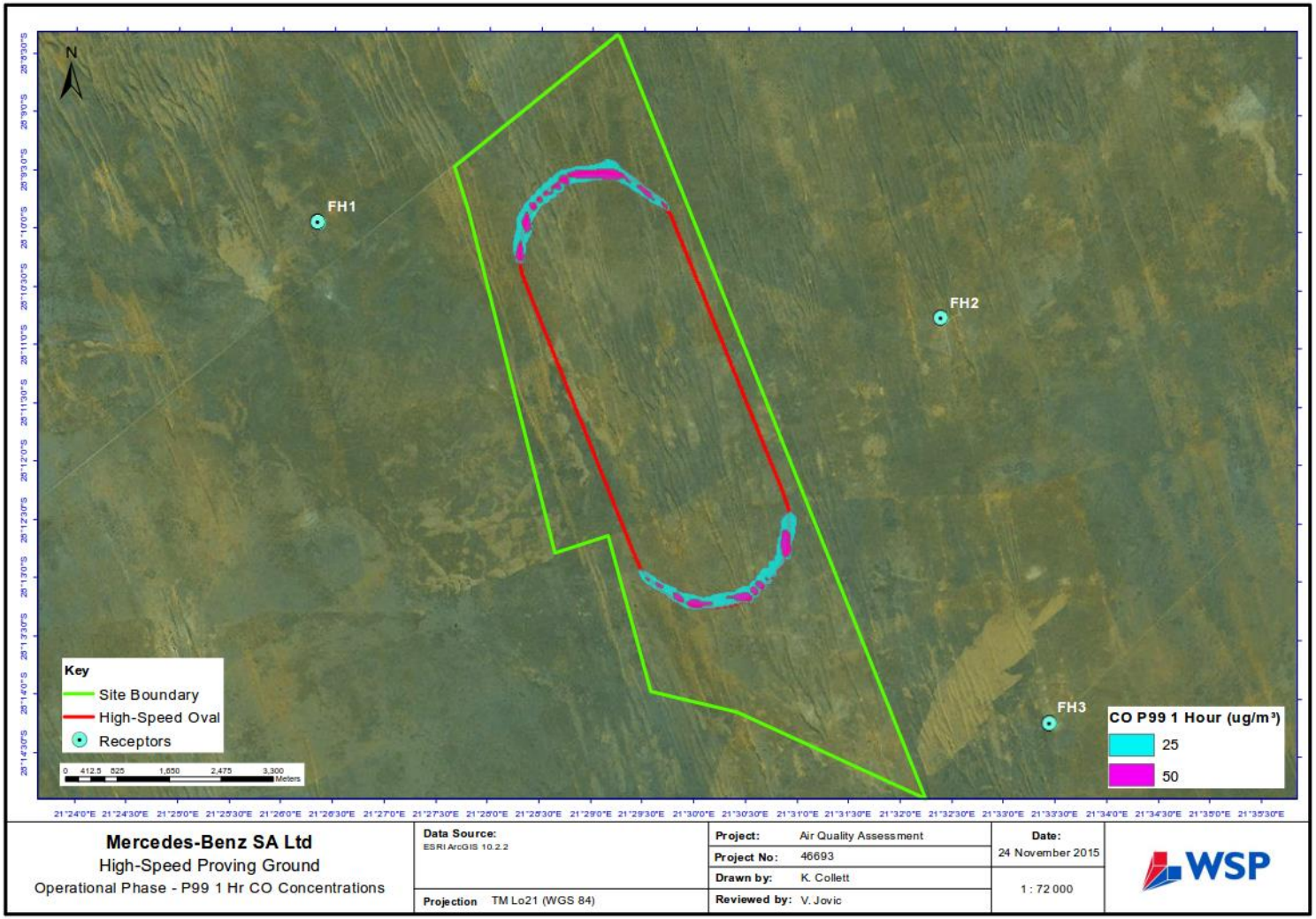

Figure 23: Predicted P99 hourly CO concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

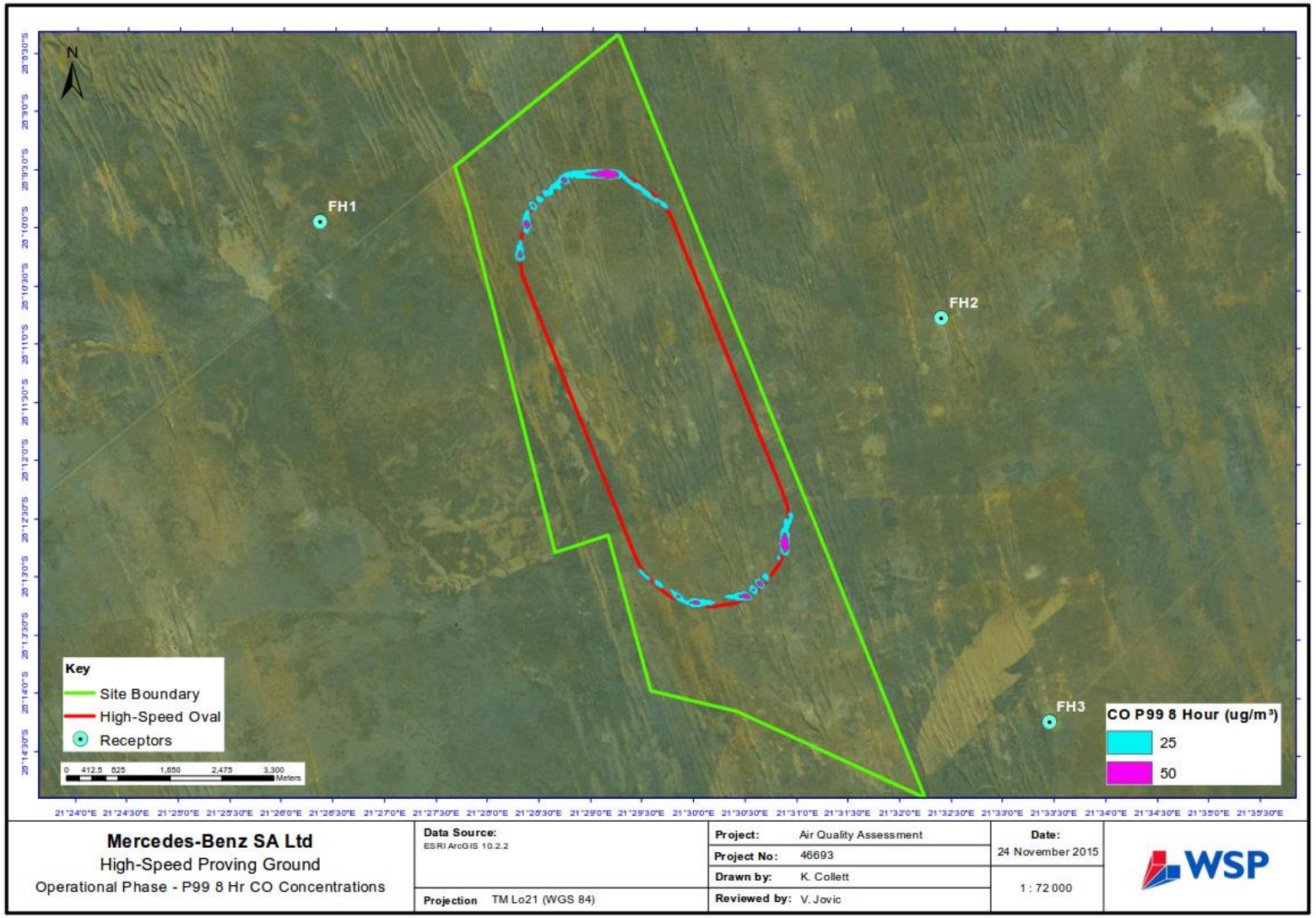

Figure 24: Predicted P99 8-hourly CO concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

VOLATILE ORGANIC COMPOUNDS

The predicted VOC concentrations at the three nearest farm house receptors during the operational phase are presented in **Table 21**. Since there is no legislated VOC standard, concentrations are assessed against the National Ambient Air Quality Standard for benzene. Predicted annual average VOC concentrations at all three receptors are considerably low and well below annual benzene standard of 5 µg/m³, indicating that benzene concentrations are essentially compliant.

Graphical outputs of the VOC model results are presented in **Figure 25**. The highest concentrations are predicted along the high-speed oval, however, concentrations remain well below the annual standard with no exceedences predicted. The test car tailpipes are the main source of emissions.

Table 21: Predicted VOC concentrations at receptor locations during the operational phase

Receptor	Annual VOC (µg/m³)
FH1	0.0005
FH2	0.0026
FH3	0.0009

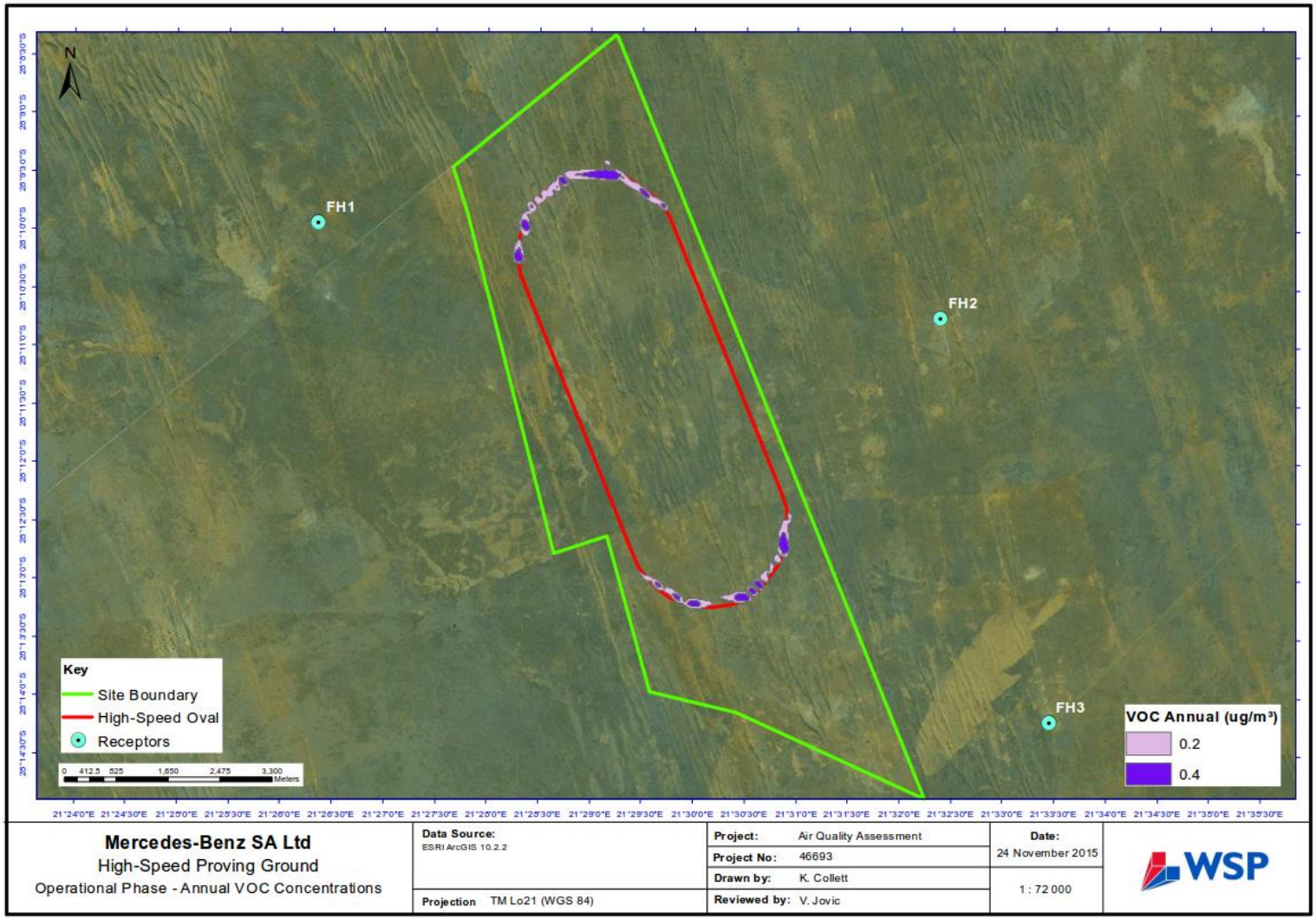

Figure 25: Predicted annual average VOC concentrations associated with the operational phase of the Proposed High-Speed Proving Ground

8.3 MITIGATION RECOMMENDATIONS

Since emissions associated with the construction and operation of the Proposed High-Speed Proving Ground will not impact on any surrounding receptors, no specific mitigation interventions are recommended. Should MBSA want to decrease particulate matter emissions from construction activities even further, the following mitigation options can be employed:

- Installation of windbreaks alongside cut-to-fill operations to limit the amount of dust that is entrained by wind;
- Covering of any stockpiles on site; and
- The use of dust masks for personnel working onsite in close proximity to general construction activities.

9 IMPACT ASSESSMENT

The purpose of this air quality impact assessment is to identify the potential impacts of the construction and operation of the Proposed High-Speed Proving Ground on the ambient air quality in the area. The outcomes of the impact assessment provide a basis to make informed decisions to ensure that there is not unacceptable social or environmental impact of the proposed facility.

The impact assessment was evaluated using the Hackings risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the severity, extent, duration, probability and confidence of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix A**.

Outcomes of the air quality impact assessment are presented in **Table 22**, outlining the impact of each parameter and the resulting risk level during the construction and operational phases. Based on the distance of the residential receptors from the proposed site, the air quality impacts during both the construction and operational phases of the Proposed High-Speed Proving Ground are deemed “Low”.

Table 22: Impact Assessment of Air Quality Risks Associated with the Proposed High-Speed Proving Ground

Description	Without Mitigation						With Mitigation					
	Severity	Duration	Extent	Consequence	Probability	**Risk Level**	Severity	Duration	Extent	Consequence	Probability	**Risk Level**
Air quality impacts on residential receptors (construction)	L	L	L	L	L	Low	L	L	L	L	L	Low
Air quality impacts on residential receptors (operations)	L	L	L	L	L	Low	L	L	L	L	L	Low

10 CONCLUSIONS

This air quality impact assessment investigated emissions associated with the construction and operation of the Proposed High-Speed Proving Ground near Upington in the Northern Cape. The assessment consisted of the development of a comprehensive emissions inventory accounting for all construction and operational sources, as well as dispersion modelling to determine the dispersion of pollutants from the proposed site.

During the construction phase, particulate matter (PM_{10} and $PM_{2.5}$) concentrations at the three nearest farm house receptor locations are predicted to be low, with no exceedences of the relevant National Ambient Air Quality Standards predicted. Concentrations within the site boundary are predicted to exceed the relevant standards, with the highest concentrations predicted along the high-speed oval where cut-to-fill and general construction activities will occur.

During the operational phase, PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and VOC concentrations at the nearest farm house receptor locations are predicted to be low, with no exceedences of the relevant National Ambient Air Quality Standards predicted. Exceedences of PM_{10} concentrations are predicted along the off-site access road. Since this access road is unpaved, such concentrations can be attributed to the movement of vehicles along this road, to and from the site. The highest concentrations of SO_2, NO_x, CO and VOC are predicted along the high-speed oval, however, concentrations remain well below the relevant standards with no exceedences predicted. The test car tailpipes are the main source of such emissions.

The air quality impacts of the Proposed High-Speed Proving Ground were evaluated using a risk matrix which assessed the severity, extent, duration, probability and confidence of potentially significant impacts. Based on this rating system, it was calculated that the air quality impacts of the proposed project are expected to be “Low”.

11 REFERENCES

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Appendix A

IMPACT RATING METHODOLOGY

In accordance with GNR 982, promulgated in terms of Section 24(J) of the National Environmental Management Act, 1998 (Act 107 of 1998), the significance of potential impacts are assessed in terms of the following criteria:

- Cumulative impacts;
- The nature, significance and consequences of the impact and risk;
- The extent and duration of the impact and risk;
- The probability of the impact and risk occurring;
- The degree to which the impact and risk can be reversed;
- The degree to which the impact and risk may cause irreplaceable loss of resources; and
- The degree to which the impact and risk can be mitigated.

The significance of environmental aspects can be determined and ranked by considering the criteria presented in **Table 23**. In some cases it may be necessary to undertake the impact assessment to determine whether a particular aspect is significant. Therefore, a fair degree of iteration is unavoidable during the assessment process.

Table 23: Criteria Used to Determine the Significance of Environmental Aspects

Significance Ranking	Negative Aspects	Positive Aspects
H (High)	Will always/often exceed legislation or standards. Have characteristics that could cause significant negative impacts.	Compliance with all legislation and standards. Have characteristics that could cause significant positive impacts.
M (Moderate)	Have characteristics that could cause negative impacts.	Have characteristics that could cause positive impacts.
L (Low)	Will never exceed legislation or standards. Unlikely to cause significant negative impacts.	Will always comply with all legislation and standards. Unlikely to cause significant positive impacts.

Where significant environmental aspects are present ("high" or "moderate"), significant environmental impacts may result. The significance of the impacts associated with the significant aspects can be determined by considering the risk:

- Significance of Environmental Impact (Risk) = Probability x Consequence
- The consequence of impacts can be described by considering the severity, spatial extent and duration of the impact.

SEVERITY OF IMPACTS

Table 24 presents the ranking criteria that can be used to determine the severity of impacts on the bio-physical and socio-economic environment. **Table 25** provides additional ranking criteria for determining the severity of negative impacts on the bio-physical environment.

Table 24: Criteria for Ranking the Severity of Environmental Impacts

	Negative			Positive		
Criteria	High-	Medium-	Low-	Low+	Medium+	High+
Qualitative	Substantial deterioration. Death, illness or injury.	Moderate deterioration. Discomfort.	Minor deterioration. Nuisance or minor irritation.	Minor improvement.	Moderate improvement.	Substantial improvement.
Quantitative	Measurable deterioration.		Change not measurable i.e. will remain within current range.		Measurable improvement.	

	Negative			Positive	
	Recommended level will often be violated.	Recommended level will occasionally be violated.	Recommended level will never be violated.	Will be within or better than recommended level.	
Community Response	Vigorous community action.	Widespread complaints.	Sporadic complaints.	No observed reaction.	Favourable publicity

Table 25: Criteria for Ranking the Severity of Negative Impacts on the Bio-physical Environment

	Ranking Criteria		
	Low (L-)	Medium (M-)	High (H-)
Soils and land capability	Minor deterioration in land capability. Soil alteration resulting in a low negative impact on one of the other environments (e.g. ecology).	Partial loss of land capability. Soil alteration resulting in a moderate negative impact on one of the other environments (e.g. ecology).	Complete loss of land capability. Soil alteration resulting in a high negative impact on one of the other environments (e.g. ecology).
Ecology (Plant and animal life)	Disturbance of areas that are degraded, have little conservation value or are unimportant to humans as a resource. Minor change in species variety or prevalence.	Disturbance of areas that have some conservation value or are of some potential use to humans. Complete change in species variety or prevalence.	Disturbance of areas that are pristine, have conservation value or are an important resource to humans. Destruction of rare or endangered species.
Surface and Groundwater	Quality deterioration resulting in a low negative impact on one of the other environments (ecology, community health etc.)	Quality deterioration resulting in a moderate negative impact on one of the other environments (ecology, community health etc.).	Quality deterioration resulting in a high negative impact on one of the other environments (ecology, community health etc.).

SPATIAL EXTENT AND DURATION OF IMPACTS

The duration and spatial scale of impacts can be ranked using the criteria in **Table 26**:

Table 26: Ranking the Duration and Spatial Scale of Impacts

	Ranking Criteria		
	Low (L-)	Medium (M-)	High (H-)
Duration	Quickly reversible (less than the project life - Short-Term)	Reversible over time (within life of the project - Medium-Term)	Permanent (beyond closure - Long-Term)
Spatial Scale	Localised (within site boundary - Site)	Fairly widespread (beyond site boundary – Local)	Widespread (far beyond site boundary – Regional / National)

Where the severity of an impact varies with distance, the severity should be determined at the point of compliance or the point at which sensitive receptors will be encountered. This position corresponds to the spatial extent of the impact.

CONSEQUENCE OF IMPACTS

Having ranked the severity, duration and spatial extent, the overall consequence of impacts can be determined using the following qualitative guidelines:

Table 27: Ranking the Consequence of an Impact

Severity = L

DURATION	Long Term	H	Medium	Medium	Medium
	Medium Term	M	Low	Low	Medium
	Short Term	L	Low	Low	Medium

Severity = M

DURATION	Long Term	H	Medium	High	High
	Medium Term	M	Medium	Medium	High
	Short Term	L	Low	Medium	Medium

Severity = H

DURATION	Long Term	H	High	High	High
	Medium Term	M	Medium	Medium	High
	Short Term	L	Medium	Medium	High
			Low	Medium	High
			Localised - within site boundary (Site)	Fairly widespread - beyond site boundary (Local)	Widespread - Far beyond site boundary (Regional/National)
			SPATIAL SCALE		

To use **Table 27**, firstly go to one of the three "layers" based on the severity ranking obtained from **Table 24** and/ or **Table 25**. Thereafter determine the consequence ranking by locating the intersection of the appropriate duration and spatial scale rankings.

OVERALL SIGNIFICANCE OF IMPACTS

Combining the consequence of the impact and the probability of occurrence, as shown by **Table 28**, provides the overall significance (risk) of impacts.

Table 28: Ranking the Overall Significance of Impacts

Probability	Definite Continuous	H	Medium	Medium	High
	Possible Frequent	M	Medium	Medium	High
	Unlikely Seldom	L	Low	Low	Medium
			Low	Medium	High
			CONSEQUENCE (from Table 27)		

The overall significance ranking of the negative environmental impacts provides the following guidelines for decision making (**Table 29**):

Table 29: Guidelines for decision-making

	Nature of Impact	Decision Guideline
High	Unacceptable impacts	Likely to be a fatal flaw.
Moderate	Noticeable impact	These are unavoidable consequence, which will need to be accepted if the project is allowed to proceed.
Low	Minor impacts	These impacts are not likely to affect the project decision.