REVIEW OF MONITORING AND MODELLING REQUIREMENTS

Progress Report No. GRDM-2019 PR.5, Draft Report

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COMPILED BY

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ABBREVIATIONS AND DEFINITIONS

AQA	Air Quality Act, Act 39 of 2004
AQM	Air Quality Monitoring
AQMP	Air Quality Management Plan
AQO	Air Quality Officer
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEADP	Department of Environmental Affairs and Development Planning
DEA	Department of Environmental Affairs
EIA	Environmental Impact Assessment
GRDM	Garden Route District Municipality
H_2S	Hydrogen Sulphide
IDP	Integrated Development Plan
mg/ton	Milligrams per Ton
MSA	Municipal Systems Act
MSW	Municipal Solid Waste
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
PM10	Particulate Matter with aerodynamic diameter smaller than 10 micron
SAAQIS	South African Air Quality Information System
SAWS	South African Weather Service
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
THC	Total Hydrocarbon Content
tpa	Tons per Annum
TPM	Total Particulate Matter
USEPA	United States of America Environmental Protection Agency

MONITORING AND MODELLING REQUIREMENTS

1 INTRODUCTION

An air quality management plan (AQMP) was compiled for the Garden Route District Municipality (GRDM) in 2007 and included in GRDM's Integrated Development Plan (IDP) shortly thereafter.

As is required by law, the AQMP must be revised on a 5 to 6-yearly basis to ensure that it remains current. As a result it was revised in 2012/13 and the revised plan was also included in GRDM’s IDP.

The process of revision of the 2012/13 version of the AQMP commenced early in 2019 after Lethabo Air Quality Specialists (Pty) Ltd (LAQS) was awarded the contract to do so. The following items were included in the Service Level Agreement (SLA) entered into between GRDM and LAQS:

1. Assessment of compliance with existing AQMP
2. Status quo assessment
3. Compile an emissions inventory
4. Assess the level of air quality monitoring and modelling in the district
5. Assess the relevant municipal resources in the district
6. Review the air quality duties, functions and responsibilities within Garden Route District Municipality
7. Conduct a public participation process
8. Review and compile and AQMP for the Garden Route District Municipality

LAQS’s findings of the first item are contained in its report No. GRDM-2019 Progress Report No. 1 of April 2019.

As the two items are interlinked, LAQS assessed the air quality status quo and municipal activity as a single investigation and its findings are contained in its report No. GRDM-2019 Progress Report No. 2 of April 2019.

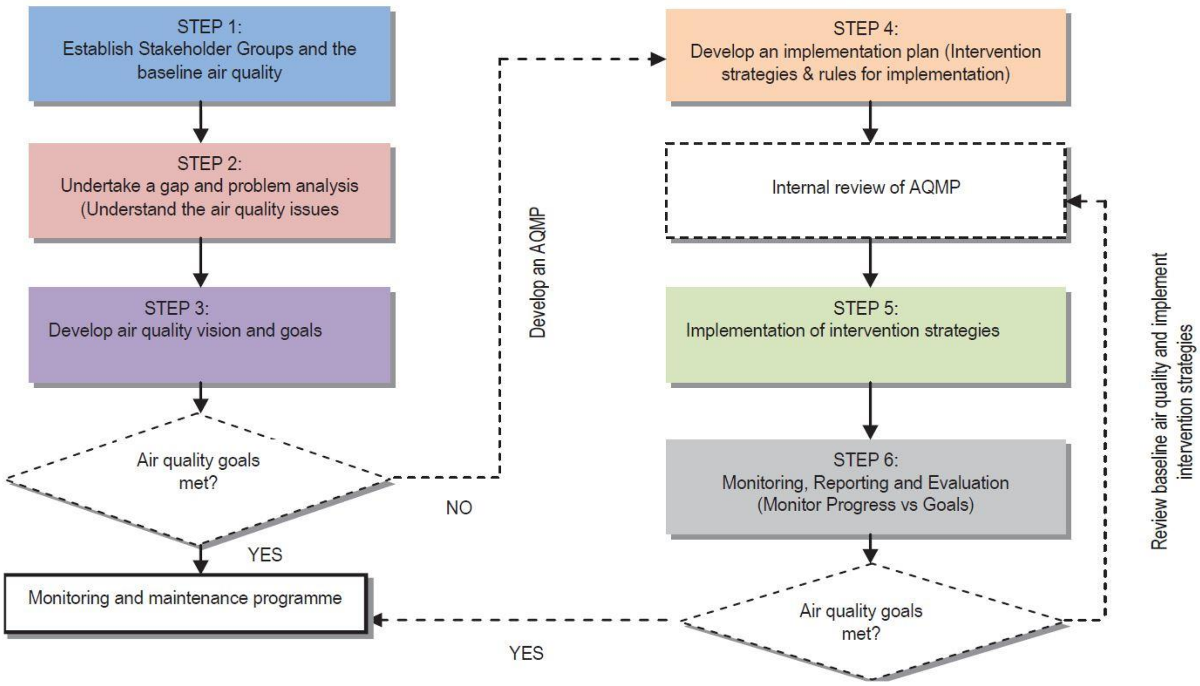
The completed emissions inventory for the GRDM region is discussed in LAQS’s report No. GRDM-2019 Progress Report No. 3 of May 2019.

This information served as input data to an extensive dispersion modelling study for each of the seven municipalities in the Garden Route district and the findings are given in LAQS’s report No. GRDM-2019 Progress Report No. 4 of May 2019.

This progress report gives LAQS's interpretation of the current state of air quality monitoring and modelling activities within GRDM.

2 LEGAL FRAMEWORK

The Department of Environmental Affairs (DEA) defined a National Framework for Air Quality Management in the Republic of South Africa in 2007 and reviewed the Framework in 2017. In the section dealing with air quality management plans the 2017 National Framework suggests the following graphic generic air quality management process:



The process shown above indicates that all decisions on air quality management are based on the air quality goals in the region which is defined as part of the AQMP development process. These goals have been set by GRDM as is discussed in LAQS report No. GRDM0-2019 PR.1 of April 2019. Once these goals are met, a program of monitoring and maintenance must be followed to test whether the air quality goals are met continuously.

Section 24 of the Constitution states that everyone has the right:

a. *To an environment that is not harmful to their health or well-being; and*

b. *To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that -*

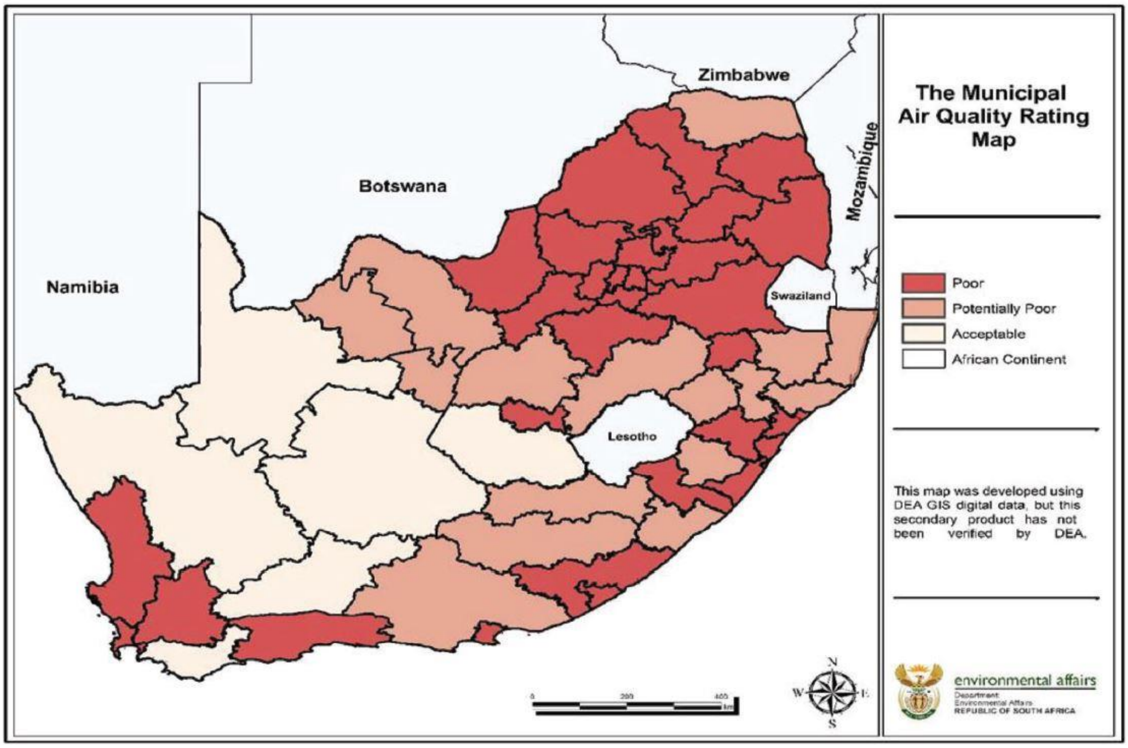
   i *prevent pollution and ecological degradation;*

ii promote conservation; and

iii secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development

In order to give effect to this right in the context of air quality, it is necessary to ensure that levels of air pollution are not harmful to human health or well-being. There is only one way of ensuring that the ambient air is not harmful and that is to measure it continuously.

While it may be the perception in some quarters that the quality of the air in the GRDM is good, Section 5.3.4.2 of the 2017 National Framework classifies the air quality in the Garden Route District municipal area as "poor" as a result of the combined urban and industrial activities in the region. DEA's municipal air quality rating map is shown below. The National Framework defines "poor" air as "ambient air quality standards regularly exceeded". LAQS, however, does not agree with this classification as air quality monitoring done to date does not support this conclusion.



The National Framework lists some pollutants as "criteria pollutants", i.e. SO_2, NO_2, O_3, CO, lead, PM10 particulates and benzene. Ambient air quality (AQ) standards for all have been determined by Standards South Africa and have been published in Government Notice No 1210 on 24 December 2009. AQ standards for the following integration periods have been defined:

SO_2:	10 minutes, 1 hour, 24 hours, 1 year
NOx:	1 hour, 1 year
O_3:	8 hours,
CO:	1 hour, 8 hours
Benzene:	1 year
Lead:	1 year
PM10:	24 hours, 1 year
PM2.5:	24 hours, 1 year

In order to verify that the ambient air in Garden Route is, in fact, poor, or has deteriorated to the point where ambient air quality standards are exceeded regularly, it is necessary to monitor the ambient air in the GRDM.

This report discusses some air quality monitoring (AQM) requirements and modelling facilities that would be of great assistance to the GRDM

3 AIR QUALITY MONITORING

3.1 GENERAL

Distinction should be made between "monitoring" air pollutants and "measuring" air pollutants. The term "air quality monitoring" is not really the correct one to apply.

According to The Concise Oxford Dictionary the word "monitor" as a noun means "*any of various persons or devices for checking or warning about a situation, operation, etc*." As a verb it means "*maintain regular surveillance*". "Surveillance" is defined as "*close observation*." In a nutshell it means to watch closely.

A more descriptive term to use is "measure" which is defined as "*ascertain the quantity by comparison with a fixed unit of known size*". The keyword here is "quantify".

In reality, air quality monitoring is a combination of watching and quantifying. In some cases it is just not possible to compare a quantity with a known size, i.e. obtain actual values, and a relative change is the only indication available.

3.2 AIR QUALITY MONITORING REQUIREMENTS

Air quality monitoring can be conducted by either (or both) of two approaches. Firstly, the air quality can be monitored using "screening" methods. Secondly, internationally validated and approved methodology can be used.

SCREENING METHODS

Screening methods are relatively inexpensive and fairly simple to operate, but the resulting data will be subject to substantial levels of uncertainty. The outcome of screening methods cannot be used for regulatory purposes and are, therefore, only suitable for monitoring purposes. An example of a screening method is the use of passive samplers to monitor the concentration of a gas, or group of gases, over a period of time.

Screening methods will provide average results over the sampling period which, in many cases, can be several days. As a result screening methods will not provide short-term data, e.g. hourly or daily averaged concentrations.

Due to their relatively low costs screening methods are used to identify if an air quality problem potentially exists. Should results be significantly lower or significantly higher than ambient air quality standards, the results can be interpreted accordingly. However, if the results show marginal deviation from air quality standards screening methods do not have sufficient accuracy on which interpretations can be based.

INTERNATIONALLY ACCEPTED METHODS

Equipment meeting the requirements of internationally validated methods usually carry some form of official approval, e.g. USEPA certification, German TÜV approval, MCERTS certification, etc., indicating that they have been assessed thoroughly and found to comply with reference test methods.

The results provided by such methods are suitable for regulatory purposes, i.e. they are defendable, but they imply a significant increase in costs and complexity. An example of this approach is the establishment of a monitoring station fitted with automated pollutant measuring equipment.

This level of equipment is usually accompanied by strict operating environment limitations that must be met if the results are to be regarded as reliable and representative.

As most of the equipment falling in this category is automated, they are capable of measuring the concentrations of air pollutants continuously and with short integration intervals, e.g. 1 minute. As a result it is possible to measure short-term variations in pollutant levels.

In order to identify the direction from which the pollutants reach such an installation it is customary to add some basic weather sensors, e.g. wind speed, wind direction, temperature, etc., at the same location.

4 CURRENT MONITORING ACTIVITIES

Current air quality monitoring activities consist of a combination of screening and regulatory methods.

4.1 SCREENING METHODS

GRDM conducts monthly passive sampling tasks in various locations within the Garden Route district. The main purpose of the passive sampling project is to provide sampling information on problem pollutants in areas where Garden Route experiences complaints.

The passive sampling locations are, therefore, located in the receptor areas near industrial activities (source). Pollutants measured are NO_2, SO_2, H_2S and BTEX (benzene, toluene, ethyl-benzene and xylene) and the following programs are undertaken.

-- NO_2 and SO_2 is measured in Plettenberg Bay, Knysna (2 locations), Great Brak River and Mossdustria

-- HCl in Great Brak River

-- H_2S is currently measured in Mossdustria and Oudtshoorn

-- BTEX is measured in Albertinia and Great Brak River. Previously BTEX were also measured in Voorbaai

Passive sampling is not an accurate method of monitoring as it does not provide peaks and is not correlated to dispersion factors like meteorological conditions. Therefore, the results cannot indicate any incidents where ambient air quality limits for criteria pollutants or the WHO H_2S nuisance guidelines are exceeded.

The advantages are that it is cost effective and may provide information for future location of continuous monitoring within the Garden Route region.

In addition to the passive sampling activities, GRDM procured a Scentinel transportable multi-gas analyser that has been deployed at various locations on short-term monitoring projects. The analyser is capable of monitoring PM10, PM2.5, SO_2, NOx, O_3, CO, H_2S, VOCs, wind speed, wind direction, temperature and relative humidity. While also regarded as a screening device, it is capable of measuring short-term variations in gas concentrations, records the data and transmits it to a remote server from where the data can be inspected by authorised parties.

A Minivol portable particulate sampler has also been procured and is used for short-term monitoring project as and when needed. This sampler collects airborne particulates on a filter for subsequent manual gravimetric analysis. Depending on the sampler head installed, it can measure total particulate matter (TPM), PM10 particulates or PM2.5 particulates.

4.2 REGULATORY METHODS

Monitoring by means of automated methods is very expensive. The capital costs associated with an automated station that measures the concentrations of the criteria pollutants are approximately R 1.5 to R 2 million while annual running costs can be assumed to be equal to 10% of the capital costs. To date such costs have been out of the reach of GRDM.

The Western Cape Province's Department of Environmental Affairs and Development Planning (DEADP) kindly offered three automated stations on loan to GRDM. The day-to-day operation and data management is outsourced by DEADP to a contractor on a tender basis.

The three stations are currently located in George, Mossel Bay and Oudtshoorn.

The contractor responsible for data management records and validates data prior to submitting the results in report form to DEADP. Copies of the reports are available for downloading on DEADP's web site.

GRDM's AQO and all municipal officials active in air quality have access to the data through dedicated user names and password.

4.2.1 George Data

The George air quality monitoring station is located on the grounds of the municipal swimming pool and has been in operation since August 2010. The monitoring station is also included in the National Air Quality Information System (NAQIS) network.

The AQ monitoring station measures the following parameters:

-- SO_2, NOx, O_3, CO, PM10, wind direction, wind speed, temperature, relative humidity, solar radiation and rainfall.

Of the data published so far, the level of data capture at the George AQ station is high with an overall data capture rate of air pollutants in excess of 89%. The data capture rate of two weather parameters, i.e. wind speed and direction, is 68%, resulting in an overall data capture rate of 89%. This complies with the minimum data capture rate of 80% specified by the South African National Accreditation Service (SANAS) in their publication No. TR07-03, "Supplementary Requirements for the Accreditation of Continuous Ambient Air Quality Monitoring Stations".

The station reports a very low incidence, if any, where the ambient air quality standards are exceeded

4.2.2 Mossel Bay Data

The Mossel Bay air quality monitoring station is located on the premises of GRDM’s offices in Mossel Bay and has been in operation since January 2009. It was initially located in Bayview, then moved to Dana Bay and recently relocated to Ext. 23 in Mossel Bay.

The AQ monitoring station measures the following parameters:

-- SO_2, benzene, toluene, ethylbenzene, xylene (BTEX) and the same meteorological parameters as the station in George.

Of the data published so far, the level of data capture at the Dana AQ station is high with an overall data capture rate in excess of 83%, although the data capture rate of BTEX is below 45%. This complies with the minimum data capture rate of 80% specified by the South African National Accreditation Service (SANAS) in their publication No. TR07-03, "Supplementary Requirements for the Accreditation of Continuous Ambient Air Quality Monitoring Stations".

There is no South African air quality standard for H_2S, but The World Health Organisation (WHO) defined an odour guideline H_2S concentration of 5 ppb (7 $\mu g/m^3$) over a 30 minute period.

The Ministry of the Environment of the Canadian province of Ontario defined an air quality standard for H_2S at 5 ppb (7 $\mu g/m^3$) for a 24 hour average, 10 $\mu g/m^3$ for a 30 minute average and 13 $\mu g/m^3$ for a 10 minute average concentration.

The station reports a very low incidence, if any, where the air quality standards given above are exceeded.

4.2.3 Oudtshoorn Data

The Oudtshoorn air quality monitoring station is located on the grounds of the Bongolethu Clinic and has been in operation since April 2011. At the time of writing of this document monthly reports are available on DEADP's website.

The AQ monitoring station measures the following parameters:

-- H_2S, CO_2 and the same meteorological parameters as the station in George with atmospheric pressure as an additional parameter. Benzene, toluene, ethyl-benzene and xylene (BTEX) has been added as from May 2019.

Of the data published so far, the level of data capture at the Oudtshoorn AQ station is high with an overall data capture rate of 81.3%., although the CO_2 data capture rate is only 22%. This complies with the minimum data capture rate of 80% specified by the South African National Accreditation Service (SANAS) in their publication No. TR07-03, "Supplementary Requirements for the Accreditation of Continuous Ambient Air Quality Monitoring Stations".

As discussed in Section 4.2.2 above no ambient air quality standard for H_2S exists in South Africa. However, the station reports frequent incidents where the WHO odour limit is exceeded.

4.3 AIR QUALITY MONITORING DISCUSSION

As was stated in Section 4.1 above, screening methods are most suitable as "monitoring" activities, i.e. long-term surveillance of ambient air quality levels. As such GRDM's approach to date has been successful and the methodology applied correctly.

This activity should, therefore, proceed on the current basis.

The AQ monitoring station located at George has shown that the ambient air quality standards are not at threat at its current location. As it forms part of the NAQIS network, it is unlikely that this station can be deployed elsewhere as it forms part of a long-term air quality monitoring network.

The AQ monitoring stations at Mossel Bay and Oudtshoorn should remain at their current locations. Both stations are set up to measure the concentrations of H_2S in their areas, a compound that is highly odorous and detectable at low concentrations.

5 AIR QUALITY IN GRDM

LAQS conducted an extensive dispersion modelling which covers each of the seven municipalities in the Garden Route region and its findings are discussed in detail in its report No. GRDM-2019 PR.4 of May 2019. Information contained in the emissions inventory, as given in LAQS' report No. GRDM-2019 PR.3, served as input data to the dispersion model.

The dispersion modelling study yielded some unexpected results as it indicated some potential problems that were not considered previously. LAQS derived the following conclusions:

5.1 BITOU

Emissions of PM10 particulate matter from the two brick manufacturing operations using clamp kiln methods, i.e. Kurland Bricks and Vantell Bricks, have the highest impact on air quality in Bitou. It is estimated that the 99-percentile PM10 concentrations in the immediate vicinity of these two operations may exceed and relevant ambient air quality standard, albeit only marginally so in the case of Vantell Bricks.

Emissions of SO_2, NO_2 and CO all result in ground-level concentrations that are well below the official ambient air quality standards.

5.2 KNYSNA

The dispersion model estimates that the maximum annual average concentration of NO_2 along Main Road in Knysna will be approximately 28.6 $\mu g/m^3$ which is approximately 70% of the ambient air quality standard of 40 $\mu g/m^3$. The maximum 99-percentile NO_2

concentration will be approximately 216 µg/m^3 which is in excess of the ambient air quality standard of 200 µg/m^3.

Although LAQS is of the opinion that there is too much uncertainty in the estimated vehicle emissions to state categorically that the 99-percentile air quality standard for NO_2 will be exceeded, it is of the opinion that the indications are potentially serious and should be investigated through a targeted air quality monitoring project.

5.3 GEORGE

As can be expected, the emissions from industries located in the industrial area immediately north of the N2 and east of York Street contribute the most to ground-level air pollutants in George.

While the estimated ground-level concentrations of most of the pollutants are well below the relevant ambient air quality standards, the dispersion model estimates that the 99-percentile ambient air quality standard for PM10 is 76.6 µg/m^3 which is marginally higher than the air quality limit of 75 µg/m^3.

The dispersion model further estimates that the maximum 99-percentile air quality standard of 75 µg/m^3 may be exceeded marginally in the vicinity of the Airport where a maximum ground-level concentration of 77 µg/m^3 is estimated.

As is the case with NO_2 emissions in Knysna, there is too much uncertainty in the calculation of PM10 and NO_2 emissions from the various industries in the area to make a categorical statement to this effect. It is recommended that a dedicated PM10 monitoring program is set up to monitor the situation in the industrial area over a period of time.

5.4 MOSSEL BAY

The impact of vehicle related NO_2 emissions along the R102 past Voorbaai and towards Heiderand are high. The highest 99-percentile value estimated by the dispersion model is 176 µg/m^3 which is approximately 88% of the relevant ambient air quality standard of 200 µg/m^3.

As is known, the main sources of odorous emission are located in Mossdustria and the dispersion model estimates that odours will generally be detectable in and around that area. The 99-percentile simulation shows that odours could extend well to the south-east and south-west of Mossdustria and can cover Dana Bay and the western parts of Mosssel Bay.

5.5 HESSEQUA

Due to the low density of air pollutant sources in the Hessequa region, and the substantially lower traffic flows along the N2 national road, all of the estimated ground-level concentrations are well below the respective air quality standards.

5.6 KANNALAND

The three industrial sources in Ladismith contribute jointly to the estimated ground-level concentrations of TPM, SO_2, NO_2 and CO in the area, although these concentrations are all well below the relevant air quality standards.

The small-scale wastewater treatment works is not regarded as a serious odour generator in the area.

5.7 OUDTSHOORN

The dispersion model estimates that both the annual average and 99-percentile daily average ambient air quality standards of 40 µg/m^3 and 75 µg/m^3 respectively for PM10 will be exceeded by a substantial margin in a fairly large area surrounding Johnson Bricks' operations to the north-east of Oudtshoorn. This process is also based on the use of clamp kilns. The model estimates the maximum annual average concentration to be 106 µg/m^3 while the maximum 99-percentile daily average concentration is estimated to be 955 µg/m^3.

The model further estimates that both the annual average and 99-percentile air quality standards of 50 µg/m^3 and 350 µg/m^3 respectively for SO_2 will also be exceeded by a significant margin in the same area. The model estimates the maximum annual average concentration to be 81 µg/m^3 while the maximum 99-percentile daily average concentration is estimated to be 1 042 µg/m^3.

The model also estimates that both the annual average and 99-percentile air quality standards of 40 µg/m^3 and 200 µg/m^3 respectively for NO_2 will also be exceeded by a significant margin in the same area. The model estimates the maximum annual average concentration to be 65 µg/m^3 while the maximum 99-percentile daily average concentration is estimated to be 836 µg/m^3.

As is known, the three major sources of odours to the south and south-east of Oudtshoorn, i.e. Klein Karoo International, PSP Timbers and the wastewater treatment works emit odours that are generally detectable in the southern part of Oudtshoorn, while the 99-perentile simulation shows that odours may be detected over a large part of the town.

5.8 GENERAL

While the dispersion model did not specifically point out problems in the following areas, industries located in those areas have been the source of some complaints:

-- Mossel Bay: Several complaints about emissions from Rheebok Bricks's operations have been lodged in the Tergniet area. PG Bison's Woodline plant, which uses creosote, is located in the area as Rheebok ricks and could contribute to the complaints. As can be seen from Section 4.1 some monitoring activities are already being conducted in this area.

-- Hessequa: South Cape Poles' creosote plant is the cause of some odour-related complaints in the area, although the dispersion model showed that odours may lead to sporadic complaints and not on a daily basis. Monitoring for volatile organic compounds is being conducted in the area, using screening methods.

-- Oudtshoorn: As is shown in Section 4.1 above, some odour-related monitoring activities are already being carried out in Oudtshoorn.

6 FUTURE MONITORING REQUIREMENTS

Future monitoring requirements are best described when divided into two separate sections, i.e. long-term continuous monitoring activities and short-term, project orientated monitoring activities.

6.1 LONG-TERM CONTINUOUS MONITORING

6.1.1 Air Pollutants

The emissions inventory as discussed in LAQS Progress Report No.GRDM-2019 PR.3 shows that the largest concentrations of industries are at George, Mossel Bay and Oudtshoorn. In addition, the most air quality related complaints originate from Mossel Bay / Dana Bay and Oudtshoorn. These complaints are mostly odour related.

A fixed, automated continuous ambient air quality monitoring station is located in each of these three towns. The stations were provided and are maintained by the Western Cape Provincial Government and no additional automated monitoring stations are recommended.

6.1.2 Weather Parameters

It is accepted that the three continuous monitoring stations referred to above also collect weather data, but it is not the primary goal of these stations and it is of no serious consequence if the weather parameters are not logged continuously.

GRDM only has one complete weather station and that is located in Mossel Bay. The results of the dispersion model show that problem areas may also potentially exist in George and Oudtshoorn and it is strongly recommended that weather stations are also installed in those two towns.

Such weather stations will make GRDM self-sufficient as far as gathering weather data for dispersion modelling is concerned. The weather stations should be copies of the installation in Mossel Bay as it collects data on all of the parameters required for dispersion modelling purposes.

The collected weather data will not only be of use to GRDM, should they decide to set up their own dispersion model, but also provide accurate and reliable weather data to consultants that carry out air quality impact assessments as and when required. A single source of reliable weather data will remove some of the uncertainties associated with the use of different weather data sets for such purposes, thus assisting GRDM in their evaluation of air quality impact assessments.

6.2 PROJECT ORIENTATED MONITORING

LAQS made the following recommendations after concluding the dispersion modelling study:

Knysna

The results of the dispersion modelling study show that there is a possibility that the short-term air quality standard for NO_2 may be breached along Main Road in Knysna. NO_2 affects human health as it affects, inter alia, lung function as it dissolves in tissue fluid to form nitrous and nitric acid.

Given the close proximity of shops to Main Road, the large number of pedestrian that frequent Main Road and the large number of motorists that make us of it, LAQS sees the high estimated NO_2 concentrations as a health threat that warrants further investigation.

As a result LAQS recommends that a dedicated air quality monitoring program is set up, using GRDM's Scentinel analyser. Such a monitoring program should be carried out in the following two phases:

-- Phase 1: Monitoring continuously during the months of June and July, i.e. mid winter when poor dispersion conditions usually occur due to prevailing weather conditions

-- Phase 2: Monitoring continuously during the months of December and January when by far the highest vehicle flows through man Road occur.

Bitou

The dispersion model predicts that the short-term PM10 air quality standard may be exceeded in the vicinity of the two brick manufacturing operations, i.e. Kurland Bricks and Vantell Bricks, with the former having the greatest impact. It is fortuitous that both of these operations are active in areas of low population density.

It is likely that both of these operations carry our dust-fallout measurements as part of their AEL obligations, but dust fallout limits far exceed ambient air quality PM10 standards.

It is recommended that a PM10 monitoring program is set up to monitor on a daily basis. A MiniVol-type sampler will suffice. The monitoring program should be carried out for a period of one month during mid winter and daily samples should be collected and analysed.

George

Similarly, it is recommended that a PM10 monitoring program is set up in the industrial area of George immediately to the north of the N2 as the dispersion model estimates high daily averaged concentrations in that area.

The monitoring program should also be carried out during mid winter and daily samples of PM10 should be collected and analysed.

Oudtshoorn

When it commenced operations, Johnson Bricks' operations were located some distance from residential areas. However, population growth and the concomitant expansion of residential areas resulted in the encroachment of residential on proximity of Johnson's Bricks to the point where the nearest residential area is quite close to the plant.

The dispersion model predicts that PM10, SO_2 and NO_2 emissions from this operation will exceed both the short-term and long-term air quality standards in a fairly large area around the site. According to the dispersion model these impacts are by far the greatest in the whole of the GRDM region.

It is recommended that a long-term passive sampling project is launched to monitor the ground-level concentrations of SO_2 and NO_2 at location that falls within the dispersion model's area of impact.

The passive gas monitoring activities should be supplemented with daily PM10 monitoring activities, using a MiniVol-type of sampler. PM10 sampling should be carried out over a period of one month during mid winter.

Mossel Bay

While not as urgent as the others, it is recommended that a road-side monitoring program along the R102 in either Voorbaai or towards Heiderand is designed, using GRDM's Scentinel analyser. The dispersion model predicts that 99-percentile NO_2 concentrations are high and should be verified by the monitoring program.

The monitoring program should cover a period of two months over mid winter.

Five of the seven municipalities require some form of air quality monitoring and these are essentially related to the monitoring of PM10 particulates and/or nitrogen dioxide.

According to the National Framework for Air Quality Management in South Africa, ambient air quality monitoring is a primary responsibility of both a B-municipality, as well as of a district municipality. LAQS recommends that the monitoring projects listed above are formalised and coordinated by GRDM, but that the day-to-day activities associated with the work are done by the individual municipalities involved. In applications where GRDM's Scentinel analyser is required the work will have to be done by GRDM personnel, but with the input and support of municipal personnel.

This implies that the municipalities must budget for the costs involved, i.e. possibly procuring sufficient equipment as well as the analytical costs that may be involved. The following components are regarded as essential if a municipality is going to do the work in-house:

PM10 particulates:

-- A battery-powered sampler that is capable of collecting a sample continuously over a period of 24 hours with a totalizer to record the total volume of air sampled during the period. The MiniVol sampler is an example of a suitable sampling unit, but there are others available on the market as well.

-- A battery charger and a spare battery that can be charged overnight while a sample is being collected.

-- A four decimal figure microbalance to determine the mass of material collected on a filter by gravimetric means.

Passive sampling for SO_2 and/or NO_2:

-- A suitable sampler housing for each sampling point

-- A diffusion tube holder for each gas at each sampling location

-- Replacement diffusion tubes to be used after 14 days of sampling

-- Access to a suitably qualified and experienced laboratory to do the chemical analysis of the diffusion tubes

The hardware components listed above are reusable and can be kept after completion of the monitoring projects for future use as and when required.

7 MODELLING REQUIREMENTS

The dispersion modelling study conducted by LAQS identified areas of concern that were not previously regarded as such and has shown that a dispersion modelling facility is of great use in the management of air quality.

A comprehensive GIS-based dispersion modelling facility is, therefore, recommended for the Garden Route District Municipality as, in LAQS's opinion, it is the most cost-effective tool to investigate the impact of air pollutant emissions in the district.

A centralised dispersion model will allow GRDM's AQO to investigate ambient air quality in general without installing expensive ambient air quality monitoring equipment. The model will indicate areas where ambient air quality limits may be exceeded, thus identifying hot-spots that require further investigation and enabling the optimum location of ambient air quality monitoring equipment.

Application of the model in individual municipal areas can be achieved either by granting access to the model through controlled internet access to the software installed on GRDM's servers, by entering into service level agreements with GRDM, or by commissioning GRDM to do such work on an ad hoc basis.

Such a facility must not be seen as a tool that can be used instead of ambient air quality monitoring. At the end of the day it is only a model that predicts ambient air quality as a result of air pollution emissions. This prediction is based on a mathematical model that uses emission and meteorological data supplied by the user. The output of the model is, therefore, only as reliable as the quality of the input data.

A centralised dispersion modelling facility must be seen as complementary to ambient air quality monitoring activities. Its output can be correlated against actual measurements taken with ambient air monitoring equipment, where such equipment is available, and this correlation can be used to investigate air quality impacts in areas where no monitoring activities occur.

A dispersion model needs the following information:

-- What is emitted?

-- How much is emitted?

-- When is it emitted?

-- From where is it emitted?

-- What are the prevailing weather conditions in the area where emissions occur?

The first two questions are answered by GRDM's emissions inventory.

The third question can be answered by a simple questionnaire to industries in the region (if not already known).

By choosing a GIS-based dispersion model, the fourth question is answered as emissions sources are inserted in the model's GIS-based emission database as the coordinates of the emission sources are assigned automatically.

The most difficult question to answer is the prevailing weather conditions. One of the objectives of the first AQMP recommended the installation of a suitable weather station in each of the seven municipalities in the District. Due to financial constraints, only one such station could be erected to date and it is in Mossel Bay. It is highly recommended that at least two additional weather monitoring stations are planned and budgeted for, i,e, for George and Oudtshoorn.

Fortunately there are organisations that monitor weather conditions continuously in the region, i.e. South African Weather Service and the Agriculture Research Council, and annual updates can be obtained from these organisations until such time that GRDM can set up their own weather monitoring stations.

A comprehensive dispersion model must also be seen as a cost-effective tool to study and manage air quality in the GRDM region. It was stated in Section 4.2 above that the capital costs associated with one AQ monitoring station amount to approximately R 1.5 to R2 million for a tool that can measure air pollutant concentrations at a single point only.

The costs of an extensive air pollution dispersion model can be expected to amount to approximately R 150 000 for a tool that is applicable across the whole of the GRDM region.

7.1 DISPERSION MODEL DISCUSSION

Much has been written about the preferred dispersion model for specific scenarios. DEADP launched a project some time ago to define which dispersion models are best applicable to various areas in the Western Cape. Two models came to the fore, i.e. Aermod and Cal-Puff, both of which as USEPA-approved dispersion models, and DEADP defined the use of either of the two models to be applicable to specific areas within GRDM.

Aermod is described by the USEPA as suitable for the following applications:

A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD can be applied on scales of up to 50 km from source.

Cal-Puff is described by the USEPA as suitable for the following applications:

A non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. 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 subgrid 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 basic differences between the two models are:

-- Aermod is a steady-state model, i.e. assumes that emissions do not undergo any chemical or physical reaction in the air, but disperses vertically and horizontally, mainly due to the instability of the boundary air layer. CalPuff is a non-steady-state model which allows for secondary changes to air pollutants in air.

-- Aermod can be used for dispersion studies up to 50 km from a source. CalPuff is typically used for dispersion studies on long-distance scales.

-- The meteorological data requirements for Aermod are must less complex than for CalPuff as data from a single surface monitoring station will suffice. Calpuff requires input from a number of such stations.

Therefore, Calpuff is more suitable for large-scale dispersion modelling studies, e.g. for DEADP's requirements of provincial scale studies.

The impact of emissions from any source reaches a maximum relatively close to the source, i.e. less than 2 to 3 km from source, provided, of course, that emissions occur below the inversion layer. As none of the industrial sources in GRDM have stacks high enough to breach the inversion layer, Aermod is far more useful for GRDM's purposes and requires far less meteorological data than CalPuff.

8 CONCLUSIONS

LAQS is of the opinion that the current screening air quality monitoring activities should be maintained at its current level and approach.

The current fixed AQM stations in Mossel Bay, George and Oudtshoorn are regarded as sufficient for the GRDM region. However, the installation of dedicated weather stations in George and Oudtshoorn to collect data for dispersion modelling studies is recommended. This will make GRDM self-sufficient in the field of collecting weather data for dispersion modelling purposes.

It is recommended that the additional targeted AQ monitoring projects, as set out in Section 6.2, are planned and initiated to address the concerns resulting from LAQS' dispersion modelling study. These projects should be coordinated by GRDM, but carried out by the individual municipalities concerned as much as possible as part of their primary air quality management responsibilities.

A centralised air dispersion facility accessible to all air quality officials, both at GRDM and at the individual municipalities, is strongly recommended. It is a cost-effective way of carrying out desk-top investigations into a wide variety of air quality issues. Should such a facility be set up, it will require suitable weather data, such as is currently being recorded by GRDM's weather station in Mossel Bay, and will be recorded in George and Oudtshoorn should LAQS's recommendation for weather stations in those towns be accepted.