2015

BASELINE AIR QUALITY ASSESSMENT REPORT FOR THE PROPOSED LAMU COAL POWER PLANT PROJECT FOR

KURRENT TECHNOLOGIES LIMITED

3/2/2015

Client	**KURRENT TECHNOLOGIES LIMITED**
Report no.	**52-1481**
Project Title	**BASELINE AIR QUALITY ASSESSMENT FOR PROPOSED LAMU COAL POWER PLANT PROJECT**
Project Location	**KWASASI MAINLAND- LAMU COUNTY**
Revision Status	**FINAL**

PROJECT QA/QC

Rev.	Date	Prepared	Reviewed	Approved
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Company Stamp	Signatures		

Disclaimer

This Baseline Air Quality Assessment Report has been carried out to the best of our knowledge and ability and within the terms of contract with the client and is limited to the exercise of reasonable care. This report is not intended to relieve the Establishment from their contractual obligations. This report reflects our findings at the time and place of intervention and is issued under the General Conditions of Service.

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Abbreviations

µg/m3	Micro gram per cubic meter
AQG	Air Quality Guidelines
EIA	Environmental Impact Assessment
EMC	Environment Management Coordination
GC-MS	Gas Chromatography – Mass Spec
KTL	Kurrent Technologies Limited
NOx	Oxides of Nitrogen
PM10	Particulate matter (<10 microns)
SOx	Oxides of Sulphur
WHO	World Health Organization

INTRODUCTION

SGS has undertaken air quality baseline measurements within and at the vicinity of the proposed Lamu Coal Power Plant site in Lamu. The measurements were done to evaluate concentrations of the following: particulate matter PM, Sulphur Dioxide (SO_2), and Nitrogen Dioxide (NO_2) in the environment in relation to the applicable guidelines provided by the Draft Air Quality Guidelines and the World Health Organization (WHO). Monitoring began from 10th January and ended on 17th February 2015. The data was collected for a maximum one month and then reported for the period of collection.

SCOPE OF WORK

The scope of work was as follows:

- Identify suitable monitoring locations taking cognizance of inhabitants patterns within the vicinity of the proposed site
- Undertake monitoring for NO_2 and SO_2 utilizing passive diffusion tubes at positions both up- and downind location from the proposed location of the site, collecting samples for a period of one calender month.
- Undertake monitoring for $PM_{2.5}$ and PM_{10}, collecting a four hours sample per location/ point.
- The $PM_{2.5}$ and PM_{10} filters were then submitted to the laboratory for gravimetric determination
- Compile the findings of the air quality survey in a final report

PROJECT DESCRIPTION

Based on the proposal submitted by SGS and adopted by Kurrent Technologies Limited, VOCs, NO_2, SO2 and Particulates measurements took place using Minivol (for particulate matter) and Radiello Passive diffusion tubes for the gases. The measurements were done at

- The proposed site (Kwasasi)
- 19 exposure points surrounding the proposed project site.

This report assesses the data collected from the monitoring locations for four hours for particulates and one month for gases.

The environmental impact of the coal associated industries includes issues such as land use, waste management, water and air pollution caused by use of coal products.

Furthermoin, addition to atmospheric pollution, coal burning produces hundreds of millions of tonnes of solid waste including ash and flue-gas desulfurization sludge that may contain mercury, uranium, thorium, arsenic and other heavy metals. It's therefore important to monitor these impacts prior and after the commisiong of the project.

In order to enable a fair judgement on the environmental implications of Lamu Caol Power plant, data relating to current state of the environment is presented below, however, due to resources the data deals with varying time scales.

- **Biodiversity flora nad fauna**

Lamu has an extensive mangrove forest and the project area around Kwasasi is home to many wildlife habitats and species which are relatively common and abundant in Kenya. Though not under any immediate threat, these habitats and species still need looking after and managed so they don't get out of control or put their future at risk.

The effects of air pollution both during construction and operation phases of the plant through motor vehicles and exhausts from the plant which are high in nitrogeneous gases may exert adverse effect on this ecosystem.

An action plan must be mapped commited on arresting these effects.

- **Population and Human Health**

Lamu is one of the 47 counties in Kenya. It measures approximately 6,167km^2 and has a population of 101,539 (as per 2009 census). Due to socio-economic factors, there exists a number of health inequalities. The project area currently has low car ownership and the occupants rely on motorcycles fro transport and hence poor road transport network. Based on this, the air quality within Kwasasi is assumed to be good with relatively low accident rates.

- **Air Quality**

Currently, domestic smoke and motorcycles are the primary causes of air pollution within Kwasasi area. The emissions include Nitrogen Dioxide, Sulphur dioxide, fine particles ($PM_{2.5}$ & PM_{10}) and Carbon Monoxide. With the introduction of the Coal power plant, heavy traffic is anticipated and fumes emitted from the plant's exhausts may aggravate this pollutants and cause health effects making breathing problems. The project must therefore roll out a plan on the mitigation of this emissions which should include continous monitoring at a specified time.

- **Climate**

Carbon dioxide is recognized as a major contributing factor to climate change. Road transport and operations at the proposed plant will impact on these on its daily release.

Coal-burning power plants are a significant source of Sulphur dioxide (SO2) and nitrogen oxides (NOx), which are major players in acid rain and ground level ozone (smog).
Nitrogen oxides are also greenhouse gasses that react with organic compounds to form smog, which damages plant life, making it vulnerable to disease and extreme weather. It can also impair human health by causing increased risk of asthma, lung damage and premature death.

Acid rain occurs when SO2 and NOX interact with water, oxygen, and other chemicals in the air to form sulphuric acid and nitric acid. This toxin can fall from the sky in rain over a widespread area, killing fish and plants. Forests are also impacted via direct damage to foliage and where forest soils have been stripped of nutrients by acid rain. The shocking impacts of acid rain on forests around the world have led to progress, in curbing toxic rain in the US and Europe for example, but it is estimated that acid rain still falls on 30 percent of the land in China, and on hundreds of its cities.

DESCRIPTION OF MONITORING POINTS

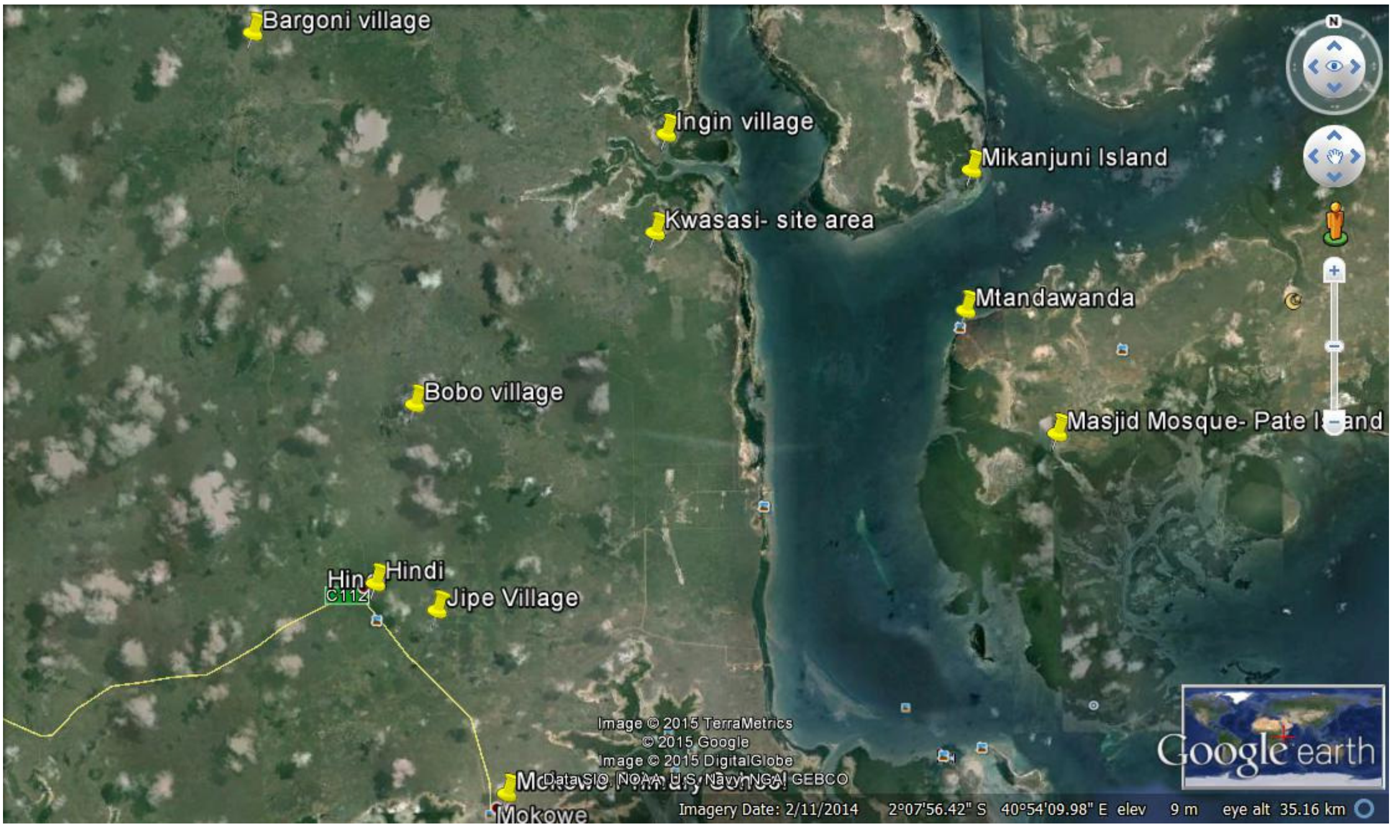
The project area is predominantly fallow land for agriculture with simsim and maize farming under-taken. A large area is covered by mangrove forest. A total of ten points were considered for baseline air quality study; one point within the project area and nine in the villages around the project site. The monitoring points were marked by a GPS and indicate as per below:

Table 1: baseline air quality monitoring locations

SAMPLING POINT	POINT COORDINATE		Site description.
	Latitudes	Longitudes	
BARGONI VILLAGE	*S02°02'50.4"*	*E040°47'10.0"*	This is a village along Hindi- Kiunga road and its baseline data is highly impacted by traffic along the road and emissions from thehouses
INGIN VILLAGE	*S02°03'46.7"*	*E040°53'40.6"*	This is a small residential village off Hindi- Kiunga road. Its baseline air data will be impacted by domestic emissions from the houses
BOBO VILLAGE	*S02°07'59.5"*	*E040°49'38.7"*	A village along Hindi- Kiunga road. The baseline data from this point is impacted by traffic and smoke from the commercial shades.
MOKOWE PRI-MARY SCHOOL	*S02°14'09.4"*	*E040°51'00.7"*	This is a school within Mokowe town. Mokowe town is considered an industrial set up hence the baseline air quality data will be influenced by traffic
JIPE VILLAGE	*S02°11'14.7"*	*E040°49'57.1"*	This is a residential village mostly inhabited by farmers and most of its baseline air quality influence would be domestic smoke.

HINDI AREA	*S02°10’48.3”*	*E040°48’59.1”*	Hindi is a busy shopping centre with relatively heavy traffic influencing on the baseline air quality data.
MASJID MOSQUE-PATE VILLAGE	*S02°08’49.5”*	*E040°59’89.2”*	This area is mostly inhabited by fishermen and farmers with domestic activities as the most probable sources of baseline air data
MIKANJUNI ISLAND OPPOSITE RE-SORT	*S02°04’24.8”*	*E040°58’29.6”*	This area is an island surrounded by the ocean. The baseline air quality at this point would be impacted by fishermen’s boat.
MTANDAWANDA-PATE JETTY	*S02°06’37.7”*	*E040°58’22.2”*	The area’s baseline air quality data is highly impacted by traffic of vehi-cles and motorcycles from the Jetty to Pate Island. Domstic smoke from the surrounding shades also contributes to air data.
KWASASI- SITE AREA	*S02°05’19.9”*	*E040°53’28.9”*	This point is within the project area with simsim farming as a major op-eration within the area. Sources of baseline air influence would be mo-torcycles and domestic smoke.

AERIAL PRESENTATION OF THEAIR QUALITY MONITORING POINTS



LEGISLATION AND GUIDELINES

It is understood that Lamu Coal Power Plant will put in place an environmental policy and action plan designed to ensure that all their facilities comply with the applicable national legislation, environmental and social safeguard policies and health safety guidelines upon its inception. Pursuant to this baseline air quality measurement shall be conducted on the proposed project site prior and after commissioning.

The current baseline air quality was assessed against the following legislation and guidelines; The Environmental management and coordination (Draft Air Quality Regulations), 2011 and the WHO air quality guidelines for particulate matter, Nitrogen Dioxide and Sulphur Dioxide, *Global update 2005.*

EMC (AIR QUALITY STANDARDS) REGULATIONS, 2011 (DRAFT)

The draft air quality guidelines have the objective to provide for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. Part 65 and 66 details the requirements on monitoring and assessment of ambient air quality, part 85 shows the need for establishment of baseline levels of priority air pollutants listed in the first schedule of the guideline and include; particulate matter, nitrogen dioxide and sulphur dioxide. The limits included in the Draft Air quality guidelines are shown in Table 2: Ambient air quality tolerance limits.

Table 2: Ambient air quality tolerance limits

Pollutant	TWA	Industrial Area	Residential, rural and other area
Sulphur oxides, Sox	24hrs*	120µg/m^3	80 µg/m^3
Oxides of Nitrogen, NOx	24hrs*	120µg/m^3	80 µg/m^3
Particulate Matter (<10µm)	24hrs*	120µg/m^3	60 µg/m^3

***These 24hr limits may not be exceeded more than three times in one year**

For the purpose of this project, residential, rural and other areas specifications shall be applied for the current data. Future assessment after the commissioning of the project will apply the industrial area specifications.

Further, Table 3: Ambient Air quality at property boundary, provides guidelines for pollutant concentrations at the property boundary.

Table 3: Ambient Air quality at property boundary

Pollutant	TWA	Property Boundary
Sulphur oxides, SOx	24hrs	125 µg/m^3

	Annual Average	50 μg/m^3
Oxides of Nitrogen, NOx	24hrs	150 μg/m^3
	Annual Average	80 μg/m^3
Particulate Matter	24hrs	70 μg/m^3
	Annual Average	50 μg/m^3

WHO AIR QUALITY GUIDELINES, GLOBAL UPDATE 2005

The WHO air quality guidelines (AQGs) are designed to achieve air quality that protects public health in different contexts and to offer guidance in reducing the health impacts of air pollution. The guidelines are based on expert evaluation of current scientific evidence. The guidelines recommend that pollutant concentrations be measured at monitoring sites that are representative of population exposures.

Table 4: WHO Ambient air quality guidelines

Particulate matter	Guideline Value
NO_2	40 μg/m^3 annual mean; 200 μg/m^3 1-hr mean
SO_2	20 μg/m^3 24hr- mean; 500 μg/m^3 10 minute mean
PM_{10}	20 μg/m^3 annual mean; 50 μg/m^3 24-hr mean
$PM_{2.5}$	10 μg/m^3 annual mean; 25 μg/m^3 24-hr mean

POTENTIAL PARTICULATE MATTER SOURCES

Possible sources of particulate matter are summarized in Table 1: Potential particulate matter sources below.

Table 1: Potential particulate matter sources

Particulate Source Group	Source Origins
Native soils and Fugitive Dust	Natural windblown deposits
Natural Sources	Plant pollen and spores and activities upwind of site
nearby activities	Motorcycle traffic and domestic smoke

ASSESSMENT METHODOLOGY

PASSIVE SAMPLING FOR GASES

Passive sampling involves adsorption of the pollutant gas in a capture tube. The capture tubes/filters are then sent to accredited laboratories for analysis in accordance with standard methodologies (ion chromatography/GCMS). The laboratory results and sampling duration information are used to calculate the gases concentrations. Figure 1 below shows an image of passive sampling tubes.

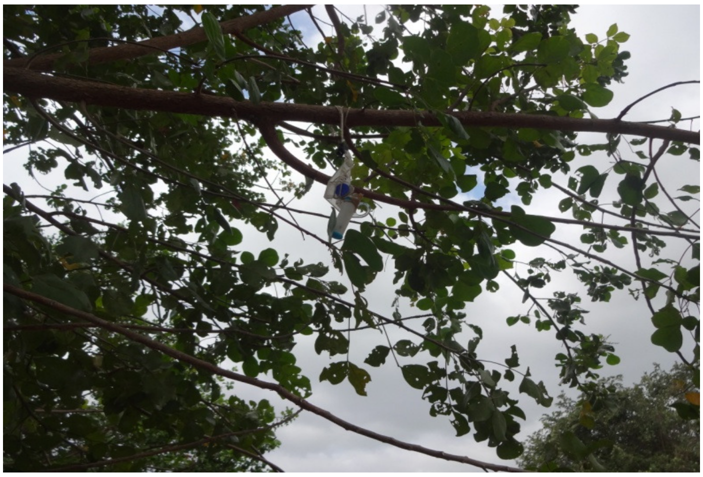


Fig 1: Image showing diffusive sampling tube

MINIVOL SAMPLERS

Minivol air samplers were used at the selected locations for fine particulate monitoring. The Minivol portable air sampler (fig. 2) is an ambient air sampler for particulate matter. The sampler is positioned with the intake upward in an unobstructed area, free from any obstruction to airflow. The sampler is fitted with a PM_{10} inlet, which only allows for particles of an aerodynamic diameter of less than 10 µm (PM_{10}) to pass through it for PM10 sampling and a $PM_{2.5}$ inlet, which only allows for particles of an aerodynamic diameter of less than 2.5µm ($PM_{2.5}$) to pass through it for PM2.5 sampling. The sample was drawn through the unit at a predetermined flow rate and collected onto filter papers over typically 4-hr sampling periods. Figure 2 below shows an image of the Minivol sampler.

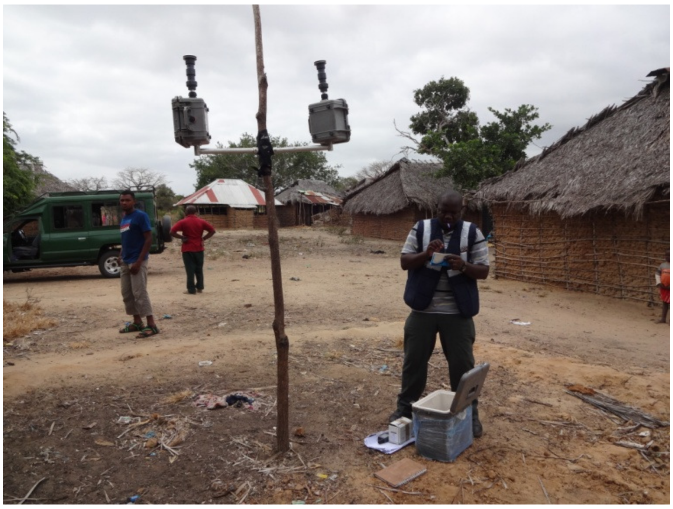


Figure 1: An image of Minivol air sampler

While not a reference method sampler, the mass concentrations of the MiniVol™ TAS gives results that closely agree with reference method concentrations in accuracy and precision. The MiniVol™ TAS features a programmable timer, a constant flow control system, an elapsed time totalizer, rechargeable battery packs, and an all-weather enclosure.

ASSESEMENT RESULTS

METEOROLOGICAL CONDITIONS

The average weather conditions observed during the survey period were mainly dry with clear skies. Day temperatures peaked at 32^{o}C and lowest at 23 ^{o}C during the day. Wind speed was typically between 5m/s and 9m/s. the recorded humidity was between 54 to 59%.

PARTICULATES (PM2.5 & PM10) RESULTS

PM 2.5 MONITORINGRESULTS

Table 6, below shows PM2.5 concentrations compared against the Draft Air Quality Guidelines and the WHO guidelines for each of the measurement locations.

Table 6 Measurement results for PM2.5

Filter Ref No.	Location ID	Start Date	Finish Date	PM2.5 (µg/m3)	WHO guidelines	Draft air quality guidelines
KTL 2	BARGONI VILLAGE	10-Jan- 15 @ 12:20hrs	10-Jan-15 @ 16: 25hrs	17,917	25	-
KTL 6	MTANDAWANDA-PATE JETTY	11-Jan- 15 @ 12:15hrs	11-Jan-15 @ 16: 15hrs	500		

KTL 7	MIKANJUNI ISLAND	11-Jan- 15 @ 12:45hrs	11-Jan-15 @ 16: 30hrs	455	25	
KTL 10	MASJID MOSQUE- PATE ISLAND	11-Jan- 15 @ 11:20hrs	11-Jan-15 @ 15: 25hrs	342		
KTL 11	HINDI MOSQUE	12-Jan- 15 @ 08:20hrs	12-Jan-15 @ 12: 20hrs	133		
KTL 14	JIPE VILLAGE	12-Jan- 15 @ 09:20hrs	12-Jan-15 @ 13: 20hrs	133		
KTL 16	MOKOWE PRIMARY SCHOOL	12-Jan- 15 @ 13:50hrs	12-Jan-15 @ 17: 50hrs	267		
KTL 18	BOBO VILLAGE	13-Jan- 15 @ 09:05hrs	13-Jan-15 @ 13: 05hrs	286		
KTL 20	INGIN VILLAGE	13-Jan- 15 @ 11:20hrs	13-Jan-15 @ 15: 20hrs	74		
KTL 22	KWASASI- SITE AREA	15-Jan- 15 @ 08:55hrs	15Jan-15 @ 12: 55hrs	606		

PM 10 MONITORING RESULTS

Table 6 Measurement results for PM10

Filter Ref No.	Location ID	Start Date	Finish Date	PM2.5 (µg/m3)	WHO guidelines	Draft air quality guidelines
KTL 1	BARGONI VILLAGE	10-Jan- 15 @ 12:20hrs	10-Jan-15 @ 16: 25hrs	16,519	50	60
KTL 5	MTANDAWANDA-PATE JETTY	11-Jan- 15 @ 12:15hrs	11-Jan-15 @ 16: 15hrs	342		
KTL 8	MIKANJUNI ISLAND	11-Jan- 15 @ 12:45hrs	11-Jan-15 @ 16: 30hrs	606		
KTL 9	MASJID MOSQUE-PATE ISLAND	11-Jan- 15 @ 11:20hrs	11-Jan-15 @ 15: 25hrs	444		
KTL 12	HINDI MOSQUE	12-Jan- 15 @ 08:20hrs	12-Jan-15 @ 12: 20hrs	667		
KTL 13	JIPE VILLAGE	12-Jan- 15 @ 09:20hrs	12-Jan-15 @ 13: 20hrs	227		
KTL 15	MOKOWE PRIMARY SCHOOL	12-Jan- 15 @ 13:50hrs	12-Jan-15 @ 17: 50hrs	317		

KTL 17	BOBO VILLAGE	13-Jan- 15 @ 09:05hrs	13-Jan-15 @ 13: 05hrs	147		
KTL 19	INGIN VILLAGE	13-Jan- 15 @ 11:20hrs	13-Jan-15 @ 15: 20hrs	310		
KTL 21	KWASASI- SITE AREA	15-Jan- 15 @ 08:55hrs	15Jan-15 @ 12: 55hrs	3,667		

SO_2 ASSESSMENT RESULTS

Table 2 SO_2 Monitoring Results as per Analytical report No. DB15-09627 RO attached.

Monitoring Point	Monitorng Duration (minutes)	SO2 Results	WHO guidelines	Draft air quality guidelines
		(µg/m³)		
BARGONI VILLAGE	**888**	**BDL**		
INGIN VILLAGE	**816**	**BDL**		
BOBO VILLAGE	**745**	**BDL**		
JIPE VILLAGE	**735**	**BDL**		
HINDI	**840**	**-**	**500**	**120**

MOKOWE PRIMARY SCHOOL	**730**	**BDL**		
MIKANJUNI ISLAND	**864**	**BDL**		
MTANDAWANDA- PATE JETTY	**820**	**-**		
PATE ISLAND- MASJID MOSQUE	**865**	**BDL**		
SITE AREA- KWASASI	**768**	**BDL**		

Key:

- **BDL** the findings were below the detection limits i.e. 1.0µg/filter (10 µg/m^3)
- **-** the sampling diffusion tubes were either destroyed or missing

SO_2 assessment Results

NO_2 ASSESSMENT RESULT

Table 3 NO_2 Monitoring Results as per Analytical report No. DB15-09627 RO attached.

Monitoring Point	**Monitorng Duration (minutes)**	**NOX Results**	**WHO guidelines**	**Draft air quality guidelines**
		(µg/m³)		
BARGONI VILLAGE	**888**	**17.3**	**200**	**120**
INGIN VILLAGE	**816**	**9.42**		
BOBO VILLAGE	**745**	**15.5**		
JIPE VILLAGE	**735**	**5.2**		
HINDI	**840**	**-**		

MOKOWE PRIMARY SCHOOL	**730**	**3.2**		
MIKANJUNI ISLAND	**864**	**2.2**		
MTANDAWANDA- PATE JETTY	**820**	**-**		
PATE ISLAND- MASJID MOSQUE	**865**	**26.6**		
SITE AREA- KWASASI	**768**	**10.0**		

Key:

- **-** the sampling diffusion tubes were either destroyed or missing

FACTORS THAT WILL AFFECT AIR QUALITY

DURING CONSTRUCTION

The most significant issues that could potentially impact on air quality and climate during construction are combustion gas emissions, NO_2, SO_2, CO, CO_2 and also nuisance dust. These pollutants are generated in varying amounts as a result of burning fossil fuels. The sources of atmospheric emissions containing these pollutants during construction are expected to be:

- Diesel exhaust emissions from construction vehicles and construction equipment
- Dust generation from vehicle movements and typical construction activities (e.g. grubbing, excavation, backfill, compacting etc).

The emissions will fluctuate based on the operating periods, nature of operations and the combination of machinery being used at any one time.

Construction activities and vehicle movements is expected to cause dust agitation in addition to that already caused by wind and ocean waves. It is likely that this will be exacerbated as a result of ground intrusion. Winds are expected to cause dilution effects, but also spread the dust over a larger area. The potential impacts are nuisance to the people in the area, coverage of crops and deposition on natural vegetation.

DURING OPERATION

These impacts on air quality anticipated during the operation phase should be monitored once the project is in operation.

RESIDUAL IMPACTS

The long term impact of nuisance dust will decline as stripped areas of land re-vegetate. The short term residual impact arising from the construction phase activities is anticipated to be **low**.

Because of the use of paved roads, and minimal, if any, intrusive excavation during operation, the level of nuisance dust associated to the operational phase is expected to be **very low**.

An environmental audit should be done during operation and the data compared to the baseline (background) levels. Mitigation will then be based on the significance of the effects of the pollutants.

CONSULTANT'S OBSERVATIONS AND CONCLUSIONS

OBSERVATIONS

For PM_{10} measurements, the filters were received in the laboratory in good condition without any tears or lose of sample evident. The main contributing factor to the dust load on the filters could be the dusty feeder roads in close proximity with the locations of the measurement points.

Out of the ten diffusion tubes set at different locations,

- ✓ eight were well recovered and sent to the laboratory for analysis.
- ✓ One was missing (at Mtangawanda- Pate jetty)
- ✓ One was received in damaged condition- probably by the birds.

Hwever, the main influence on the levels of Sox and NOx is the road traffic.

With prolonged exposure, four of the metals, Nickel, Cadmium, Chromium and Arsenic, are believed to cause cancer. Using standard risk factors and some very conservative assumptions, TRC calculated a cancer risk of six deaths per one million people for a 70-year exposure to maximum predicted particulate metal concentrations. The TRC analysis points out, however, that the predictions should be viewed as overly conservative for several reasons. For example, the metal mass fraction of all particulates was assumed to be that of the highly mineralized ore. In addition, a person would have to be physically located outdoors at the place of maximum metals concentrations for a period of 70 years well in excess of the expected mine life. In fact staffs conclude that the actual cancer risk would be far less.

<u>Visual Impacts</u>. The Final SEIS discusses visual impacts associated with predicted emissions. A screening model (VISCREEN) was used to predict visibility impacts due to particulates and nitrogen oxides. (A more thorough description of the overal Visual Management System used to predict and assess visual impacts from the overall mining operation is included in the staff report on Visual Resources.)

CONCLUSION

SOX AND NOX

There was **no** exceedance of the WHO AQG or the Draft air quality guidelines at all measurement points.

PARTICULATE MATTER,PM2.5 & PM_{10}

There was exceedance of the WHO AQG or the Draft air quality guidelines at all measurement points.

RECOMMENDATIONS

During the construction phase the proponent will be required to observe proper mitigation methods so as to maintain the low levels of the contaminants.

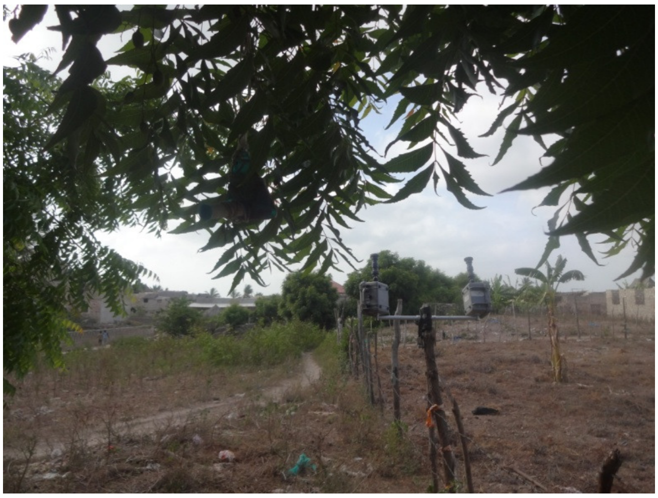
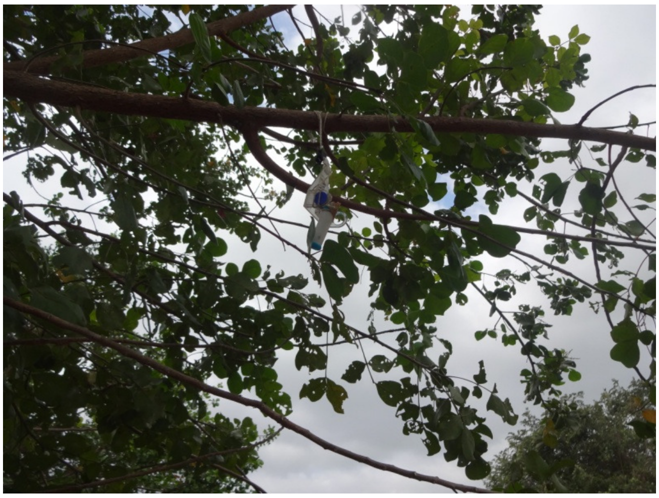
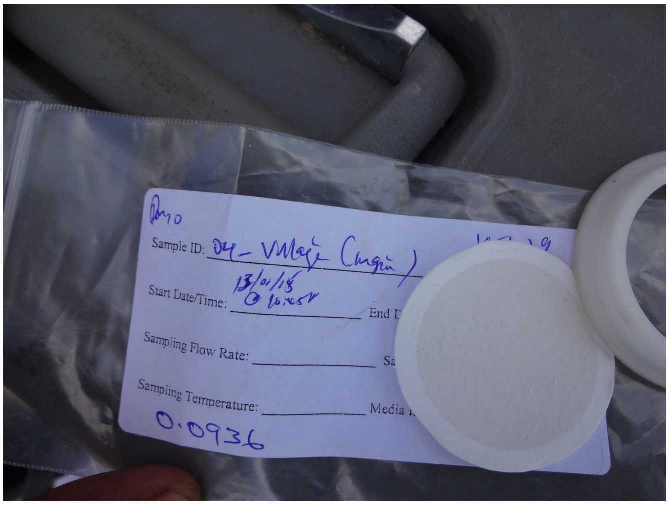
Furthermore, with prolonged exposure, four of the metals, Nickel, Cadmium, magnesium, magnesium, Chromium and Arsenic, are believed to cause cancer. Using standard risk factors and some very conservative assumptions, metals calculated a cancer risk of six deaths per one million people for a 70-year exposure to maximum predicted particulate metal concentrations. The metal analysis points out, however, that the predictions should be viewed as overly conservative for several reasons.

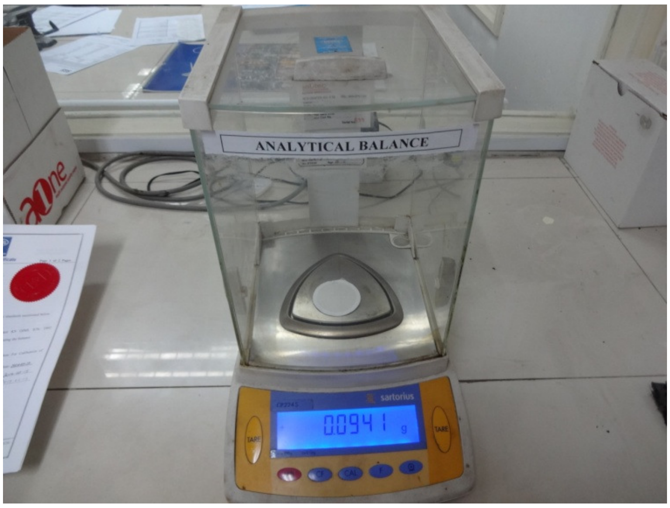
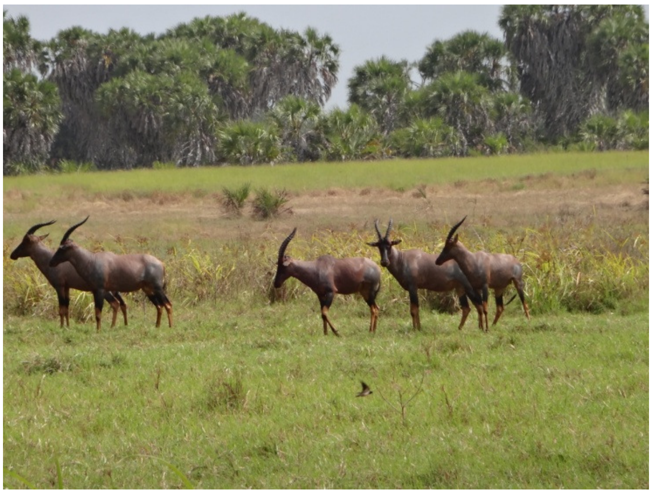
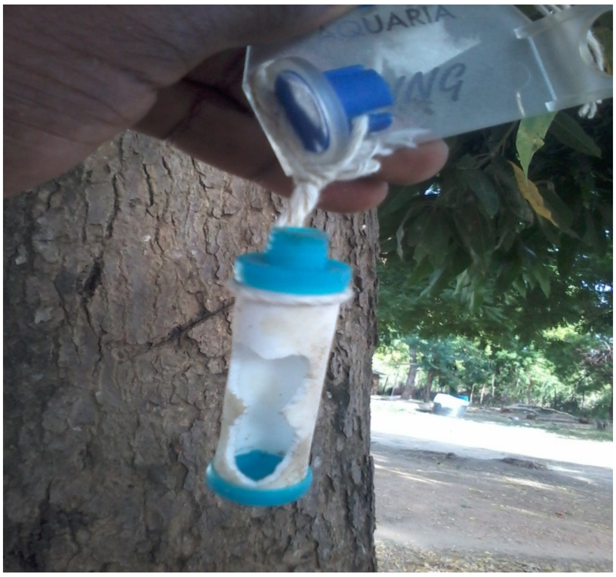
Future assessments should therefore include these metals.

REFERENCES

- Environmental Management and Co-ordination (Air Quality Standards) regulations, 2008
- WHO Air Quality Guidelines, for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global Update 2005
- Compendium Method IO-2.1, Sampling Of Ambient Air For Total Suspended Particulate Matter (SPM) And Pm10 Using High Volume (HV) Sampler
- Centre for Environmental Research Information Office of Research and Development U.S. Environmental Protection Agency Cincinnati, OH 45268 June

APPENDIX 1
PHOTOGRAPHIC REPORT

	Particulates ($PM_{2.5}$ & PM_{10}) in progress
	Sox and NOx monitoring in progress
	Particulate sample on a filter paper

	Gravimetric determination of the particulates
	Some of the diversity within the vicinity of the project.
	Damaged Sox/ NOx diffusion tube holder at Hindi mosque