# AIR QUALITY MONITORING REPORT
# FOR
# MM PORT FZE PROJECT ESIA

## EXECUTIVE SUMMARY

**Overview:** The Ambient Air Quality study of the proposed project area was conducted from July 4th to July 17th, 2023. The exercise was carried out in compliance with statutory requirements as per approved ToR by FMEnv. Monitoring locations within and outside the project area were chosen for the air quality study, an hourly mean monitoring was carried out for 14 to 23 hours.

**Methodology:** The air quality study exercise was conducted using digital gas detector instruments. The parameters measured were sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), hydrocarbon (CxHy) as $CH_4$, volatile organic compounds (VOCs), ammonia ($NH_3$), total suspended particulate matter (TSPM), particulate matter $PM_{10}$, and particulate matter $PM_{2.5}$). A total of fourteen (14) sampling stations were monitored for the assessment of existing baseline ambient air quality status of the project area. Twelve (12) stations were established within and around the project site, while two (2) stations were established outside the project area as control stations. Secondary data from previous studies conducted in the area was used for the dry season analysis.

**Result:** Baseline results obtained from field monitoring indicated that mean values of sulphur dioxide ranged from 2.19µg/$m^3$ to 3.13µg/$m^3$; nitrogen dioxide from 8.18µg/$m^3$ to 10.54µg/$m^3$; carbon monoxide from 4.29µg/$m^3$ to 6.71µg/$m^3$; ground-level ozone from 5.93µg/$m^3$ to 8.88µg/$m^3$; hydrocarbon (as methane) from 1.57µg/$m^3$ to 2.65µg/$m^3$; volatile organic compounds from 1.57µg/$m^3$ to 2.91µg/$m^3$; ammonia from 1.23µg/$m^3$ to 2.70µg/$m^3$; total suspended particulate matter from 21.68µg/$m^3$ to 26.45µg/$m^3$; $PM_{10}$ particulate matter from 11.55µg/$m^3$ to 13.40µg/$m^3$; and $PM_{2.5}$ particulate matter from 6.18µg/$m^3$ to 7.63µg/$m^3$. These values are below both FMEnv and IFC permissible limits. Seasonal variation showed significant change in pollutant

concentrations in both dry and rainy seasons. The concentrations of $NO_2$ and particulate matter were higher in the dry season than in the wet season.

Identified existing potential sources of air pollution around the project site were exhaust emissions from trucks, heavy duty equipment/ machinery, and power generating facilities around the proposed project site. The domestic burning of firewood for smoking of fish and cooking; and burning of biomass as well as the use of electric generators (DG sets) were observed in the communities (ANC1 and ANC2), which are considered as control stations in this study.

Conclusively, baseline results showed that concentrations of air pollutants in the area are generally low and air shed can be categorized as un-degraded. This represents the baseline condition of existing air environment of the proposed project area before construction and operation activities.

## 1. Introduction

Field monitoring exercise of ambient air quality for the proposed project was conducted from July 4th to July 17th, 2023. The ambient air quality survey was carried out in compliance with statutory requirements, as per approved ToR by FMEnv. Ambient air quality monitoring was required to determine the quality of the existing air environment in the proposed project area. The ambient air quality objectives/standards are pre-requisite for developing management programme for effective management of ambient air quality and to reduce the impact. The results of baseline ambient air quality obtained from field monitoring were compared with the maximum stipulated permissible limits by the Federal Ministry of Environment (FMEnv.) of Nigeria and World Bank Ambient Air Quality Guidelines (International Finance Corporation (IFC, 2007).

### 1.1 Aim and Objectives of the study

The specific objectives of the air quality study are to:

i. Assess the existing baseline conditions of air quality of the proposed project area.
ii. Identify potential impacts of the proposed project on air quality environment during construction and operation.
iii. Proffer control and mitigation measures to minimize impacts during construction and operation.
iv. Develop air quality management and monitoring plans during construction and operation.

## 2. Methodology

### 2.1 Sampling Strategy

The ambient air quality monitoring survey was carried out at fourteen (14) sampling stations (shown in Table 1) within the proposed project geographical zone. The ten (10) out of the fourteen (14) stations were located within the proposed site, two (2) located at nearby to the project site, while two (2) control stations were located about 2 to 3 kilometres away from the project site. Sampling stations were established during the preliminary survey of the project area.

A brief description of the locations of the sampling stations relative to the project site, the sampling station codes, and tentative coordinates are presented in Table 1 and Google earth map is shown in Figure 1. The first controls station (ANC1) was monitored at Owo ogono, located approximately 1.8km from the project site; while the second control station (ANC2) was monitored at Ele, located about 2.7km from the project site.

Table 1: Sampling stations and Coordinates

| Station | Description | Latitude | Longitude |
|---|---|---|---|
| AN1 | Within the project site boundary in South, Southeast directions | 4°40'00.60"N | 7°8'47.40"E |
| AN2 | Within the project site boundary in South, Southwest directions | 4°40'02.30"N | 7°8'37.88"E |
| AN3 | Within the project site boundary in South, Southwest directions | 4°40'05.95"N | 7°8'28.79"E |
| AN4 | Within the project site boundary in West, South directions | 4°40'07.01"N | 7°8'20.89"E |
| AN5 | Within the project site boundary in West, Northwest directions | 4°40'22.98"N | 7°8'21.48"E |
| AN6 | Within the project site boundary in North, Northwest directions | 4°40'22.62"N | 7°8'30.84"E |
| AN7 | Within the project site boundary in North, Northeast, Southeast directions | 4°40'19.76"N | 7°8'42.39"E |
| AN8 | Inside the project site | 4°40'10.79"N | 7°8'41.83"E |
| AN9 | Middle of project site | 4°40'09.97"N | 7°8'29.96"E |
| AN10 | Inside the project site | 4°40'07.56"N | 7°8'45.88"E |
| AN11 | Nearby the project site boundary in South, Southeast directions | 4°40'05.08"N | 7°8'51.93"E |
| AN12 | Nearby the project site boundary in East, North, Southeast, directions | 4°40'17.68"N | 7°8'52.74"E |
| ANC1 | Outside the project site boundary in South, Southeast directions – Owo-ogono | 4°39'33.39"N | 7°9'21.92"E |
| ANC2 | Outside the project site boundary in Northeast, Southeast directions - Ele | 4°41'23.76"N | 7°9'39.04"E |

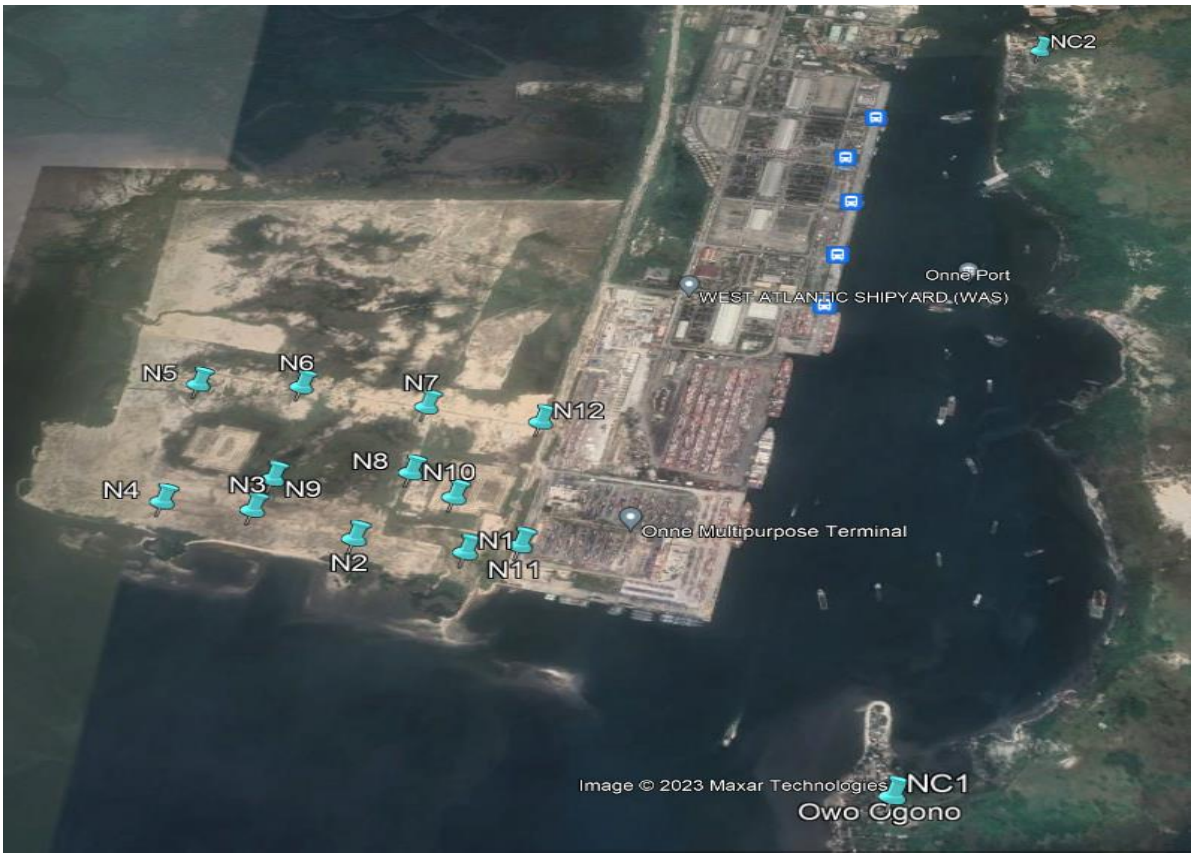



Figure 1: map showing ambient air quality monitoring stations.

### 2.2 Instrumentation and Sampling Techniques

The digital AEROQUAL 500 series monitor with sensor heads were used to monitor and record the priority parameters of ambient air quality. The different and calibrated sensor heads were used for the specific gases and particulate matter monitored. The battery-operated monitor has on-board diagnostics, which will inform the user about the functionality of sensor head. The monitor can log up to 8188 data points. The data can be downloaded to a personal computer or can also be logged directly to a personal computer via a serial connection while displaying real time data on the monitor screen. The data logging interval was set in one-minute increments. A mini-volume portable air sampler (Airmetrics ®) with a pre-weighed membrane filter (45µm) was used to collect total suspended particulate matter. After sampling, the membrane filter was dried in a desiccator and weighed in the laboratory to determine concentrations. $PM_{10}$, $PM_{2.5}$ and gases were monitored by using Aeroqual 500 series monitors fixed with sensor heads. The details of sensors heads used are shown in below table 2.

Table 2: Sensor details

| Sensor | Sensor type | Range | Minimum detection limit | Accuracy | Resolution |
|---|---|---|---|---|---|
| Nitrogen dioxide (NO2) | GSE (Gas Sensitive Electrochemical) | 0-1ppm | 0.005ppm | <±0.02ppm 0-0.2ppm <±10% 0.2-1ppm | 0.001ppm |
| Sulphur dioxide (SO2) | GSE (Gas Sensitive Electrochemical) | 0-10ppm | 0.04ppm | <±0.05ppm 0-0.5ppm <±10% 0.5-10 ppm | 0.01ppm |
| Carbon Monoxide (CO) | GSE (Gas Sensitive Electrochemical) | 0-25ppm | 0.05ppm | <±0.5ppm 0-5ppm <±10% 5-25 ppm | 0.01ppm |
| Ozone (O3) | GSE (Gas Sensitive Electrochemical) | 0-10ppm | 0.01ppm | <±0.01ppm + 7.5% | 0.01ppm |
| Ammonia (NH3) | GSE (Gas Sensitive Electrochemical) | 0-25ppm | 0.05ppm | <±0.5ppm 0-5ppm <±10% 5-25 ppm | 0.01ppm |
| Hydrocarbons (CxHy) | GSS (Gas Sensitive Semiconductor) | 0-25ppm | 0.1ppm | <±0.1ppm +10% | 0.1ppm |
| Volatile organic compounds (VOCs) | PID (Photo Ionization Detector) | 0-20ppm | 0.01ppm | <±0.02ppm +10% | 0.01ppm |
| Particulate Matter (PM2.5 & PM10) | LPC (Laser Particle Counter) | 0.001-1000 mg/m3 | 0.001mg/m3 | ±0.005 mg/m3 +15% | 0.001 mg/m3 |

### 2.3 Air Quality Sampling Procedure

The sampling period for ambient air quality within the project area and its environs was varied from minimum fourteen hours to twenty-three hours depending on the location of sampling station and security of equipment and personnel. At each locations the readings of all the parameters were taken on hourly basis. The monitoring period was carried out from day to day so that reading could be taken from early morning to late at night over the monitoring period. All precautions taken when setting up the instruments. The instruments were positioned away from obstacles like buildings and tall vegetation. The series of monitors with specific sensors head are fixed in a stand about 2-3m above the ground level in open space and allowed to run for an hour to determine the values. After recording the values, the instrument was allowed to run for suitable period with recording values every hour. Table 3 shows the monitoring dates and hours for each sampling station including field observation.

Secondary data from a previous study conducted around the proposed project area (ICTS, 2022) was used for the dry season analysis. The data were aggregated, processed, and analysed to determined trends.

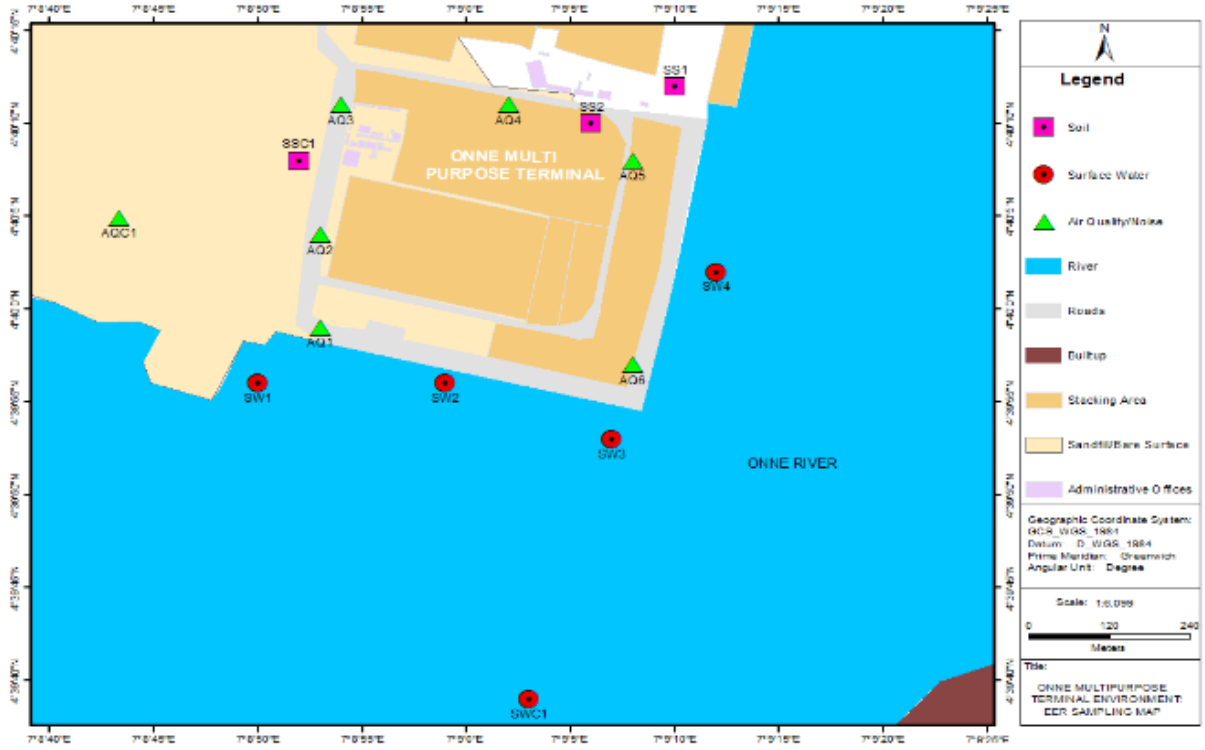
Table 3: Monitoring station details

| Station Code | Sampling Location | Monitoring Date | Monitoring Duration | Remark or Field Observation, if any |
|---|---|---|---|---|
| AN1 | Within the project site boundary in South, Southeast directions | 04/07/23 | 20 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN2 | Within the project site boundary in South, Southwest directions | 05/07/23 | 22 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN3 | Within the project site boundary in South, Southwest directions | 06/07/23 | 21 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN4 | Within the project site boundary in West, South directions | 07/07/23 | 21 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN5 | Within the project site boundary in West, Northwest directions | 08/07/23 | 22 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN6 | Within the project site boundary in North, Northwest directions | 09/07/23 | 21 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN7 | Within the project site boundary in North, Northeast, Southeast directions | 10/07/23 | 20 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN8 | Inside the project site | 11/07/23 | 23 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN9 | Middle of project site | 12/07/23 | 22 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN10 | Inside the project site | 13/7/2023 | 21 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN11 | Within the project site boundary in South, Southeast directions | 14/7/2023 | 19 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| AN12 | Within the project site boundary in East, North, Southeast, directions | 15/7/2023 | 18 | A dense fume emission from a Nigerian Navy Ship (NNS) power generating and earth moving equipment. |
| ANC1 | Outside the project site boundary in South, Southeast directions-Owo-ogono | 16/7/2023 | 14 | Domestic burning of biomass and use of petrol generators. |
| ANC2 | Outside the project site boundary in Northeast, Southeast directions-Ele | 17/7/2023 | 18 | Domestic burning of biomass and use of petrol generators. |

## 3. Results of Baseline Air Quality

This section provides information on the existing baseline air quality environment of the proposed project area, which shall be used as benchmarks for future monitoring during project construction and operation. The summary results, showing average values of air pollutants measured in the wet season during field survey is presented in Table 4.

Table 5 shows the summary results, showing mean values of air pollutants in the dry season obtained from a previous study conducted around proposed project environment as and used as secondary data in this study (EIA-ICTS, 2022). Figure 2 shows the sampling stations including coordinates, monitored during this dry season study.




| Stn. | Longitude | Latitude | Stn. | Longitude | Latitude |
|---|---|---|---|---|---|
| AQ1 | 7° 08' 53" E | 4° 39' 59" N | AQ5 | 7° 09' 08" E | 4° 40' 08" N |
| AQ2 | 7° 08' 53" E | 4° 40' 04" N | AQ6 | 7° 09' 08" E | 4° 39' 57" N |
| AQ3 | 7° 08' 54" E | 4° 40' 11" N | AQC1 | 7° 09' 00" E | 4° 40' 03" N |
| AQ4 | 7° 09' 02" E | 4° 40' 11" N | | | |

Figure 2: Dry season sampling stations including coordinates (Janu-2022)

**Table 4: Summary of Wet Season Baseline Air Quality of the proposed project area**

| Parameter | AN1 | AN2 | AN3 | AN4 | AN5 | AN6 | AN7 | AN8 | AN9 | AN10 | AN11 | AN12 | ANC1 | ANC2 | FMEnv limit | IFC limit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SO_2$ (µg/$m^3$) | 2.71 | 3.00 | 2.79 | 2.98 | 2.51 | 2.27 | 2.30 | 2.2 | 2.29 | 2.19 | 2.66 | 2.43 | 3.05 | 3.13 | 26 | 20 |
| $NO_2$ (µg/$m^3$) | 9.85 | 9.65 | 9.84 | 9.48 | 9.24 | 9.91 | 8.35 | 9.05 | 9.02 | 8.18 | 9.04 | 8.74 | 10.54 | 9.55 | 75-113 | 40* |
| CO (µg/$m^{3)}$ | 4.29 | 5.61 | 6.27 | 4.92 | 5.41 | 6.06 | 5.63 | 4.90 | 5.31 | 5.66 | 5.82 | 6.14 | 6.71 | 6.37 | 22.8 | |
| $O_3$ (µg/$m^3$) | 6.26 | 7.10 | 7.33 | 6.24 | 6.75 | 7.23 | 6.98 | 5.93 | 6.58 | 6.74 | 7.35 | 7.89 | 8.88 | 8.25 | 117 | 100 |
| CxHy (µg/$m^3$) | 1.57 | 2.13 | 1.77 | 1.89 | 2.08 | 2.15 | 2.18 | 2.04 | 2.31 | 2.02 | 2.01 | 2.30 | 2.65 | 1.97 | | |
| VOC (µg/$m^3$) | 2.57 | 1.57 | 2.70 | 2.70 | 2.73 | 2.43 | 2.27 | 2.46 | 2.32 | 2.54 | 2.33 | 2.64 | 2.91 | 2.52 | | |
| $NH_3$ (µg/$m^3$) | 1.33 | 1.45 | 2.13 | 1.33 | 1.23 | 1.75 | 1.63 | 2.07 | 1.76 | 1.73 | 1.92 | 1.81 | 2.70 | 2.33 | | |
| TSPM (µg/$m^3$) | 22.58 | 22.17 | 23.04 | 21.68 | 22.26 | 24.12 | 24.45 | 23.28 | 22.00 | 22.71 | 23.26 | 24.93 | 26.45 | 25.28 | | |
| $PM_{10}$ (µg/$m^3$) | 12.61 | 15.51 | 12.47 | 11.55 | 11.96 | 12.20 | 11.76 | 12.36 | 12.60 | 13.13 | 12.75 | 12.44 | 13.40 | 12.76 | | 75 |
| $PM_{2.5}$ (µg/$m^3$) | 7.28 | 7.12 | 7.10 | 6.24 | 6.76 | 6.85 | 6.72 | 6.18 | 6.62 | 6.71 | 6.45 | 6.93 | 7.63 | 7.34 | | 35 |
| WIND SPD (m/s) | 1.40 | 1.55 | 1.61 | 1.64 | 2.05 | 1.84 | 2.09 | 2.17 | 1.93 | 1.97 | 1.99 | 2.26 | 1.64 | 1.84 | | |
| TEMP ($^oC$) | 27.36 | 26.21 | 28.79 | 28.28 | 28.50 | 29.38 | 29.08 | 28.44 | 29.55 | 28.60 | 26.36 | 29.04 | 28.39 | 29.20 | | |
| REL. HU (%) | 86.91 | 86.38 | 83.12 | 87.65 | 86.23 | 86.36 | 84.00 | 88.40 | 83.99 | 86.14 | 87.99 | 85.06 | 86.14 | 86.74 | | |

*Annual Average (1Hour max - 200µg/$m^3$)

Table 5: Summary of Dry Season Air Quality

| Parameter/ Station | $SO_2$ ($\mu g/m^3$) | $NO_2$ ($\mu g/m^3$) | CO ($\mu g/m^3$) | $O_3$ ($\mu g/m^3$) | CxHy ($\mu g/m^3$) | VOC ($\mu g/m^3$) | $NH_3$ ($\mu g/m^3$) | $PM_{10}$ ($\mu g/m^3$) | $PM_{2.5}$ ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| AQ1 | 0.00 | 22.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 52.00 | 19.00 |
| AQ2 | 0.00 | 24.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 48.00 | 21.00 |
| AQ3 | 0.00 | 30.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 33.00 | 17.00 |
| AQ4 | 0.00 | 18.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 54.00 | 22.00 |
| AQ5 | 0.00 | 22.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 47.00 | 16.00 |
| AQ6 | 0.00 | 30.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 35.00 | 26.00 |
| AQ7 | 0.00 | 22.57 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 39.00 | 18.00 |

Note: 0.00 indicates below instrument's detection limit.

The dry season air quality data retrieved from previous study (EIA-ICTS, 2022) indicates that the study followed spot monitoring procedure in which the pollutants were measured for maximum of 10 minutes and values were recorded and presented.

## 4. Discussion of results and findings

### 4.1 Sulphur dioxide ($SO_2$)

Result (shown in Table 4) indicates that the wet season mean concentration of sulphur dioxide ranged from 2.19$\mu g/m^3$ to 3.13$\mu g/m^3$; whereas, the dry season mean $SO_2$ from secondary data (Table 5) was below instrument's detection limit of 1.75$\mu g/m^3$.The minimum wet season mean value (2.19$\mu g/m^3$) of $SO_2$ was observed at station AN10, located inside the project site; while the maximum mean value of 3.13$\mu g/m^3$ was obtained at station ANC2 (Ele community), located outside the project site boundary. The reason for sulphur dioxide can be attributed to the use of petrol or diesel power generators, vehicles exhaust emissions and operation activities of earth moving and other heavy equipment. The level of $SO_2$ observed at the control can be attributed to human activities. Table 4 and Figure 3 show that the mean values of $SO_2$ both at the project site and the control are below both FMEnv and IFC permissible limits. This result represents the baseline concentration of sulphur dioxide in the air environment of the proposed project area before construction and operation activities.

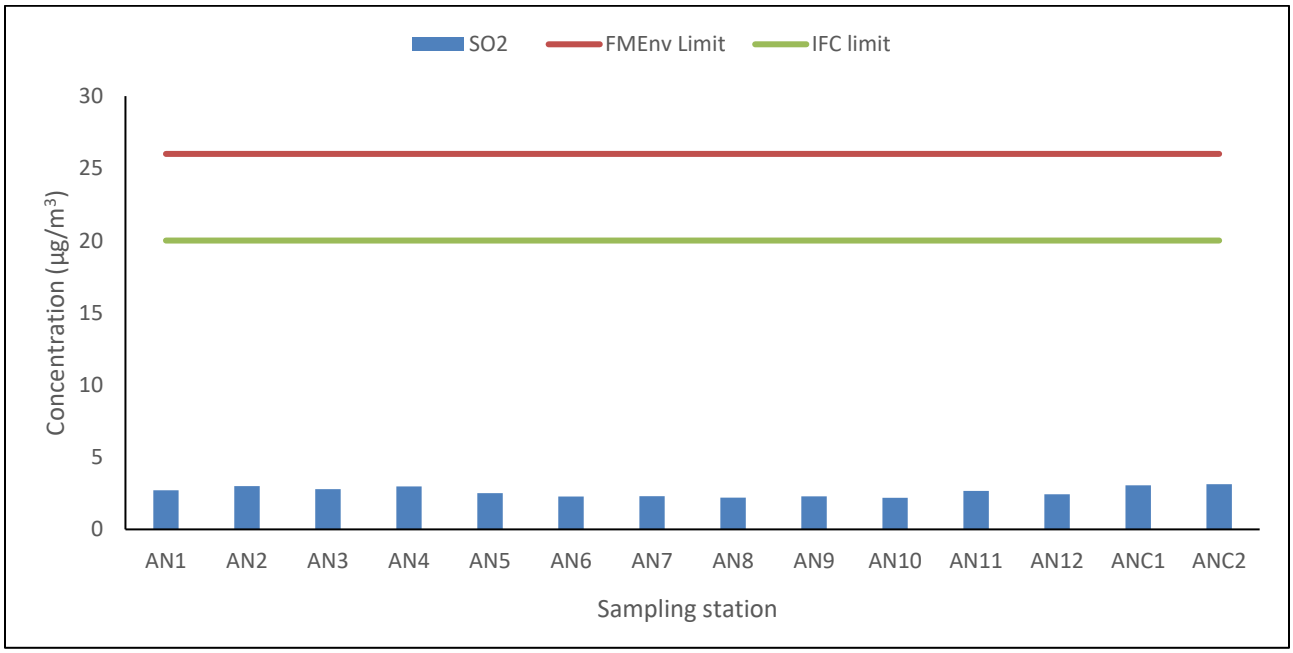



Figure 3: Trend in mean concentration of sulphur dioxide

**4.2 Nitrogen dioxide ($NO_2$)**

The field measurement (Table 4) in the wet season shows that the mean concentration of nitrogen dioxide ranged from 8.18µg/$m^3$ to 10.54µg/$m^3$; while the dry season secondary data (Table 5) shows that mean $NO_2$ ranged from 18.81µg/$m^3$ to 30.10µg/$m^3$. The mean values of $NO_2$ are higher in the dry season than in the wet season. Figure 4 shows the trend in the diurnal variations of mean concentration of nitrogen dioxide in comparison with regulatory standards. The minimum value (8.18µg/$m^3$) of $NO_2$ was observed at station AN10, located inside the project site; while the maximum value of 10.54µg/$m^3$ was obtained at station ANC1 (Owo gono community), outside the project site. The level of nitrogen dioxide observed in the project area may be caused by emissions from trucks, heavy duty equipment, power plants emissions as well as operation activities of earth moving equipment. The level of $NO_2$ observed at the control may be caused by domestic activities such as combustion of fossil fuels and burning of biomass. Table 4 and Figure 3 show that the values of $NO_2$ are below both FMEnv and IFC permissible limits. This result represents the baseline concentration of nitrogen dioxide in the air environment of the proposed project area before construction and operation activities.

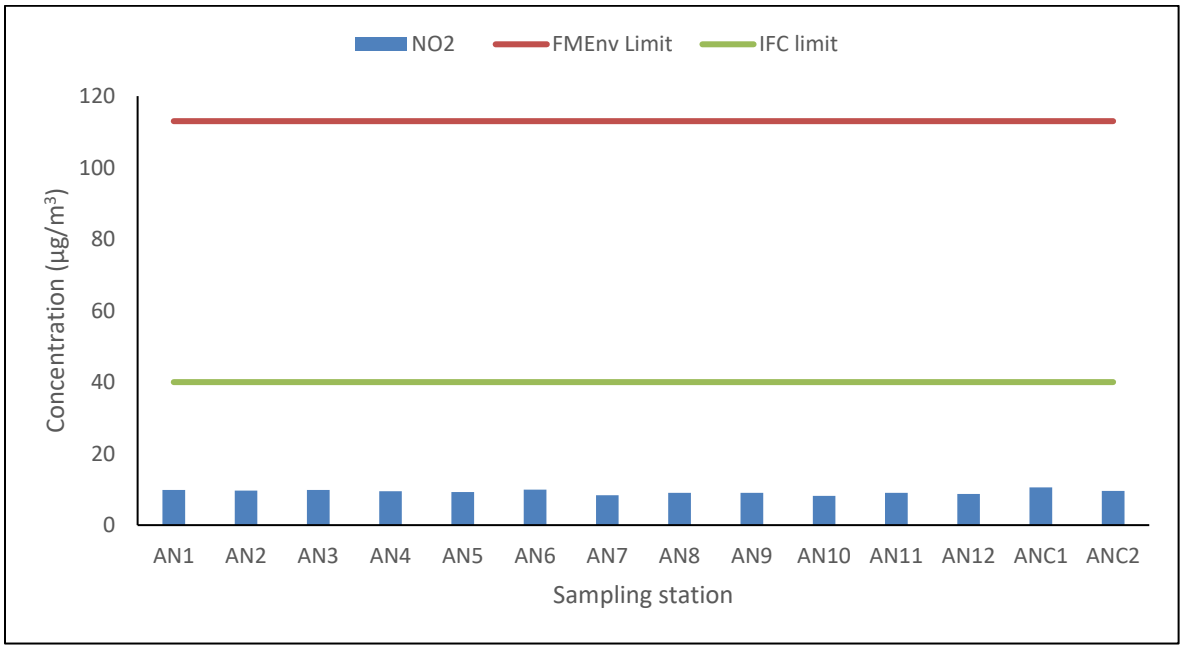



Figure 4: Trend in mean concentration of Nitrogen dioxide

### 4.3 Carbon Monoxide (CO)

The mean concentration levels of carbon monoxide obtained during field monitoring ranged from 4.29µg/$m^3$ to 6.71µg/$m^3$ as shown in Table 4. However, dry season secondary data (Table 5) indicates that CO was below instrument's detection limit of 0.95µg/$m^3$. Figure 4 shows the trend in the diurnal variations of mean concentration of carbon monoxide in comparison with regulatory standards. The minimum value (4.29µg/$m^3$) of CO was recorded at station AN1, located within the project site boundary; while maximum value of 6.71µg/$m^3$ was obtained at station ANC1 (Owo ogono), located outside the project site boundary. The level of carbon monoxide observed in the project area may be caused by emissions from trucks, heavy duty equipment/machinery, power plants as well as operation activities of earth moving equipment. Similarly, the level of CO obtained at ANC1 (Owo ogono) could be attributed to domestic burning of firewood for smoking of fish and cooking; and burning of biomass as well as the use of electric generators. As indicated in Table 4 and Figure 5, CO values obtained during field monitoring are below both FMEnv permissible limits. This result represents the baseline concentration of carbon monoxide in the air environment of the proposed project area before construction and operation activities.

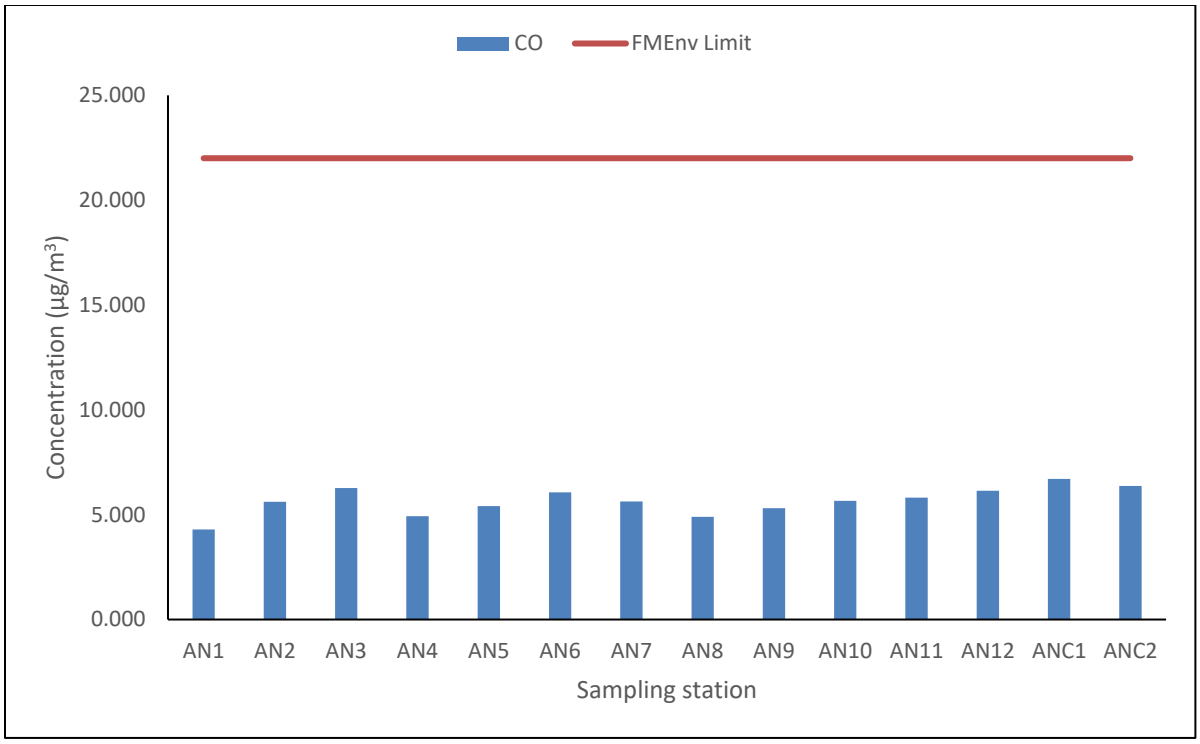



Figure 5: Trend in mean concentration of carbon monoxide

### 4.4 Ground-level ozone ($O_3$)

The mean concentrations of ground-level ozone monitored in the area during field sampling ranged from 5.93µg/m$^3$ to 8.88µg/m$^3$ as shown in Table 4; while the dry season values of $O_3$ from secondary data (Table 5) was below instrument's detection limit of 0.33µg/m$^3$. The trend in the diurnal variations of mean concentration of ground-level ozone in comparison with regulatory standards is shown in Figure 5. The minimum value (5.93µg/m$^3$) of ground-level was recorded at station AN8, located inside the project site; while maximum value of 8.88µg/m$^3$ was obtained at station ANC1 (Owo gono community), located outside the project site boundary. The presence of ground-level ozone in ambient air is a common characteristic of the Niger Delta region where the proposed project is to be sited due to hydrocarbon activities. It is evident from Table 4 and Figure 6 that $O_3$ values obtained during field monitoring are below both FMEnv and IFC permissible limits. This result represents the baseline concentration of ground-level in air environment of the proposed project area before construction and operation activities.

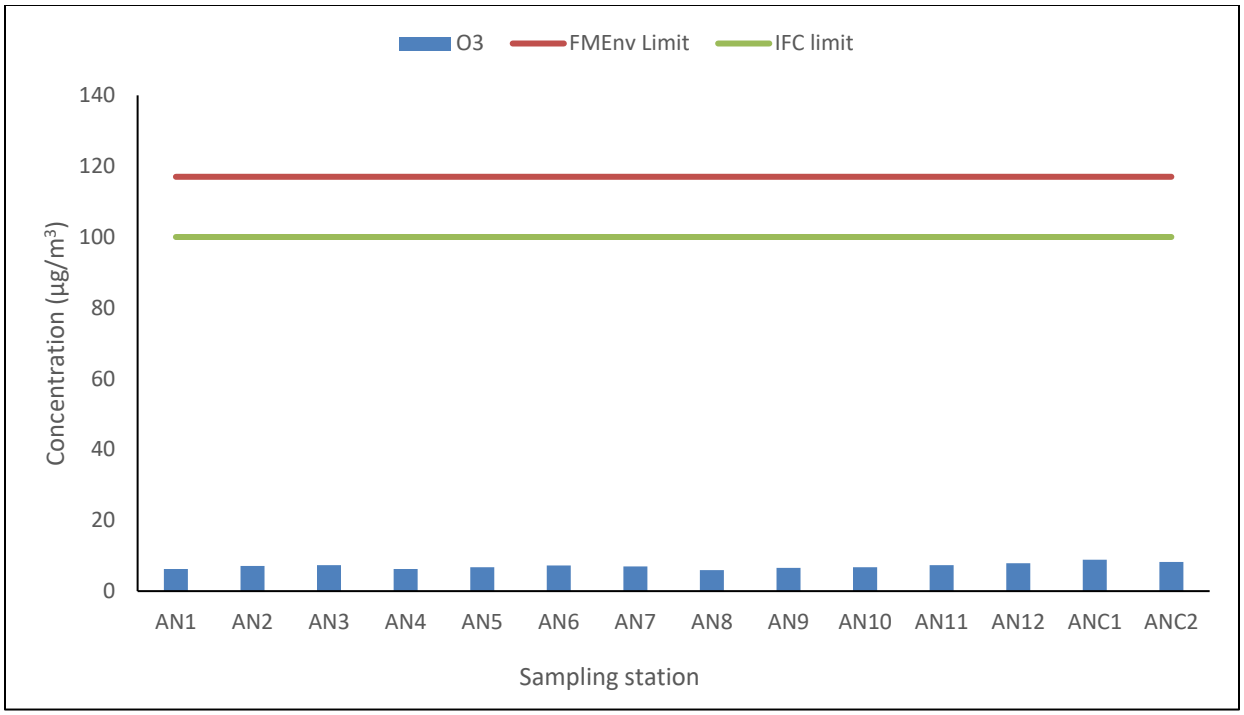



Figure 6: Trend in mean concentration of ground-level ozone

### 4.5 Hydrocarbon (as methane, $CH_4$)

The mean concentration of hydrocarbon (as methane) obtained during field monitoring ranged from 1.57µg/m$^3$ to 2.65µg/m$^3$ as shown in Table 4; however, the dry season methane hydrocarbon from secondary data (Table 5) was below instrument's detection limit of 1.23µg/m$^3$. The trend in the diurnal variations of mean concentration of hydrocarbon is shown in Figure 7. The minimum value (1.57µg/m$^3$) of methane hydrocarbon was recorded at station AN1, located within the project site boundary; while maximum value of 2.65µg/m$^3$ was obtained at station ANC1 (Owo ogono), located outside the project site boundary. Also, the presence of hydrocarbon in ambient air is a common characteristic of the Niger Delta region where the proposed project is to be sited due to hydrocarbon activities. This result represents the baseline concentration of methane hydrocarbon in the air environment of the proposed project area before construction and operation activities.

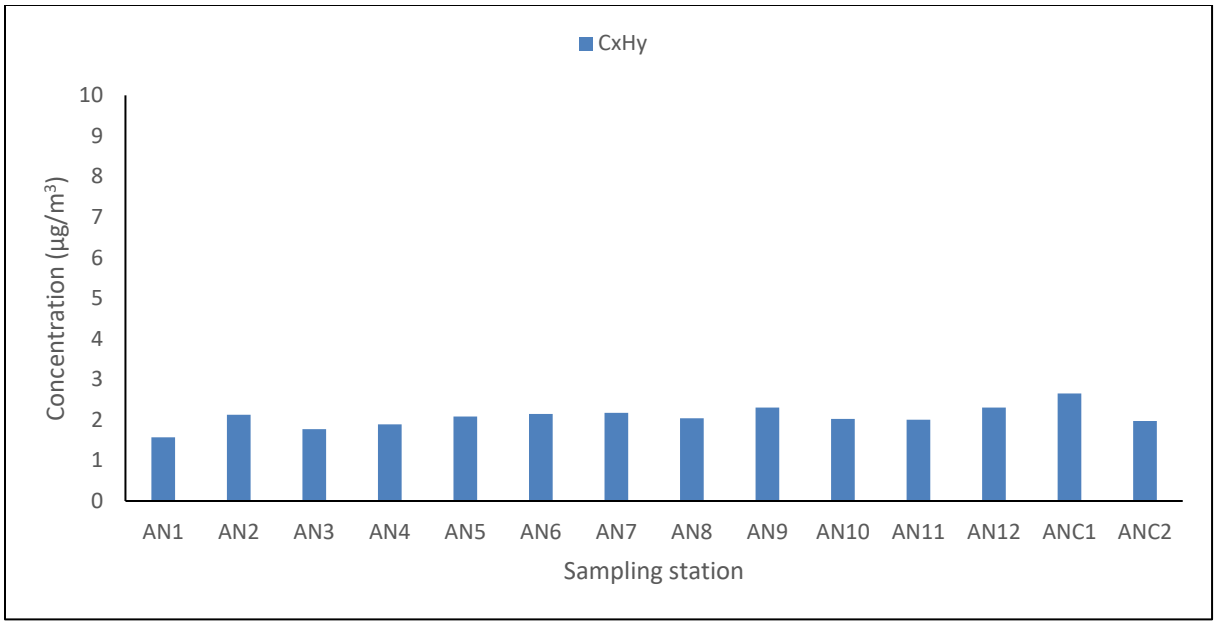



Figure 7: Trend in mean concentration of hydrocarbon as methane

### 4.6 Volatile Organic Compounds (VOC)

The result of field measurement (Table 4) indicates that the mean concentration of volatile organic compounds in the area ranged from 1.57µg/m$^3$ to 2.91µg/m$^3$, while the dry season VOCs from secondary data (Table 5) was below instrument's detection limit of 1.12µg/m$^3$. The trend in the diurnal variations of mean concentration of volatile organic compounds is shown in Figure 7. The minimum value (1.57µg/m$^3$) of volatile organic compounds was recorded at station AN2, located within the project site boundary; while maximum value of 2.91µg/m$^3$ was obtained at station ANC1 (Owo ogono), located outside the project site boundary. The presence of volatile organic compounds in ambient air may be due to human activities around the Onne port area. This result represents the baseline concentration of volatile organic compounds in the air environment of the proposed project area before construction and operation activities.

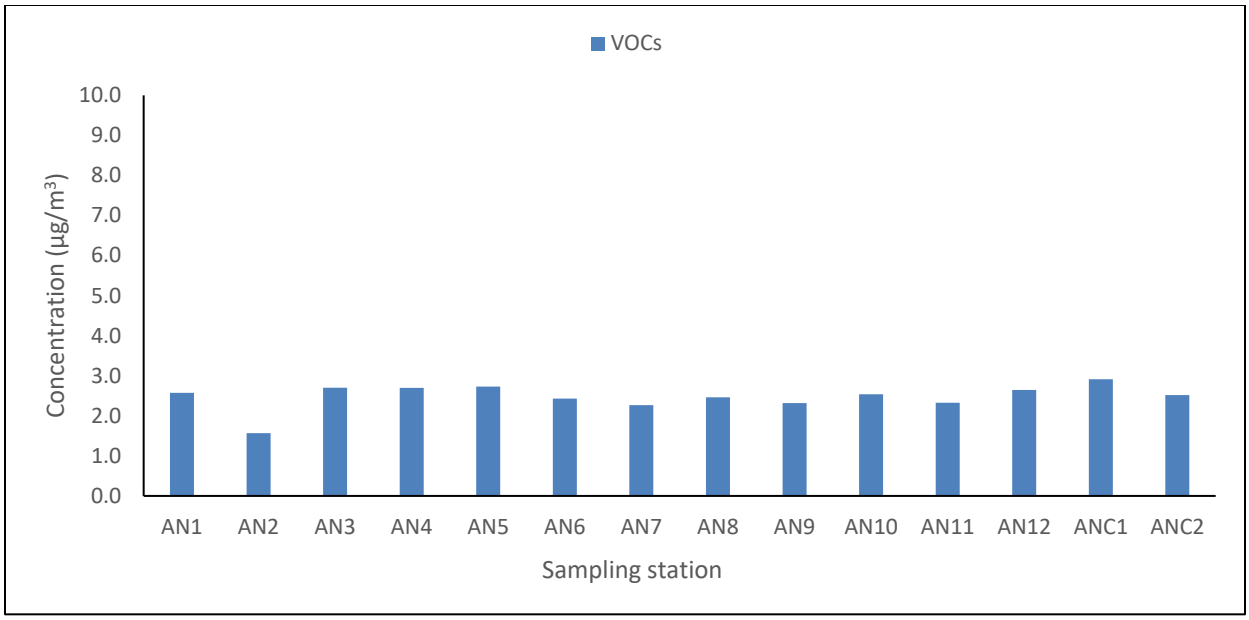



Figure 8: Trend in mean concentration of volatile organic compounds

### 4.7 Ammonia ($NH_3$)

The mean concentration of ammonia (Table 4) measured during field monitoring of the project area ranged from 1.23µg/$m^3$ to 2.70µg/$m^3$; while the dry season results secondary data (Table 5) indicates that $NH_3$ was below instrument's detection limit of 0.58µg/$m^3$. The trend in the diurnal variations of mean concentration level of ammonia in the proposed project area is shown in Figure 9. The minimum value (1.23µg/$m^3$) of $NH_3$ was recorded at station AN5, located within the project site boundary; while maximum value of 2.70µg/$m^3$ was obtained at station ANC1 (Owo ogono), located outside the project site boundary. The presence of traces of ammonia in ambient air may be due to anthropogenic activities. This result represents the baseline concentration of ammonia in the air environment of the proposed project area before construction and operation activities.

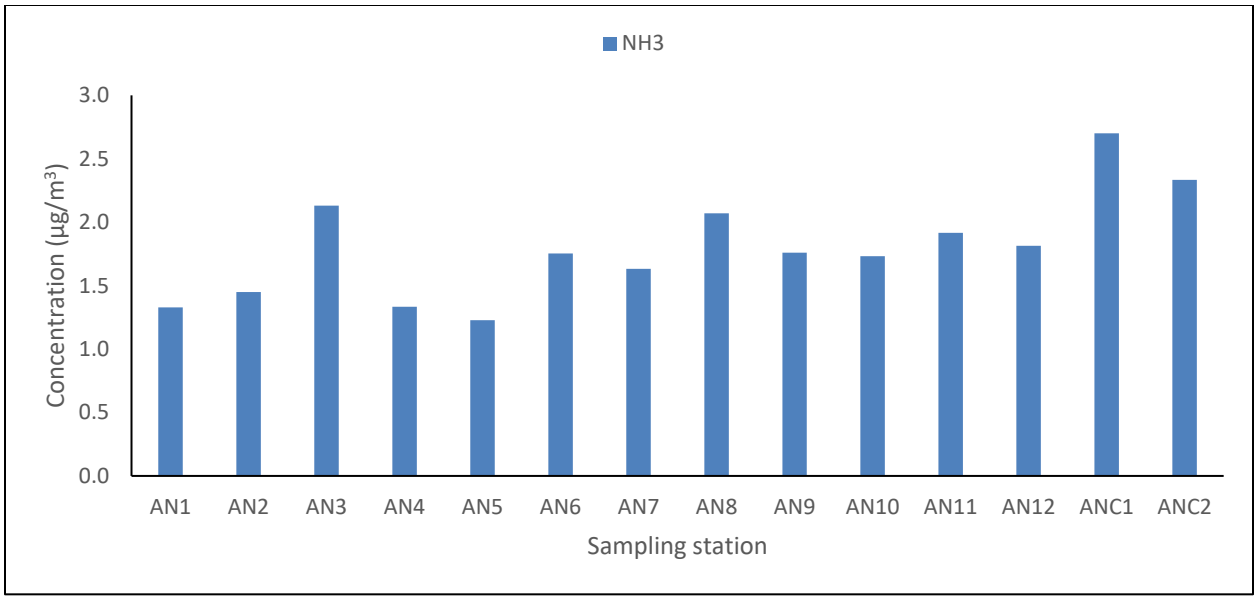



Figure 9: Trend in mean concentration of ammonia

### 4.8 $PM_{10}$ Particulate Matter

The mean concentration levels of $PM_{10}$ particulate matter obtained during field monitoring (Table 4) ranged from 11.55µg/$m^3$ to 13.40µg/$m^3$; while the dry season mean values of $PM_{10}$ from the previous study ranged from 33.00µg/$m^3$ to 54.00µg/$m^3$. The mean values of $PM_{10}$ are higher in the dry season than in the wet season. Figure 10 shows trend in the diurnal variations of mean concentration of $PM_{10}$ particulate matter in comparison with regulatory standards. The minimum mean value (11.55µg/$m^3$) of $PM_{10}$ particulate was obtained at AN4, located within the project site boundary; while maximum value of 13.40µg/$m^3$ was obtained at ANC1 (Owo ogono), located outside the project site boundary. The level of particulate matter observed in the project area may be caused by emissions from trucks, heavy duty equipment, power plants emissions as well as operation activities of earth moving equipment. The level $PM_{10}$ obtained at control 1 was due to domestic activities. It is clearly shown in Figure 10 that $PM_{10}$ values obtained during field monitoring are below IFC permissible limits. This result represents the baseline concentration of $PM_{10}$ in air environment of the proposed project area before construction and operation activities.

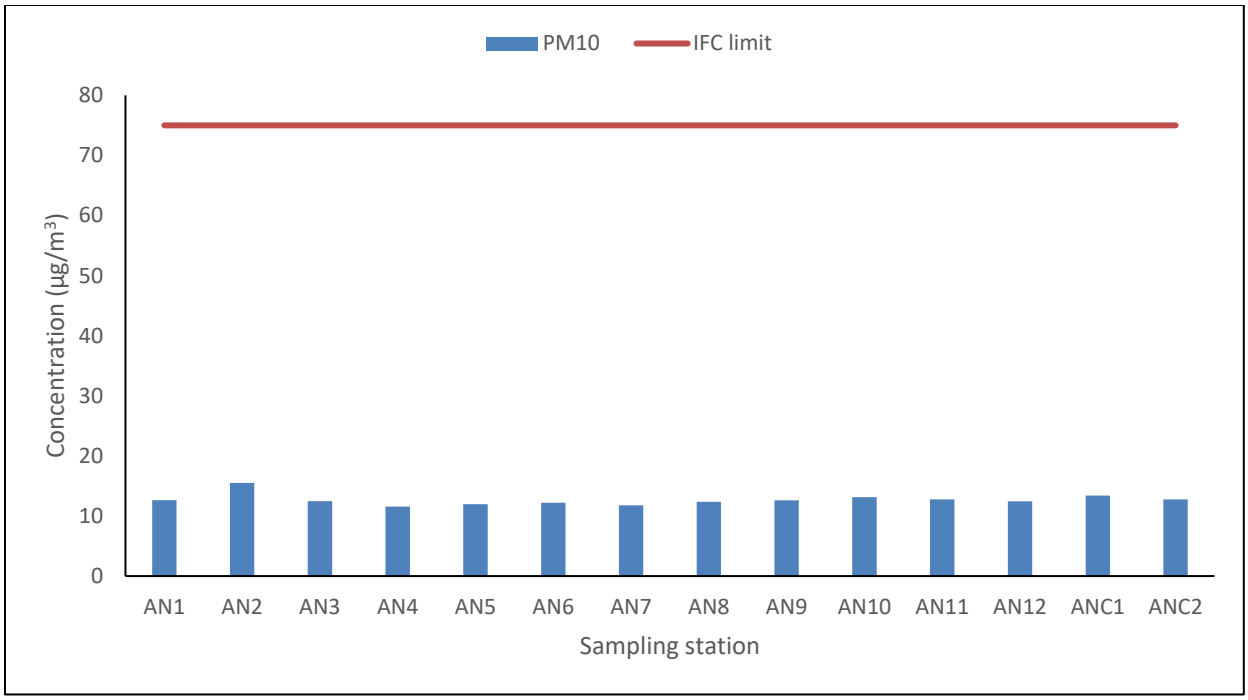



Figure 10: Trend in mean concentration of $PM_{10}$ particulate matter

### 4.9 $PM_{2.5}$ Particulate Matter

The mean concentration levels of $PM_{2.5}$ particulate matter obtained during monitoring (Table 4) ranged from 6.18µg/m$^3$ to 7.63µg/m$^3$; while the dry season mean values of $PM_{2.5}$ from the previous study ranged from 16.00µg/m$^3$ to 26.00µg/m$^3$. The mean values of $PM_{2.5}$ are higher in the dry season than in the wet season. Figure 11 shows trends in the diurnal variations of mean concentration of $PM_{2.5}$ particulate matter in comparison with regulatory standards. The minimum mean value (6.18µg/m$^3$) of $PM_{2.5}$ particulate was obtained at AN8, located inside the project site; while maximum value of 7.63µg/m$^3$ was obtained at ANC1 (Owo ogono), located outside the project site boundary. The level of particulate matter observed in the project area may be caused by emissions from trucks, heavy duty equipment, power plants at the port as well as operation activities of earth moving equipment. The level $PM_{2.5}$ obtained at control 1 was due to domestic activities. It is clearly shown in Figure 11 that $PM_{2.5}$ values obtained during field monitoring are below IFC permissible limits. This result represents the baseline concentration of $PM_{2.5}$ in air environment of the proposed project area before construction and operation activities.

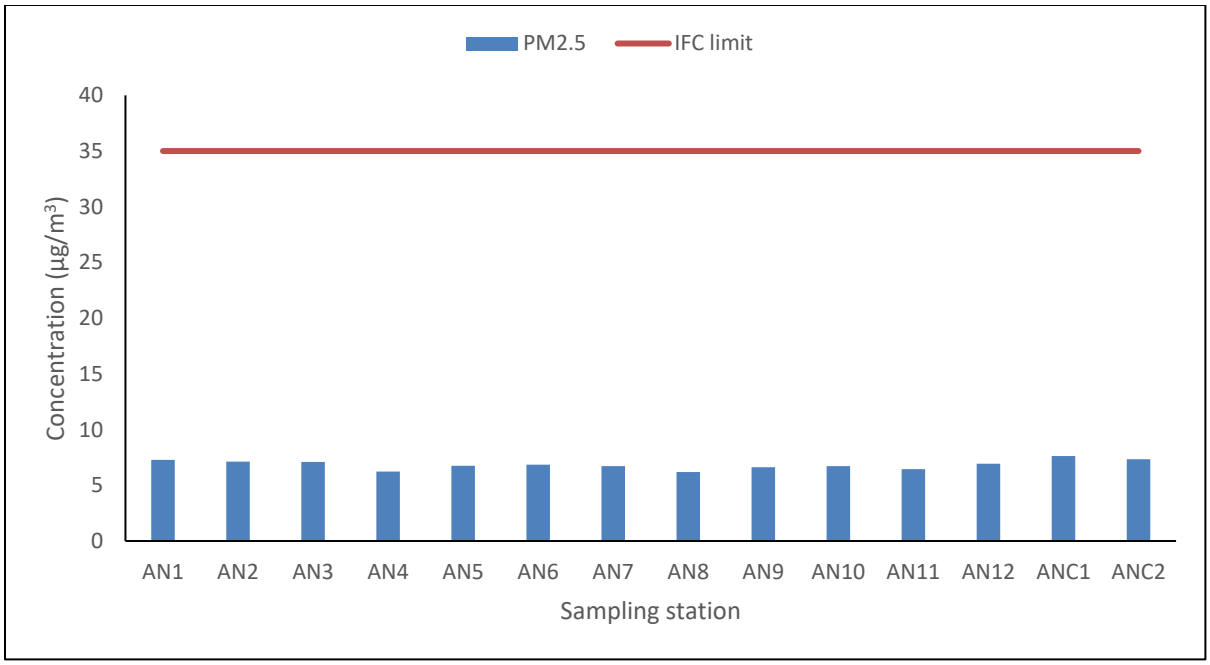



Figure 11: Trend in mean $PM_{2.5}$ particulate matter

## 5. Conclusion

Generally, the environmental baseline describing the pre-construction air quality of the project area has been conducted through intensive measurements of air pollutants and meteorological parameters of the area. Existing air quality in the proposed area is affected by the daily weather condition of the area, particularly the strength of the North-East and South-West trade winds that are prevalent in the wet and dry seasons respectively. Baseline results showed that concentrations of air pollutants in the area are generally low, and the air shed can be classified as un-degradable. Seasonal variation showed significant change in pollutant concentrations in both dry and rainy seasons. The concentrations of $NO_2$ and particulate matter were higher in the dry season than in the wet season. These results represented the baseline condition of the area prior to the construction and operation of the proposed project.

## 6. Air Quality Impact Assessment

a) Construction phase

This section of the study describes the potential environmental impacts that are likely to result from the construction phase of the proposed project. Construction activities would cause the release of some number of gaseous pollutants and dust, which may have short-term impacts on the environment. This will cause reversible short-term degradation of the air quality of the area.

The release of air pollutants will emanate mainly from the following activities:

- ✓ Use of earthmoving equipment during earth works (grading and surfacing),
- ✓ Vehicular movements such as heavy trucks for hauling materials
- ✓ Power generating engines.
- ✓ Construction equipment/machineries

b) Operation phase

i. The following activities may have potential to impact air quality.

ii. Vehicular exhaust emissions

Transportation of ammonia and urea from IEFCL complex to port will increase the traffic. This may likely cause increase in vehicular exhaust emissions.

iii. Power generating gas engines during operation will also release emissions.

iv. Fugitive emissions

Leakages from storage tanks, valves, flanges will cause fugitive emissions of $NH_3$.

**7. Mitigation of Air Quality Impacts**

A series of mitigation measures will be employed to minimize impact on air quality during construction and operation using best available technologies (BAT). With these measures in place, air quality impacts would be minimal or minor. The overall impacts during operation phase may be judged minor. However, some mitigation measures would be taken to further reduce any unpredicted negative impacts on air quality to acceptable levels.

During construction phase, trucks and earth moving machines would be maintained in good condition. Water spray system would be employed in all active construction areas to reduce the generation of dust particles during construction activities. All trucks hauling sand, soil, and other loose materials would be covered to prevent the escape of dust particles.

Recommended measures for controlling fugitive emissions include:

- ✓ Selection of appropriate valves, flanges, fittings during design,
- ✓ Implementation of monitoring, maintenance, and repair programs, particularly in stuffing boxes on valve stems and seats on relief valves, to reduce or eliminate accidental releases.
- ✓ Installation of gas detection sensors in sensitive areas.
- ✓ The ammonia storages, unloading and loading arms shall be provided with vapor recovery system.
- ✓ Leak detection alarm system shall be installed on storage tanks.

## Calibration Certificates


**WALDEN OILTECH SERVICES LIMITED**

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WOSL


### *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/ECSLAQOZ22**

**CUSTOMER NAME**: ENVIRONMENTAL & CHEMICAL SERVICES LIMITED
**INSTRUMENT TYPE**: AEROQUAL OZONE SENSOR HEAD
**SERIAL NUMBER**: OZUL1904206-071-146
**MODEL**: OZONE SENSOR, Ultra Low, 0-0.15ppm

**ENVIRONMENTAL CONDITIONS**
Temperature: 28.9 degree centigrade. Relative Humidity: 67.9%RH

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/ppm | 0.017 | 5.510 | 7.645 | 0.00 |
| AQL Sensor (Mean) /ppm | 0.016 | 5.520 | 7.654 | 0.000 |

**Calibration Standard**

The Aeroqual ozone sensor was calibrated in a controlled environment against a NATA certified OZONE UV photometer whose traceability is maintained with international standards organizations.

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER
SIGNATURE: ----------
DATE OF CALIBRATION: 19/03/2021
DATE OF NEXT CALIBRATION: 20/03/2022

# WALDEN OILTECH SERVICES LIMITED

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W
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## *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/ESCLAQNO21**

**CUSTOMER NAME**: ENVIRONMENTAL & CHEMICAL SERVICES LIMITED
**INSTRUMENT TYPE**: AEROQUAL NITROGEN DIOXIDE SENSOR HEAD
**SERIAL NUMBER**: ENW-1409202-006
**MODEL**: ENW-N02, 0-1 ppm

**ENVIRONMENTAL CONDITIONS**
Temperature: 28.6 degree centigrade. Relative Humidity: 69.4%RH

This sensor was calibrated against a chemiluminescence NOx analyser after Zero calibration using Aeroqual R42 Calibration kit with calibrations traceable to primary standards.

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 0.147 | 0.055 | 0.000 | 0.000 |
| Sensor(Mean)/PPM | 0.146 | 0.054 | 0.000 | 0.000 |

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006.
The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER
SIGNATURE: ----------
DATE OF CALIBRATION: 19/03/2021
DATE OF NEXT CALIBRATION: 20/03/2022

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# *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/ESCLAQMT21**

**CUSTOMER NAME**: ENVIRONMENTAL & CHEMICAL SERVICES LIMITED
**INSTRUMENT TYPE**: AEROQUAL METHANE SENSOR HEAD
**SERIAL NUMBER**: MT-0403191-020
**MODEL**: Methane 0-10000 ppm

**ENVIRONMENTAL CONDITIONS**
Temperature: 28.9 degree centigrade. Relative Humidity: 75.2%RH

This sensor was calibrated against a certified mixture of methane in synthetic air diluted with zero air using mass flow controllers with calibrations traceable to National Institute of Standards and Technology (NIST).

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 220 | 245 | 0.000 | 0.000 |
| Sensor(Mean)/PPM | 220 | 248 | 0.000 | 0.000 |

The mean deviations are calculated from three consecutive readings.

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006.
The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**
NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER
SIGNATURE: ----------
DATE OF CALIBRATION: 19/03/2021
DATE OF NEXT CALIBRATION: 20/03//2022

# WALDEN OILTECH SERVICES LIMITED

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## *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/ECSLAQSO21**

**CUSTOMER NAME**: ENVIRONMENTAL & CHEMICAL SERVICES LIMITED
**INSTRUMENT TYPE**: AEROQUAL SULPHUR DIOXIDE SENSOR HEAD
**SERIAL NUMBER**: 0305182-002
**MODEL**: SULPHUR DIOXIDE 0-100 ppm

**ENVIRONMENTAL CONDITIONS**
Temperature: 27.9 degree centigrade. Relative Humidity: 67.5%RH

This sensor was calibrated against This sensor was calibrated against a certified UV fluorescence analyser after Zero calibration using Aeroqual R42 Calibration kit with calibrations traceable to primary standards..

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 0.000 | 0.01 | 0.000 | 0.000 |
| Sensor(Mean)/PPM | 0.000 | 0.02 | 0.000 | 0.000 |

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006.
The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER
SIGNATURE: ----------
DATE OF CALIBRATION: 19/03/2021
DATE OF NEXT CALIBRATION: 20/03/2022

**WALDEN OILTECH SERVICES LIMITED**
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# *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/IEFCLAQAM2021**

**CUSTOMER NAME**: INDORAMA ELEME FERTILIZERS & CHEMICALS LTD
**INSTRUMENT TYPE**: AEROQUAL AMMONIA SENSOR HEAD
**SERIAL NUMBER**: 1707182-006
**MODEL**: NH3 0-100 PPM

**ENVIRONMENTAL CONDITIONS**
Temperature: 28.5 degree centigrade
Relative Humidity: 70.5%RH

This sensor was Zero calibrated using Aeroqual R42 calibration Kit and further calibrated against a certified mixture of Ammonia in synthetic air diluted with Zero air using mass flow controller with calibration traceable to NIST.

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 0.0 | 23.2 | 0.0 | 0.0 |
| Sensor(Mean)/PPM | 0.0 | 24.8 | 0.0 | 0.0 |

The mean and standard deviation are calculated from three consecutive readings.

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006. The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER

SIGNATURE: ----------
DATE OF CALIBRATION: 03/12/2021
DATE OF NEXT CALIBRATION: 03/12/2022

**WALDEN OILTECH SERVICES LIMITED**
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# *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/IEFCLAQPID2021**

**CUSTOMER NAME**: INDORAMA ELEME FERTILIZERS & CHEMICALS LTD
**INSTRUMENT TYPE**: AEROQUAL VOC (PID) SENSOR HEAD
**SERIAL NUMBER**: 2109181-004
**MODEL**: VOC 0-20PPM

**ENVIRONMENTAL CONDITIONS**
Temperature: 27.9 degree centigrade
Relative Humidity: 70.5%RH

This sensor was Zero calibrated using Aeroqual R42 calibration Kit and further calibrated against a certified mixture of isobutene in synthetic air diluted with Zero air using mass flow controllers with calibrations traceable to NIST.

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 0.0 | 10.00 | 10.00 | 0.00 |
| Sensor(Mean)/PPM | 0.00 | 10.30 | 10.30 | 0.000 |

The mean and standard deviation are calculated from three consecutive readings.

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006. The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER

SIGNATURE: ----------
DATE OF CALIBRATION: 03/12/2021
DATE OF NEXT CALIBRATION: 03/12/2022

# WALDEN OILTECH SERVICES LIMITED

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## *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/IEFCPM2021**

**CUSTOMER NAME:** INDORAMA ELEME FERTILIZERS & CHEMICALS LTD
**INSTRUMENT TYPE:** PM SENSOR
**SERIAL NUMBER:** 5001-FD54-001
**MODEL:** AEROQUAL PM 2.5 PM 10

**ENVIRONMENTAL CONDITIONS**
Temperature: 27.7 degree centigrade
Relative Humidity: 67.8%RH

This sensor was calibrated using Metone optical particle counter model 9772-1 with calibrations traceable to primary standards.

**Measurements**

| | PM2.5 mg/m3 | PM10 mg/m3 |
|---|---|---|
| Reference Zero | 0.000 | 0.000 |
| AQL Sensor zero | 0.000 | 0.000 |
| Reference Span | 0.015 | 0.023 |
| AQL Sensor Span | 0.016 | 0.024 |

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006. The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**

NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER

SIGNATURE: ----------
DATE OF CALIBRATION: 03/12/2021
DATE OF NEXT CALIBRATION: 03/12/2022

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# *CERTIFICATE OF CALIBRATION*

**CALIBRATION CERTIFICATE NO: WOSL/IEFCLAQCO02021**

**CUSTOMER NAME:** INDORAMA ELEME FERTILIZERS & CHEMICALS LTD
**INSTRUMENT TYPE:** AEROQUAL CARBON MONOXIDE SENSOR HEAD
**SERIAL NUMBER:** 0609181-008
**MODEL:** CO 0-20PPM

**ENVIRONMENTAL CONDITIONS**
Temperature: 28.8 degree centigrade
Relative Humidity: 70.6%RH

This sensor was Zero calibrated using Aeroqual R42 calibration Kit and further calibrated against a certified mixture of carbon monoxide in synthetic air diluted with zero air using mass flow controllers with calibrations traceable to NIST.

**Measurements**

| | | | | |
|---|---|---|---|---|
| Calibration Standard/PPM | 0.0 | 2.10 | 2.10 | 0.00 |
| Sensor(Mean)/PPM | 0.0 | 2.20 | 2.30 | 0.00 |

The mean and standard deviation are calculated from three consecutive readings.

The calibration is traceable to the National Standards which realize the units of measurement according to the International System of Units (S.I) ISO 10012-1 and ANSI/NCSL Z540.3-2006. The User is obliged to have the instrument re-calibrated at appropriate interval

**CALIBRATED BY:**
NAME: ADENIYI OLAWALE
TITLE: SUPPORT ENGINEER
SIGNATURE: ----------
DATE OF CALIBRATION: 03/12/2021
DATE OF NEXT CALIBRATION: 03/12/2022