THE SINAGTALA RESORT
ORANI, BATAAN

AIR QUALITY MONITORING
SINAGTALA FARM RESORT

AIR QUALITY INDEX (AQI)
Describes air quality levels in a standard way. The higher the AQI, the greater the level of pollution and the greater thehealth danger.

AQI PM 10: 10 GOOD

AQI PM 2.5: 24 GOOD

PARTICULATE MATTER (PM)
A complex mixture of extremely small particles and liquid droplets that get into the air. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

PM 10: 11 µg/m3 — DENR Limit: 150 µg/m3 — WHO Limit: 50 µg/m3

PM 2.5: 11 µg/m3 — DENR Limit: 50 µg/m3 — WHO Limit: 25 µg/m3

NITROGEN OXIDES (NO)
While all of these gases are harmful to human health and the environment, NO2 is of greater concern. NO2 primarily gets in the air from the burning of fuel. High concentration of NO2 can irritate airways in the human respiratory system. NO2 and other NOx also interact with chemicals in the atmosphere to form acid rain.

NO_2: 5 ppb — DENR Limit: 80 ppb

NO: 4 ppb

NO_x: 6 ppb

GROUND LEVEL OR "BAD" OZONE (O_3)
Not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Breathing ozone can trigger a variety of health problems, particularly for those who have lung diseases such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems.

O_3: 21 ppb | 29 ppb | 27 ppb

WHO Limit: 51 ppb
DENR Limit: 30 ppb

SULFUR DIOXIDE (SO_2)
Sulfur Dioxide (SO2) results from the burning of either sulfur or materials containing sulfur, such as fossil fuels. Short-term exposures to SO2 can harm the human respiratory system and make breathing difficult.

SO_2: 26 ppb — DENR Limit: 70 ppb — WHO Limit: 8 ppb

CARBON MONOXIDE (CO)
Carbon Monoxide (CO) is a colorless, odorless gas that can be harmful when inhaled in large amounts. CO is released when something is burned.The greatest sources of CO to outdoor air are cars, trucks and other vehiclesor machinery that burn fossil fuels. Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain.

CO: 7 ppm | 10 ppm | 1 ppm

DENR Limit: 70 ppb

METHANE (CH_4)
Methane is one of the main greenhouse gases (GHGs), or gases that trapheat in the atmosphere, contributing to such phenomena as global warmingand climate change. Methane is emitted during the production and transportof coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

CH_4: 1 ppm

Total Non-Methane Hydrocarbons (TNMHC)
Non-methane hydrocarbons are an important subset of so-called volatile organic compounds (VOCs), chemicals that contribute to ground-level ozone and photochemical smog outdoors. NMHC are emitted from petrol evaporation and incomplete combustion, and from leakage of natural gas from distribution systems. Evaporation of solvents, used in paints or industrial degreasing processes, also cause a release of NMHC to the atmosphere.

TNMHC: .05 ppm

HYDROGEN SULFIDE (H_2S)
Hydrogen sulfide (H2S) is a naturally occurring, colorless gas with a foul smell like rotten eggs. It is often produced when sulfurous compounds in organic matter, such as manure, are decomposed by bacteria in anaerobic (without oxygen) conditions. It also occurs in natural gas, groundwater, and volcanic gases. Common anthropogenic sources of hydrogen sulfide include sour crude oil refineries, pulp and paper mills, oil and gas operations, sewage treatment plants, and animal agriculture.

H_2S: 1 ppb

AQI:
- Good
- Moderate

POLLUTANTS:
- Good (Within Standard)
- Bad (Above Standard)
- No Standard

DATA FROM:

References:
https://www.epa.gov/haps
https://www.epa.gov/no2-pollution
https://www.epa.gov/ozone-pollution
https://www.epa.gov/pm-pollution
https://www.epa.gov/so2-pollution

Report Number: AAQ-19-08
Station: Sinagtala Farm Resort, Orani, Bataan
Prepared by:

For the Period of: June 20 to July 3, 2019
Date Prepared: July 5, 2019
Reviewed by:

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AMBIENT AIR QUALITY MONITORING REPORT

SUMMARY

- As part of PG-ENRO's Provincial Environmental Monitoring Program, the PGB's Mobile Ambient Air Quality Monitoring System (AQMS) was deployed at Sinagtala Farm Resort, Orani, Bataan to measure ambient air quality in the area in terms of Air Quality Index (AQI); criteria pollutants (PM10, PM2.5, NO_2 and NO_x, O_3, SO_2, CO), and non-criteria pollutants (total non-methane hydrocarbon or TNMHC and H_2S). Additionally, ambient methane (CH_4), a greenhouse gas, was also measured by the AQMS. Monitoring period was from June 20 to July 3, 2019.

- The results of the monitoring were compared with the data of Malabon City where such comparison was made to identify the difference between the air quality of upland rural areas and urban city.

- Sinagtala Farm Resort was monitored to have a good air quality with an average AQI of 10 (AQI PM10) / 24 (AQI PM2.5)

- Among the criteria pollutants monitored, parameters of concern were sulfur dioxide (SO_2) and ground level ozone (O_3). Concentrations of sulfur dioxide exceeded the allowable limit set by WHO all throughout the monitoring period while ground level ozone exceeded on June 20,21,27-28, and July 2 and 3.

- Non criteria pollutants, specifically total non-methane hydrocarbon or TNMHC and Hydrogen Sulfide (H_2S) were also monitored on-site. Average TNMHC concentrations ranged from 0.00 ppm to 0.16 ppm, while average H_2S concentrations varies from 0.03 ppb to 2.64 ppb.

- Based from the results obtained, it is recommended that the farm resort should maintain their environmental conservation practices. It would also be better if they engage in sustainable ways such as reduction of plastic usage and waste segregation. Proper disposal of wastewater treatment is also advisable to utilize resources efficiently and effectively.

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INTRODUCTION

As part of the PG-ENRO's Provincial Environmental Monitoring Program, the Mobile Ambient Air Quality Monitoring System (AQMS) of the Provincial Government of Bataan (PGB) was deployed at the identified monitoring station at Sinagtala Farm Resort, Orani, Bataan. (Figure 1).

In terms of location, the station can be considered an upland rural station, vicinal to the Roman Super Highway. Ambient air quality monitoring at said station was done from June 20 to July 3, 2019.

Figure 1. Location map of ambient air quality monitoring station at Sinagtala Farm Resort, Orani, Bataan

The deployed Mobile AQMS monitored eleven (11) air quality parameters (see Table 1). The average values of air quality parameters are compared with the following standards or guideline values:

1. National Ambient Air Quality Guideline Values (NAAQGV) prescribed by RA 8749 or the Philippine Clean Air Act of 1999 for criteria pollutants (PM 10, SO_2, NO_2, O_3);
2. DENR Administrative Order (DAO) 2013-13 for PM 2.5; and
3. World Health Organization (WHO) guideline values for criteria pollutants (PM 2.5, PM 10, SO_2, NO_2, O_3)

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Table 1. Ambient air quality monitoring parameters

PARAMETER	DESCRIPTION
Particulate Matter (PM) 1. **PM 10** 2. **PM 2.5**	A complex mixture of extremely small particles and liquid droplets that get into the air. PM includes: • PM10: inhalable particles, with diameters that are generally 10 micrometers and smaller; and • PM2.5: fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller. Some are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.
Ground Level or "Bad" Ozone (O_3) 3. **O_3**	Not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC. Breathing ozone can trigger a variety of health problems, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. Ground level ozone can also have harmful effects on sensitive vegetation and ecosystems.
Nitrogen Oxides (NO_x) 4. **NO_2** 5. **NO** 6. **NO_x**	Nitrogen Dioxide (NO_2) is one of a group of gases called nitrogen oxides (NO_x). While all of these gases are harmful to human health and the environment, NO_2 is of greater concern. NO_2 primarily gets in the air from the burning of fuel. NO_2 forms from emissions from cars, trucks and buses, power plants, and off-road equipment. Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. NO_2 and other NO_x also interact with water, oxygen and other chemicals in the atmosphere to form acid rain.
Sulfur Dioxide (SO_2) 7. **SO_2**	Sulfur Dioxide (SO_2) is one of a group of gases called sulfur oxides (SO_x). The other gases in the group are much less common in the atmosphere. SO_2 results from the burning of either sulfur or materials containing sulfur, such as fossil fuels. Short-term exposures to SO_2 can harm the human respiratory system and make breathing difficult. Children, the elderly, and those who suffer from asthma are particularly sensitive to effects of SO_2.
Carbon Monoxide (CO) 8. **CO**	Carbon Monoxide (CO) is a colorless, odorless gas that can be harmful when inhaled in large amounts. CO is released when something is burned. The greatest sources of CO to outdoor air are cars, trucks and other vehicles or machinery that burn fossil fuels. Breathing air with a high concentration of CO reduces the amount of oxygen that can be transported in the blood stream to critical organs like the heart and brain.
Methane (CH_4) 9. **CH_4**	Methane is one of the main greenhouse gases (GHGs), or gases that trap heat in the atmosphere, contributing to such phenomena as global warming and climate change. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
Total Non-Methane Hydrocarbons (TNMHC) 10. **TNMHC**	Non-methane hydrocarbons are an important subset of so-called volatile organic compounds (VOCs), chemicals that contribute to ground-level ozone and photochemical smog outdoors. NMHC are emitted from petrol evaporation and incomplete combustion, and from leakage of natural gas from distribution systems. Evaporation of solvents, used in paints or industrial degreasing processes, also cause a release of NMHC to the atmosphere.
Hydrogen Sulfide (H_2S) 11. **H_2S**	Hydrogen sulfide (H_2S) is a naturally occurring, colorless gas with a foul smell like rotten eggs. It is often produced when sulfurous compounds in organic matter, such as manure, are decomposed by bacteria in anaerobic (without oxygen) conditions. It also occurs in natural gas, groundwater, and volcanic gases. Common anthropogenic sources of hydrogen sulfide include sour crude oil refineries, pulp and paper mills, oil and gas operations, sewage treatment plants, and animal agriculture.

Sources:
http://www.air-quality.org.uk/04.php
https://articles.extension.org/sites/default/files/Hydrogensulfide%20FINAL.pdf
https://www.epa.gov/co-pollution
https://www.epa.gov/haps
https://www.epa.gov/no2-pollution
https://www.epa.gov/ozone-pollution
https://www.epa.gov/pm-pollution

RESULTS

A. Air Quality Index (AQI)

The Air Quality Index (AQI) describes air quality levels in a standard way, with an index range of 0 (good; green) to 500 (hazardous; maroon). The higher the AQI, the greater the level of pollution and the greater the health danger.On average, the PM-based AQI for Sinagtala Farm Resort is 45 which corresponds to good air quality. AQI PM10 has an average value of 10 (good), while AQI PM2.5 has an average value of 24, corresponding t0 moderate air quality (Figure 2).

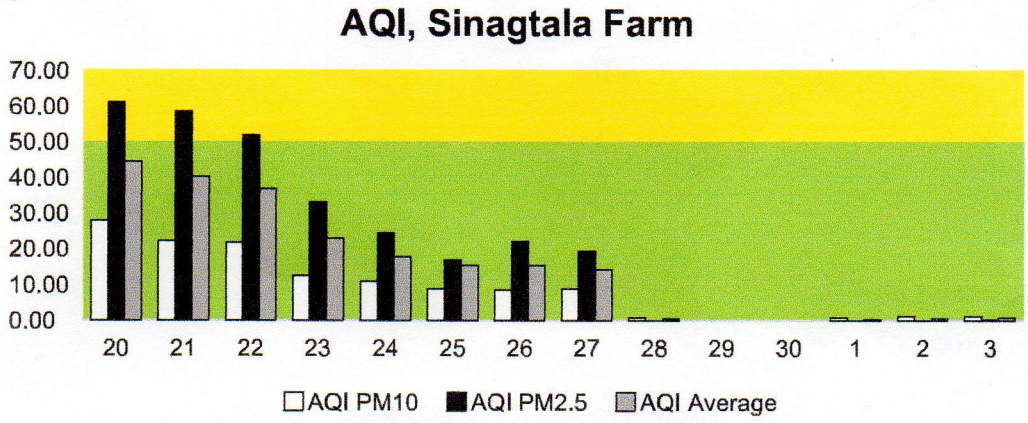

Figure 2. Air Quality Index (AQI) of Sinagtala Farm Resort

B. Criteria Pollutants

B.1. Particulate Matter (PM10 and PM2.5)

PM10. As shown in Figure 3, PM10 concentrations from two different station were contrasted. A range of 0.71 µg/m³ to 30.43 µg/m³ were accumulated from Sinagtala Farm Resort which is one third of the data gathered from Malabon City than ranges from 30.20 µg/m³ to 95.70 µg/m³. Both PM10 levels are well below the Clean Air Act (NAAQGV) limit of 150 µg/m³, but exceeded the more stringent WHO guideline value of 50 µg/m³ almost all throughout the monitoring period in the urban city.

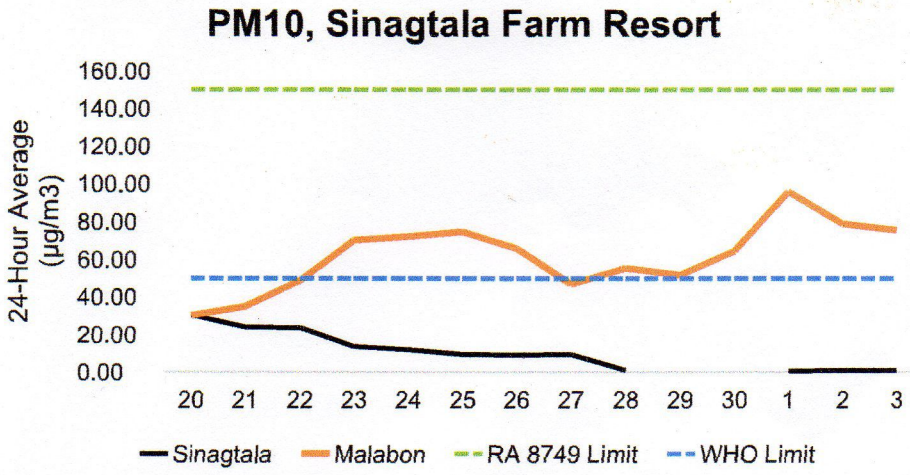

Figure 3. PM10 concentrations of Sinagtala Farm Resort and Malabon City

PM2.5. Concentrations of PM2.5 in Sinagtala Farm Resort ranged from 4.13 µg/m³ to 17.03 µg/m³ while PM2.5 values of Malabon CIty varies from 15.0 µg/m to 47.8 µg/m³. Such PM2.5 concentrations monitored in both stations are all below the Clean Air Act threshold of 50 µg/m³. When compared with the more stringent WHO guideline value (25 µg/m³), exceedances were observed to happen mainly in the urban city (Figure 4).

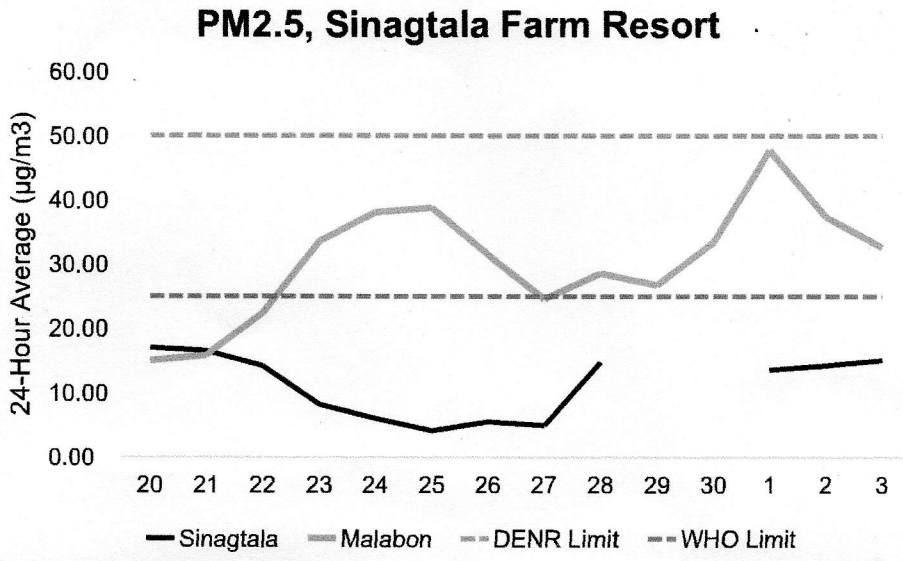

Figure 4. PM 2.5 concentrations of Sinagtala Farm Resort and Malabon City

B.2. Nitrogen Oxides (NO_2, NO and NO_x)

Figures 5 discussed the concentrations of NO, NO_2, and NO_x (NO + NO_2), with NO_2 being a criteria pollutant. NO_2 concentrations range from 0.00 ppb to 27.7 ppb in Sinagtala Station with an average of 5.40 ppb. These values are well below the NAAQGV for NO_2, which is 80 ppb.

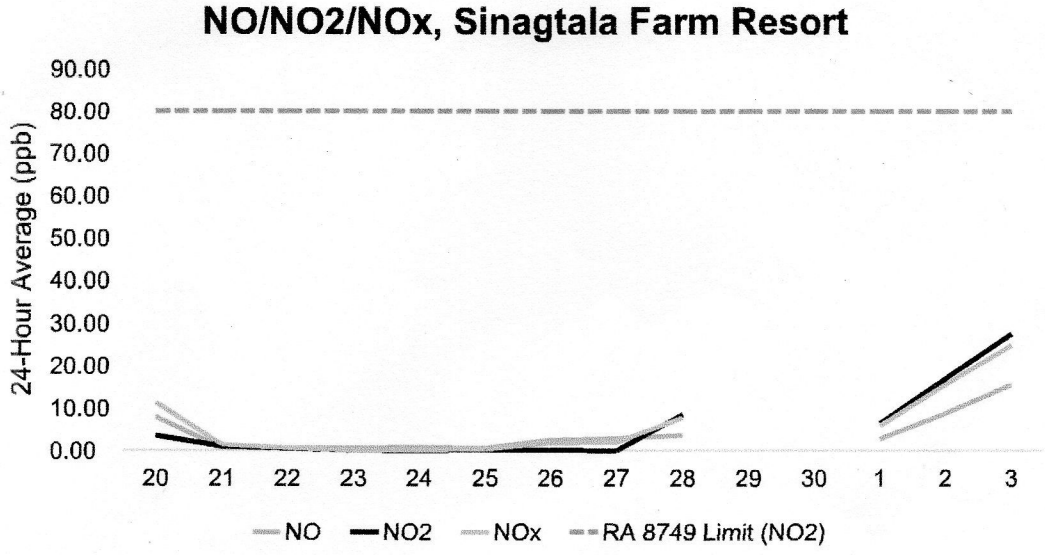

Figure 5. Nitrogen Dioxide (NO_2) concentrations of Sinagtala Farm Resort and Malabon City

Meanwhile, concentrations of NO were measured to be from 0.57 ppb to 15.63 ppb or an average concentration of 3.98 ppb. On the other hand, NO_x concentrations ranged from 0.05 ppb to 25.0 ppb and an average value of 5.99 ppb.

B.3. Ground-Level Ozone (O_3)

As shown in Figure 8, eight-hour average concentrations of O_3 show a diurnal pattern, with ambient O_3 levels usually peaking at the second third of the day (8:00 AM – 3:00 PM), during which sunlight is most abundant, and ambient temperature peaks.

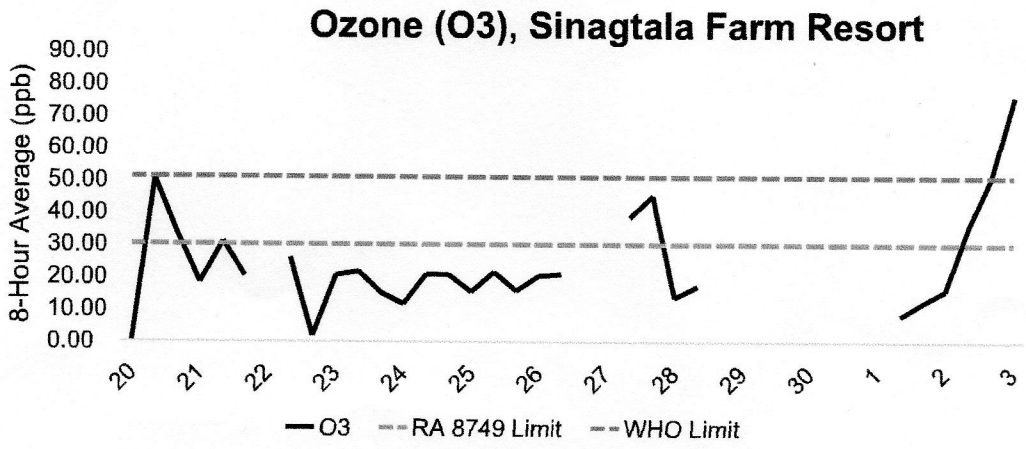

Figure 8. Ozone (O_3) concentrations of Sinagtala Farm Resort and Malabon City

For the period of 12:00 AM to 7:00 AM, O_3 levels ranged from 0.19 ppb to 76.38 ppb; from 8:00 AM to 3:00 PM, concentrations increase to a range of 8.0 ppb to 50.67 ppb; while from 4:00 PM to 11:00 PM, concentrations slightly decrease to 0.1.78 ppb to 51.0 ppb. Monitored O_3 levels at Sinagtala Station are all below the WHO limit except on July 2 while on June 20, 21, 27 and July 2, the ozone concentrations exceeded the standard the Clean Air Act guideline values.

B.4. Sulfur Dioxide (SO_2)

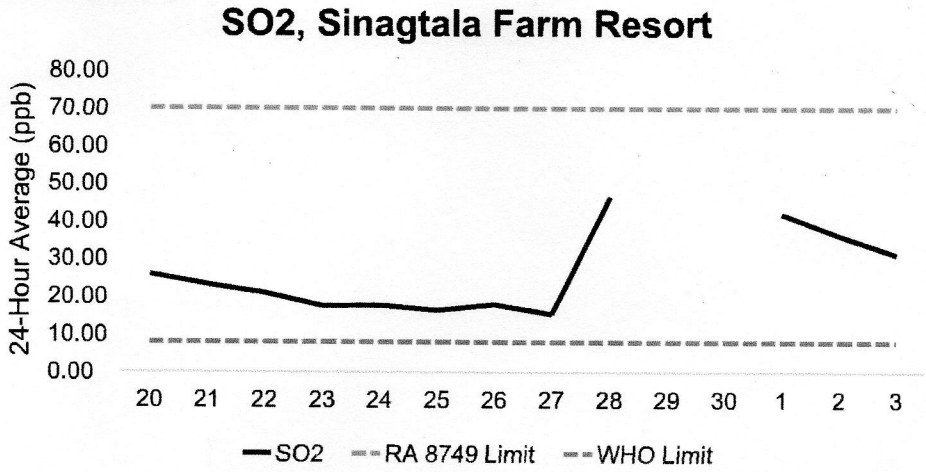

Figure 9. Sulfur Dioxide (SO_2) concentrations of Sinagtala Farm Resort

Figure 9 showed the concentrations of SO_2, ranging from 15.2 ppb to 46.5 ppb. These average values are well below the NAAQGV of 70 ppb. However, SO_2 levels for Morong Station exceeded the WHO limit of 8 ppb all throughout the monitoring period.

C. Non-Criteria Pollutants

C.1. Total Non-Methane Hydrocarbons (TNMHC)

While there are no available guideline values for comparison, TNMHC is among the parameters monitored because this subset of volatile organic compounds (VOCs) is a precursor pollutant of ground-level O_3, contributing to photochemical smog.

As shown in Figure 10, average TNMHC concentrations are all above 100 ppb (0.10 ppm), ranging from 0.00 ppb (0.00 ppm) to 161.06 ppb (0.16 ppm).

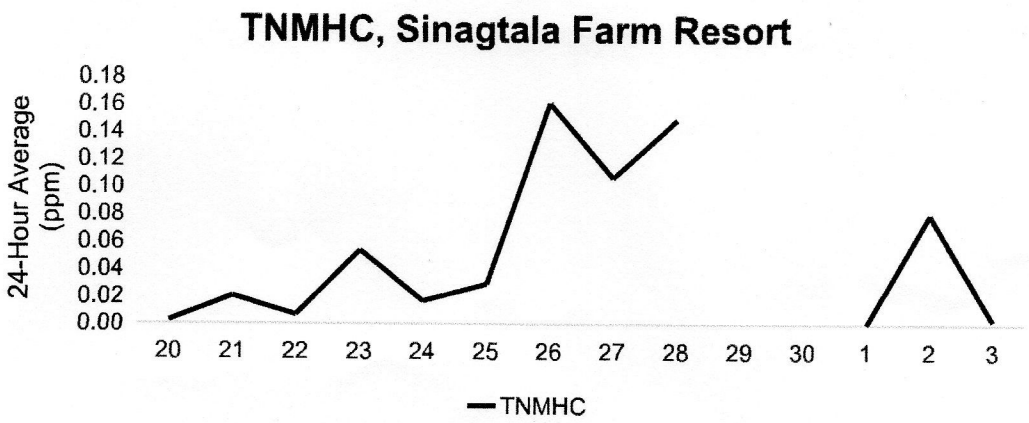

Figure 10. Average TNMHC concentrations, Sinagtala Farm Resort

As mentioned, ground-level O_3 is a secondary pollutant and therefore not directly emitted. Rather, it can be produced from the photochemical reaction (i.e., with sunlight) of NO_x and/or volatile organic compounds (VOCs) emitted from the above areas. With low NO_x concentrations (below 80 ppb) but relatively high TNMHC concentrations monitored (above 200 ppb), it can therefore be inferred that TNMHC/VOCs more likely contribute to ground-level O_3 formation at the station and its vicinities.

C.2. Hydrogen Sulfide (H_2S)

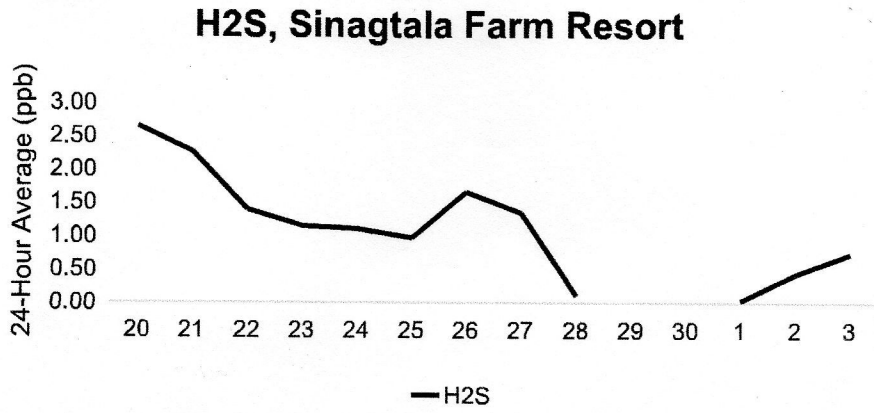

Figure 11. Average H_2S concentrations, Sinagtala Farm Resort

Hydrogen Sulfide (H_2S) is another non-criteria pollutant monitored because of its potential adverse health and environmental impact at high concentrations; it is considered as an air toxic or hazardous air pollutant. As shown in Figure 11, average H_2S concentrations ranges from 0.03 to 2.64 ppb.

C.3. Methane (CH_4)

Because of its non-reactivity, methane (CH_4) is not considered as a pollutant in most air quality studies. However, being a major greenhouse gas, it is also important to monitor ambient concentrations of said gas. As shown in Figure 12, average CH_4 concentrations at Sinagtala Station ranged from 0.00 ppm (0.00 ppb) to 2.8 ppm (2806.11 ppb).

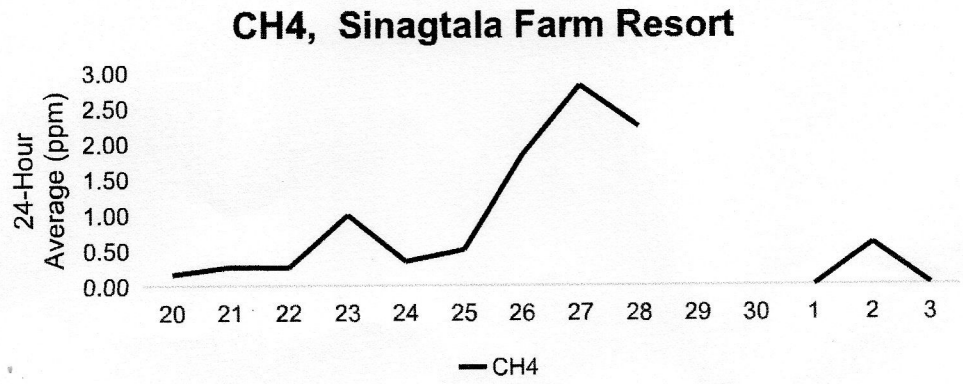

Figure 12. Average CH_4 concentrations, Sinagtala Farm Resort

RECOMMENDATIONS

Based from the results obtained, it is recommended that the farm resort should maintain their environmental conservation practices. It would also be better if they engage in sustainable ways such as reduction of plastic usage and waste segregation. Proper disposal of wastewater treatment is also advisable to utilize resources efficiently and effectively.