# MANUAL FOR SITING AND DESIGN OF AIR QUALITY MONITORING STATIONS IN THE PHILIPPINES


**Department of Environment and Natural Resources**
**ENVIRONMENTAL MANAGEMENT BUREAU**
**DENR Compound, Visayas Avenue, Diliman, Quezon City 1116**
**Tel.Nos. (632)927-1517; 928-3725; Fax No.(632)920-2258**
**Website: www.emb.gov.ph Email: recordsco@emb.gov.ph**

# Table of Contents

# List of Figures

# List of Tables

# 1 DEFINITION OF TERMS

**Carbon Monoxide (CO)**

A criteria pollutant that is colorless, odorless, and is produced in incomplete combustion.

**Nitrogen Dioxide ($NO_2$)**

A criteria pollutant produced from fossil fuel combustion processes.

**Open path**

Refers to ambient air analyzers that measure pollutant concentrations along the path of a beam of infrared, visible or ultraviolet light, as opposed to sampling analyzers, which pull air through an inlet into an analysis system.

**Ozone ($O_3$)**

A criteria pollutant that is colorless, and highly reactive compound with each molecule consists of three oxygen atoms.

**Particulate Matter 10 ($PM_{10}$)**

Particulate Matter having a diameter of 10 microns or less.

**Particulate Matter 2.5 ($PM_{2.5}$)**

Particulate Matter having a diameter of 2.5 microns or less.

**Point-sources**

Are non-moving sources, such as power plants, chemical plants, oil refineries, manufacturing plants, and other industrial facilities which emits or may emit any air pollutant.

**Siting Criteria**

General Guidelines for locating and installing an Air Quality Monitoring Station and Equipment for specific objective.

S**ulfur Dioxide ($SO_2$)**

A criteria pollutant that is heavy, colorless, and formed primarily by the combustion of coal and oil.

# 2 INTRODUCTION

Air quality has both a local and a national concern. It is mandated that a country-wide approach be adopted for air quality monitoring applications. This will ensure that all applications will be a consistent part of an overall planning to achieve the national objectives while the local problems are being attended to.

# 3 GENERAL SITING GUIDELINES

An important element for air quality monitoring station application is a clear statement of its monitoring objectives. Siting of the station shall be in accordance with the stated monitoring objectives. It is not practical to lay down definitive procedures for selection of the site since much judgmental work is involved dependent on the available siting opportunities and the practical extent of prior data gathering to assist the decision process.

The following are the general siting guidelines:

a.) The design of the station and equipment to be used must comply with available USEPA requirements;

b.) The Spatial Scale of Representativeness (SSR)[1] of the measurement must be stated. The appropriateness for the stated SSR must be supported by a critical analysis. Such analysis can be based on previously measured concentration data or can be qualitative arguments based on examination of the factors that have an impact on the SSR;

c.) The factors that have an impact on the SSR will include factors related to the characteristics of the pollutants, characteristics of any sources that influence the measurement, the terrain, meteorology and the climatology;

d.) Population that will be impacted by the findings of the air quality monitoring;

# 4 SITING CRITERIA

The siting criteria is based on USEPA guidelines for siting of air quality monitoring stations in the two appendices of the USEPA CFR Title 40 Part 58.[2]

[1] 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring
Monitoring Objectives and Spatial Scales

[2] Appendix D "Network Design for State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS)"
Appendix E "Probe Siting Criteria for Ambient Air Quality Monitoring"

## 4.1 MONITORING OBJECTIVES

The site must be selected that is most likely to fulfil these objectives.[3]

1. Sites located to determine the highest concentrations expected to occur in the area covered by the network.
2. Sites located to measure typical concentrations in areas of high population density.
3. Sites located to determine the impact of significant sources or source categories on air quality.
4. Sites located to determine general background concentration levels.
5. Sites located to determine the extent of regional pollutant transport among populated areas; and in support of secondary standards.
6. Sites located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts.

## 4.2 GENERAL GUIDELINES FOR THE REQUIRED NUMBER OF STATION BASED ON POPULATION

The site selection is based on how well a potential site can meet the stated objectives.

1. Zones with high population exposure to pollutants should be given priority.
2. Densely populated area within the vicinity of heavy pollution sources are given special attention and general guidelines based on pollutants is given by *Table 1*.

**Table 1 – General Guidelines for Stations needed based on Population Size[4]**

| URBAN POPULATION (million) | AVERAGE NUMBER OF STATIONS PER POLLUTANT | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ | TSP | $SO_2$ | $NO_2$ | $O_3$ | CO | WIND |
| 1.0 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 1.0 – 4.0 | 5 | 5 | 5 | 5 | 2 | 2 | 2 | 2 |
| 4.0 – 8.0 | 8 | 8 | 8 | 8 | 4 | 3 | 4 | 2 |
| Above 8.0 | 10 | 10 | 10 | 10 | 5 | 4 | 5 | 3 |

3. Meteorological factors (e.g., prevailing wind directions) and the position of the candidate station relative to the emission sources are to be considered;
4. Areas of projected growth and development to be considered.

[3] USEPA Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring Monitoring Objectives and Spatial Scales
[4] EMB Air Quality Monitoring Manual 1994

## 4.3 SPATIAL SCALE OF REPRESENTATIVENESS

Spatial scale of representativeness refers to the area within which the pollutant concentrations are reasonably well-represented by the measurements at the station.

In general, six spatial scales are defined as follows[5]:

1. Microscale – representing areas with dimensions ranging from several meters up to about 100m;
2. Middle Scale – representing areas with dimensions extending from about 100 to 500m;
3. Neighbourhood Scale – representing areas with dimensions extending 0.501 to 4.0km;
4. Urban Scale – representing areas with dimensions extending 4.001 to 50km.
5. Regional Scale – representing areas with dimensions extending hundreds of kilometers. The measurements would be applicable mainly to large homogeneous areas, particularly those which are sparsely populated.
6. National Scale – representing measurements characterizing the nation

**Table 2 - Major Monitoring Objectives and Appropriate Siting Scales**

| Monitoring Objectives | Appropriate Siting Scales |
|---|---|
| Population Exposure | Neighborhood, Urban |
| Highest Concentration | Micro, Middle, Neighbourhood, Urban |
| Source Impact | Micro, Middle, Neighbourhood |
| General/Background | Neighbourhood, Regional |

[5] 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring Monitoring Objectives and Spatial Scales

**Table 3 - SUMMARY OF PROBE AND MONITORING PATH SITING CRITERIA**[6]

| Pollutant | Scale (maximum monitoring path length, meters) | Height from ground to probe, inlet or 80% of monitoring path [1] (meters) | Horizontal and vertical distance from supporting structures [2] to probe, inlet or 90% of monitoring path [1] (meters) | Distance from trees to probe, inlet or 90% of monitoring path [1] (meters) | Distance from roadways to probe, inlet or monitoring path [1] (meters) |
|---|---|---|---|---|---|
| $SO_2$ [3 4 5 6] | Middle (300 m) Neighborhood Urban, and Regional (1 km) | 2-15 | >1 | >10 | N/A. |
| **CO** [4 5 7] | Micro [downtown or street canyon sites], micro [near-road sites], middle (300 m) and Neighborhood (1 km) | 2.5-3.5; 2-7; 2-15 | >1 | >10 | 2-10 for downtown areas or street canyon microscale; ≤50 for near-road microscale; see chapter 5.7.5, Table 5 for middle and neighborhood scales. |
| $O_3$ [3 4 5] | Middle (300 m) Neighborhood, Urban, and Regional (1 km) | 2-15 | >1 | >10 | See Table 4 for all scales. |
| $NO_2$ [3 4 5] | Micro (Near-road [50-300 m]) | 2-7 (micro); | >1 | >10 | ≤50 for near-road micro-scale. |
| | Middle (300 m) | 2-15 (all other scales) | | | |
| | Neighborhood, Urban, and Regional (1 km) | | | | See Table 4 for all other scales. |

[6] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring Summary of Probe and Monitoring Path Siting Criteria

| | | | | | |
|---|---|---|---|---|---|
| **PM, Pb** [3 4 5 8] | Micro, Middle, Neighborhood, Urban and Regional | 2-7 (micro); 2-7 (middle PM 10-2.5); 2-7 for near-road; 2-15 (all other scales) | >2 (all scales, horizontal distance only) | >10 (all scales) | 2-10 (micro); see Table 5 for all other scales. ≤50 for near-road. |

N/A - Not applicable.

[1] Monitoring path for open path analyzers is applicable only to middle or neighborhood scale CO monitoring, middle, neighborhood, urban, and regional scale $NO_2$ monitoring, and all applicable scales for monitoring $SO_2$ and $O_3$.

[2] When probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouses located on roof.

[3] Should be greater than 20 meters from the dripline of tree(s) and must be 10 meters from the dripline when the tree(s) act as an obstruction.

[4] Distance from sampler, probe, or 90 percent of monitoring path to obstacle, such as a building, must be at least twice the height the obstacle protrudes above the sampler, probe, or monitoring path. Sites not meeting this criterion may be classified as middle scale (see text).

[5] Must have unrestricted airflow 270 degrees around the probe or sampler; 180 degrees if the probe is on the side of a building or a wall.

[6] The probe, sampler, or monitoring path should be away from minor sources, such as furnace or incineration flues. The separation distance is dependent on the height of the minor source's emission point (such as a flue), the type of fuel or waste burned, and the quality of the fuel (sulfur, ash, or lead content). This criterion is designed to avoid undue influences from minor sources.

[7] For micro-scale CO monitoring sites, the probe must be >10 meters from a street intersection and preferably at a midblock location.

[8] Collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference.

## 4.4 SPATIAL SCALES OF REPRESENTATIVENESS FOR INDIVIDUAL PARAMETERS

### 4.4.1 SUSPENDED PARTICULATES (TSP, $PM_{10}$ or $PM_{2.5}$)[7]

Microscale – This scale is appropriate for assessing the condition in downtown street canyons and traffic corridors where the general public would be exposed to high concentrations from mobile sources;

Middle Scale – This scale is applicable for evaluation of possible short-term effects on public health caused by particulate matter, e.g., health effect on people moving through downtown areas, or living near major roadways;

Neighborhood Scale -- Measurements in this scale provide information about trends and compliance with standards because they often represent conditions in areas where people live and work for long periods;

Urban Scale – Measurements represent particulate concentration over an entire metropolitan area. Such measurements would be useful to assess trends in city-wide air quality, and hence the effectiveness of large-scale control strategies;

Regional Scale – Measurements applicable to sparsely populated areas with reasonably uniform ground cover.

### 4.4.2 SULFUR DIOXIDE ($SO_2$)[7]

Middle Scale – Suitable for assessing the effectiveness of control strategies to reduce urban concentrations (especially for 3-hr and 24-hr averaging times) and monitoring of air pollution episodes;

Neighbourhood Scale – Suitable for application to area where the $SO_2$ emission rate and population density are homogeneous. Also used for measurement of baseline concentrations in areas of projected growth or for studies of population responses to exposure to $SO_2$;

Urban Scale -- Data from this scale can be used for the assessment of air quality trends and the effect of control strategies on urban scale air quality.

Regional Scale -- This scale of measurement provides information on background air quality and interregional pollution transport.

[7] 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring

### 4.4.3 CARBON MONOXIDE (CO)[7]

Microscale -- Measurements on this scale represent distributions within street canyons, over sidewalks, and near major roadways. This scale of measurements provides information for devising and evaluating "hot spot" control measures;

Middle Scale -- This scale may apply to regions where reasonably homogeneous concentration of CO can be expected;

Neighbourhood Scale -- Measurements in this scale would represent conditions throughout some reasonably homogeneous urban subregions, with dimensions of a few km and generally more regularly shaped than the middle scale.

### 4.4.4 OZONE ($O_3$)[7]

Since ozone requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small-scale spatial variability.

Middle Scale -- This scale of monitoring would represent conditions close to sources of $NO_x$ such as roads where suppression of $O_3$ concentration is expected;

Neighbourhood Scale -- This scale of measurements is useful for developing, testing and revising concepts and models;

Urban Scale -- Results of measurements can be used for determining trends and designing area-wide control strategies.

Regional Scale – Such measurements will be useful for assessing the $O_3$ transport phenomena. Data from such stations may be useful in accounting for $O_3$ that cannot be reduce by local control measures.

### 4.4.5 NITROGEN DIOXIDE ($NO_2$)[7]

Micro scales -- Since nitrogen dioxide is primarily formed from the oxidation of NO, large volumes of air and mixing times are involved. Monitoring on micro scale may not be relevant especially for long averaging times;

Middle Scale -- Measurements in this scale would characterize the public exposure to $NO_2$ in populated areas;

Neighborhood Scale – Appropriate for finding those areas where long-term averages are expected to be the highest. The station can be located further downwind beyond the expected point of maximum total oxides of nitrogen to allow more time for $NO_2$ formation.

[7] 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring

## 4.5 SITING CRITERIA FOR AIR QUALITY MONITORING STATIONS USING REFERENCE AND EQUIVALENT METHODS

Proper siting of a monitor requires specification of the monitoring objective, the types of sites necessary to meet the objective, and then the desired spatial scale of representativeness.

In some cases, the physical location of a site is determined from joint consideration of both the basic monitoring objective and the type of monitoring site desired. For example, to determine PM 2.5 concentrations which are typical over a geographic area having relatively high PM 2.5 concentrations, a neighborhood scale site is more appropriate. Such a site would likely be located in a residential or commercial area having a high overall PM 2.5 emission density but not in the immediate vicinity of any single dominant source. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the [8]monitoring site.

### 4.5.1 INTAKE PROBE OR INLET PLACEMENT

The intake probe or the inlet must be at least 1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, etc., and away from dusty or dirty areas. If the intake probe or the inlet is located near the side of a building or wall, then it should be located on the windward side of the building relative to the prevailing wind direction during the season of highest concentration potential for the pollutant being measured. For appropriate siting scale for each air pollutant monitored based on the intake probe or inlet placement, *see table 4 and figures 4 and 5.*

**Table 4 – Height of sampling probe/inlet and its appropriate siting scale[9]**

| Pollutants | Height of Intake Probe/Inlet | Appropriate Siting Scales |
|---|---|---|
| TSP, $PM_{10}$, $PM_{2.5}$, $NO_2$, CO | 2 – 15 meters | Neighbourhood, Urban, Regional |
| $SO_2$, $O_3$ | 2 – 15 meters | All scales are applicable |
| TSP, $PM_{10}$, $PM_{2.5}$ | 2 – 7 meters | Micro, Middle |
| $NO_2$ | 2 – 7 meters | Micro |
| CO | 2.5 – 3.5 meters | Micro |

[8] 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring
[9] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring Horizontal and Vertical Placement

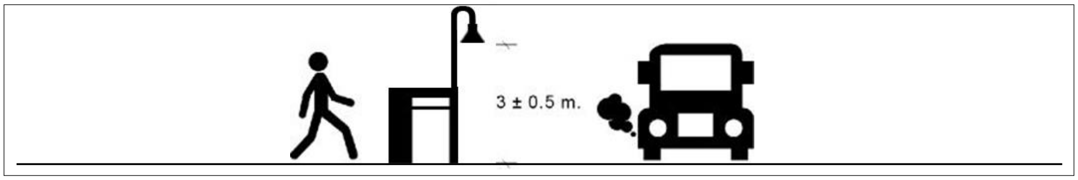



**Figure 4 – Inlet height above ground for CO monitoring (for microscale)**

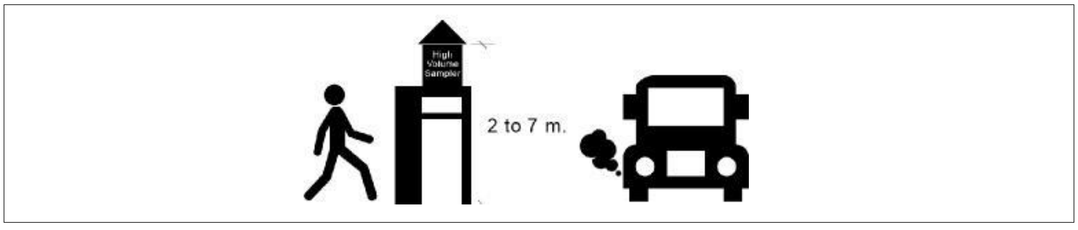
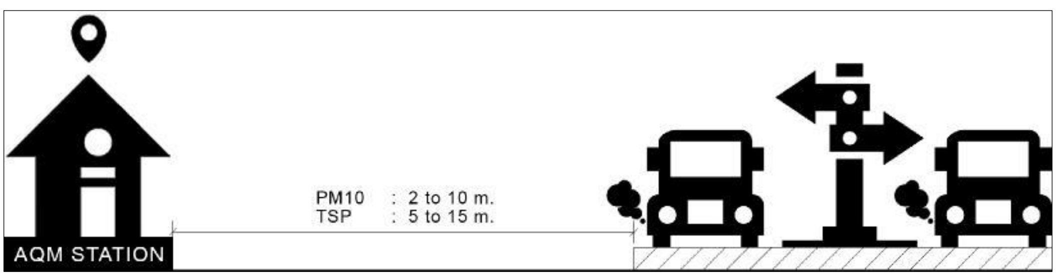



**Figure 5 – Inlet height above ground for TSP, $PM_{10}$ and $PM_{2.5}$ monitoring (for middle and microscale)**

## 4.5.2 POSITION FROM ROAD

The air sampler intake probe or inlets should be away from the edge of the nearest traffic lane. Appropriate siting scale for the air pollutant being monitored may vary depending on the average daily traffic (vehicles per day) of the roadway. *See tables 4, 5 and 6*




**Position from Road of TSP, $PM_{10}$ and $PM_{2.5}$ Sampler (for Microscale)**

Table 4 - Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood and Urban Scale Ozone ($O_3$) and Nitrogen Dioxide ($NO_2$)[10]

| Roadway average daily traffic, vehicles per day | Minimum distance 1 (meters)[1] |
|---|---|
| ≤1,000 | 10 |
| 10,000 | 10 |
| 15,000 | 20 |
| 20,000 | 30 |
| 40,000 | 50 |
| 70,000 | 100 |
| ≥110,000 | 250 |

[10] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

* In siting an $O_3$ analyzer, it is important to minimize destructive interferences form sources of NO, since NO readily reacts with $O_3$.

* A sampling site having a point analyzer probe located closer to a roadway than allowed by the Table 4 requirements should be classified as microscale or middle scale, rather than neighborhood or urban scale, since the measurements from such a site would more closely represent micro and middle scale.

Table 5 - Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide[11]

| Roadway average daily traffic, vehicles per day | Minimum distance 1 (meters) |
|---|---|
| ≤1,000 | 10 |
| 10,000 | 25 |
| 15,000 | 45 |
| 20,000 | 80 |
| 40,000 | 115 |
| 70,000 | 135 |
| ≥110,000 | 150 |

*Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

Table 6 – Distance of PM Samplers to nearest traffic lane (meters)[10]

| ADT | Distance from roadways to Probe/Inlet | | | | | |
|---|---|---|---|---|---|---|
| | Middle Scale, m | | Neighbourhood Scale, m | | Urban Scale, m | |
| | Min | Max | Min | Max (Approx) | Min (Approx) | Max |
| ≤20000 | -- | 20 | 20 | 88 | 88 | -- |
| 40,000 | -- | 40 | 40 | 108 | 108 | -- |
| 60,000 | -- | 60 | 60 | 128 | 128 | -- |
| 80,000 | -- | 80 | 80 | 148 | 148 | -- |
| 100,000 | -- | 100 | 100 | 168 | 168 | -- |
| 120,000 | -- | 120 | 120 | 188 | 188 | -- |
| 140,000 | -- | 140 | 140 | 208 | 208 | -- |
| 160,000 | -- | 160 | 160 | 228 | 228 | -- |
| 180,000 | -- | 180 | 180 | 248 | 248 | -- |
| ≥200000 | -- | 200 | 200 | 268 | 268 | -- |

* For the microscale traffic corridor site, the location must be between 5 and 15 meters from the major roadway. For the microscale street canyon site the location must be between 2 and 10 meters from the roadway.

[11] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

### 4.5.3 RESTRICTION OF AIRFLOW

Buildings and other obstacles may possibly scavenge $SO_2$, $O_3$, or $NO_2$, and can act to restrict airflow for any pollutant. To avoid this interference, the probe or the inlet must have unrestricted airflow and be located away from obstacles. The distance from the obstacle to the probe or inlet must be at least twice the height that the obstacle protrudes above the probe or inlet. An exception to this requirement can be made for measurements taken in street canyons or at source-oriented sites where buildings and other structures are unavoidable.

Generally, a probe or inlet located near or along a vertical wall is undesirable because air moving along the wall may be subject to possible removal mechanisms. A probe or inlet must have unrestricted airflow in an arc of at least 180 degrees. This arc must include the predominant wind direction for the season of greatest pollutant concentration potential. For particle sampling, a minimum of 2 meters of separation from walls, parapets, and structures is required for rooftop site placement.

For near-road $NO_2$ monitoring stations, the monitor probe shall have an unobstructed air flow, where no obstacles exist at or above the height of the monitor probe, between the monitor probe and the outside nearest edge of the traffic lanes of the target road segment.[12]

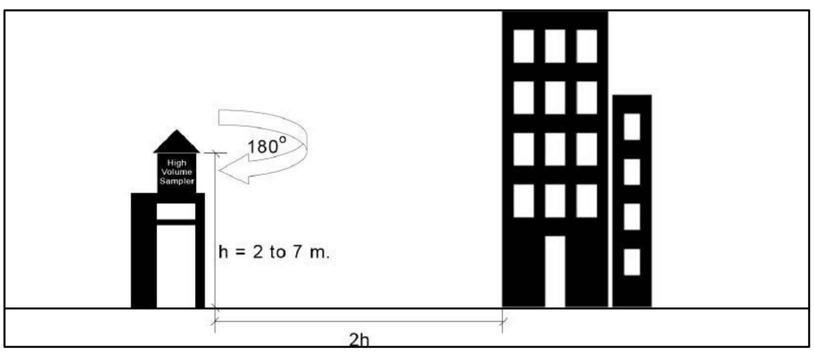



**Figure 7 – Restriction of Airflow for Gases**

### 4.5.4 POINT-SOURCE MONITORING

Sampling location should be located at sensitive receptor areas and at points downwind of the stack where the maximum ambient concentration is expected. This type of ambient monitoring is applicable for source specific sites comparable to the National Ambient Air Quality Standards for Source Specific Air Pollutants (NAAQSSAP)[13]. An approximate guide for downwind location of the maximum concentrations is five (5) to twenty (20) times the stack height[14]. For accurate siting of

[12] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
[13] DAO 2000 – 81, RA 8749
[14] EMB Air Quality Monitoring Manual 1994

point source monitoring, TIER 4[15] dispersion modelling using site specific meteorological data is recommended.

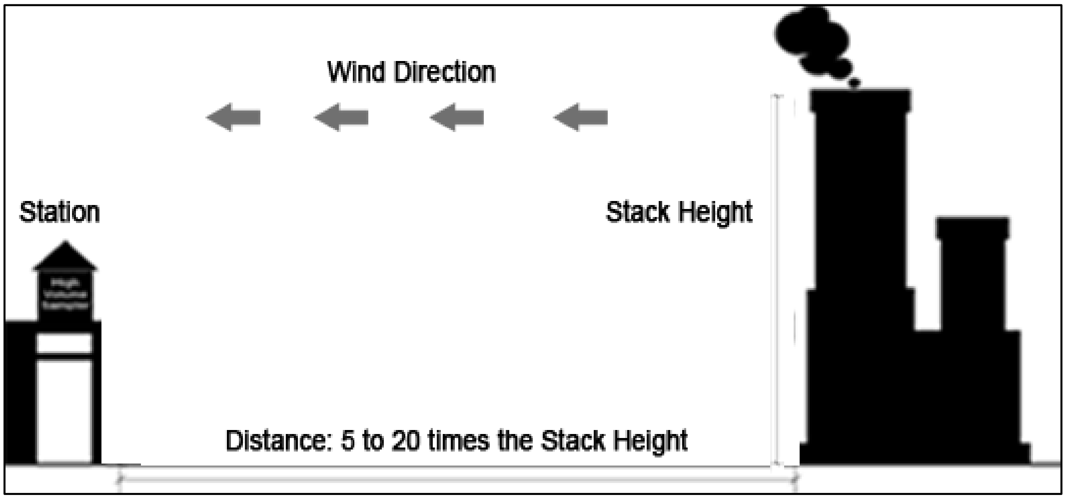



**Figure 9 – Downwind location of the station**

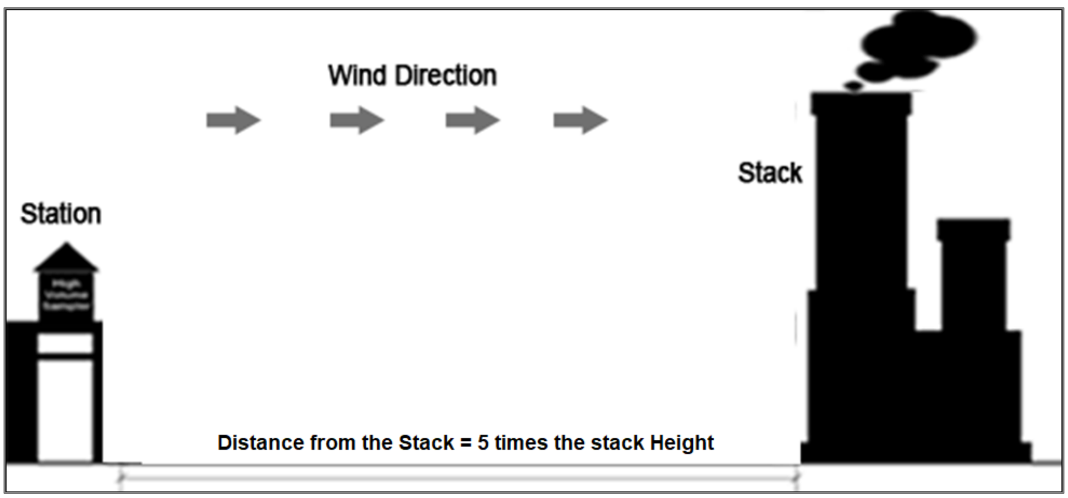



**Figure 10 – Upwind location of the station**

[15] EMB guidelines for Air Dispersion Modelling (MC 2008-003)

### 4.5.5 DISTANCE FROM TREES

Trees can provide surfaces for SO2, O3, or NO2 adsorption or reactions, and surfaces for particle deposition. Trees can also act as obstructions in cases where they are located between the air pollutant sources or source areas and the monitoring site, and where the trees are of a sufficient height and leaf canopy density to interfere with the normal airflow around the intake probe or inlet. To reduce this possible interference/obstruction, the intake probe or inlet shall be at least 10 meters or further from the drip line of trees.[16]

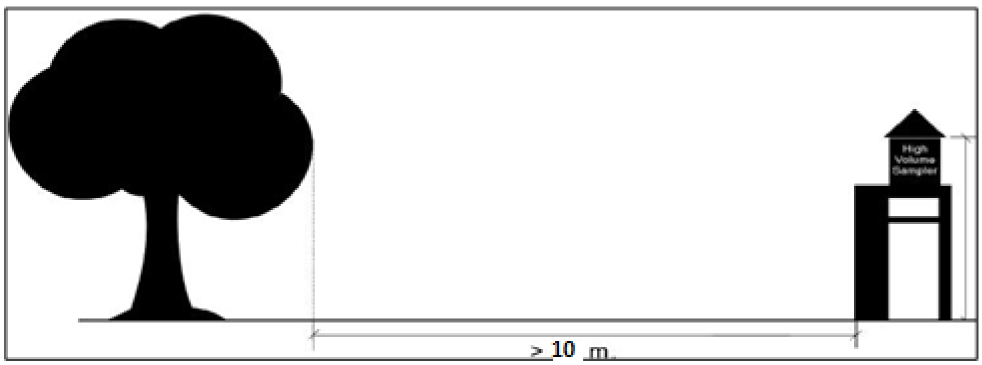



**Figure 11 – Distance from trees of air samplers and its intake probe or inlet**

[16] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring Spacing from trees

# 5 METEOROLOGICAL MAST

For microscale ground level stations, basically there is no limitation on the height of the meteorological mast (if wind speed and wind direction are to be measured) with respect to obstacle nearby. For example, a mounting pole 2-3m above station roof for wind sensors may be enough to study impact from local sources. However, suitable clearance from obstacle should be allowed so that the meteorological data is representative of the station's surrounding area. Moreover, in case of dispersion studies, the wind sensors might be needed to be installed on more representative locations such as roof of the adjacent building. Alternatively, wind data from the Observatory or nearby Air Quality Monitoring Station could be used.

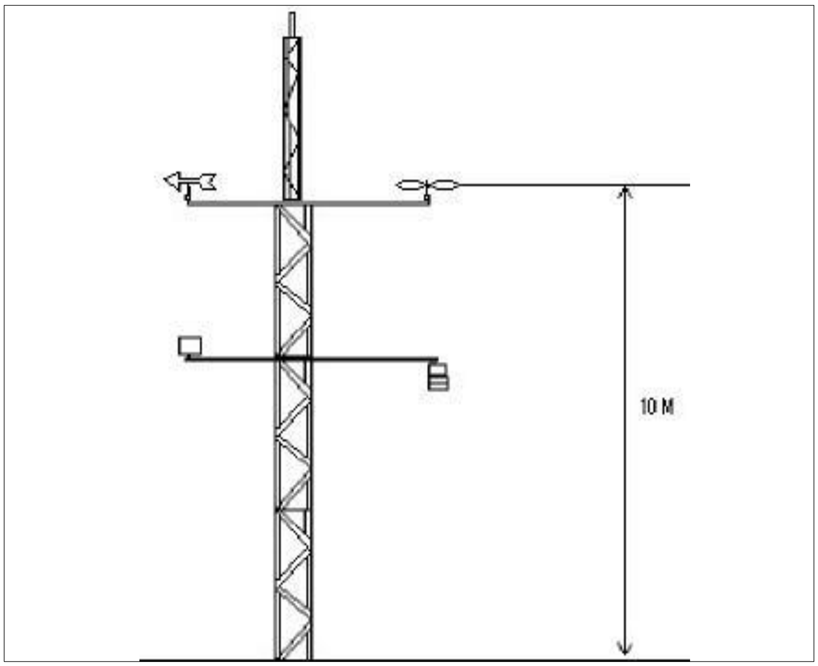



**Figure 13 – Meteorological Mast**

## 5.1 METEOROLOGICAL SENSORS

Meteorological sensors should consist of anemometer, one set of solar radiation, pressure, temperature, and precipitation sensor. The anemometer shall be mounted onto a mast at a height of at least 10m above the highest obstruction on the rooftop. However, for microscale ground level stations, there is no such requirement on height.

Lightning protection and anti-falling device must be provided.

Any structure installed must not obstruct access to the equipment installed on the mast. For solar radiation and temperature sensors, a mounting pole of about 1m above the highest obstruction should be adequate.

A junction box with conduit running into the shelter shall be provided at the foot of each mast for the signal cables of the meteorological sensors. The multi-core signal cable is 10mm in diameter. Steel draw-in wire shall be reserved inside the conduit. Since signal cables of meteorological sensors are very delicate, junction box shall be used instead of bend wherever the conduit must change its direction.

## 5.2 Met Mast Technical Specification

Telescopic crank-up/hand push operated Meteorological Mast made of anodized aluminum of Extendable Height 10-20 meters with all support to be provided, retractable, possible to climb and Hand crank to rise and lower the instruments mounted on the tower.

**Specifications are as follows:**

Extended Height : 10-20 meters
Retracted Height : 2 meters
Number of Sections : 4
Construction material : aluminum

Humidity and temperature sensors are to be supplied with weather and thermal radiation shield made of anodized aluminum and sensor should be supplied with all necessary cables, connector and mounting arrangements as required.

All incoming / outgoing electrical cabling shall be over-voltage protected with drain to one common point.

The equipment shall be constructed with aspects to transients and over-voltage that can occur during nearby thunderstorms.

# 6 POSITIONING OF COLLOCATED AIR SAMPLERS

## 6.1 HIGH-VOLUME, PROBE AND INLET-TYPE SAMPLERS

For precision check purposes, the collocated monitors must be at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference, inlet heights of samplers should be consistent between samplers[17].

When a sampler is placed within 1m from a parapet, the inlet should be at least 2m above the top of the parapet. In case the sampler is placed between 1-2m from a parapet, the inlet should be at least 1m above the top of the parapet (and at least 2m above roof or ground).

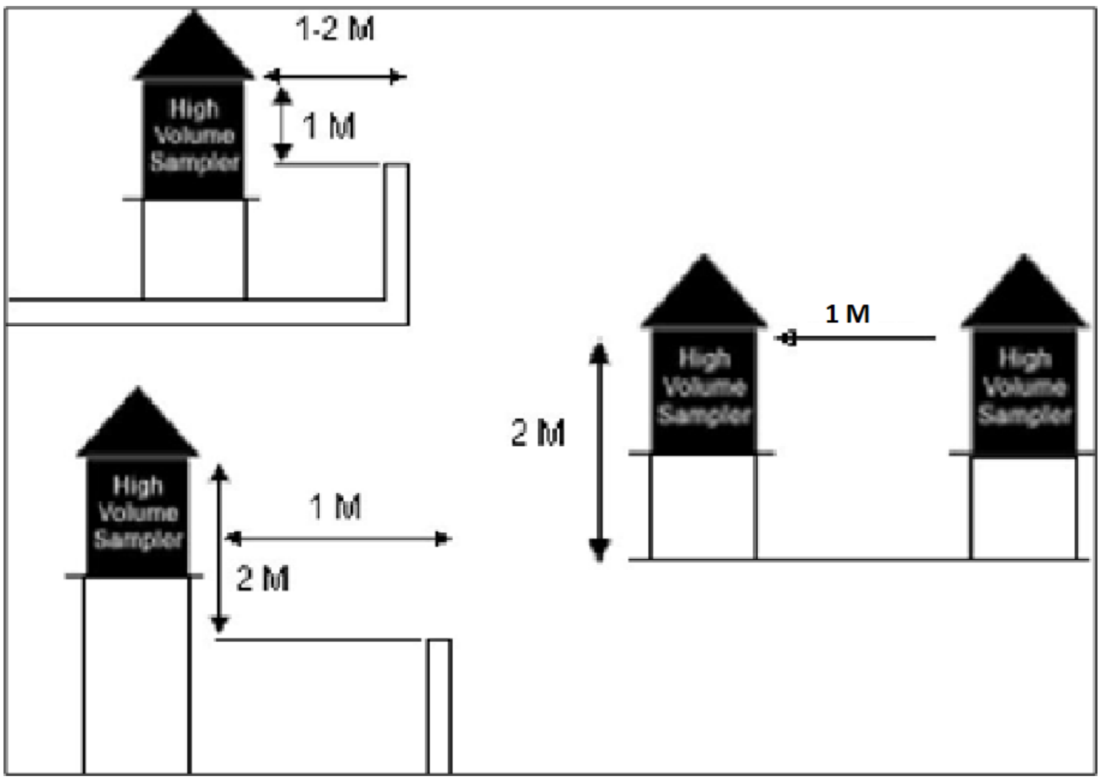



**Figure 14 – Positioning of Collocated Air Samplers**

## 6.2 SITING CRITERIA FOR OPEN-PATH MONITORING STATIONS

The monitoring path siting criteria discussed below must be followed to the maximum extent possible. It is recognized that there may be situations where some deviation from the siting criteria may be necessary. In any such case, the reasons must be thoroughly documented in a written request for a waiver that describes how and why

[17] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

the proposed siting deviates from the criteria. This documentation should help to avoid later questions about the validity of the resulting monitoring data.

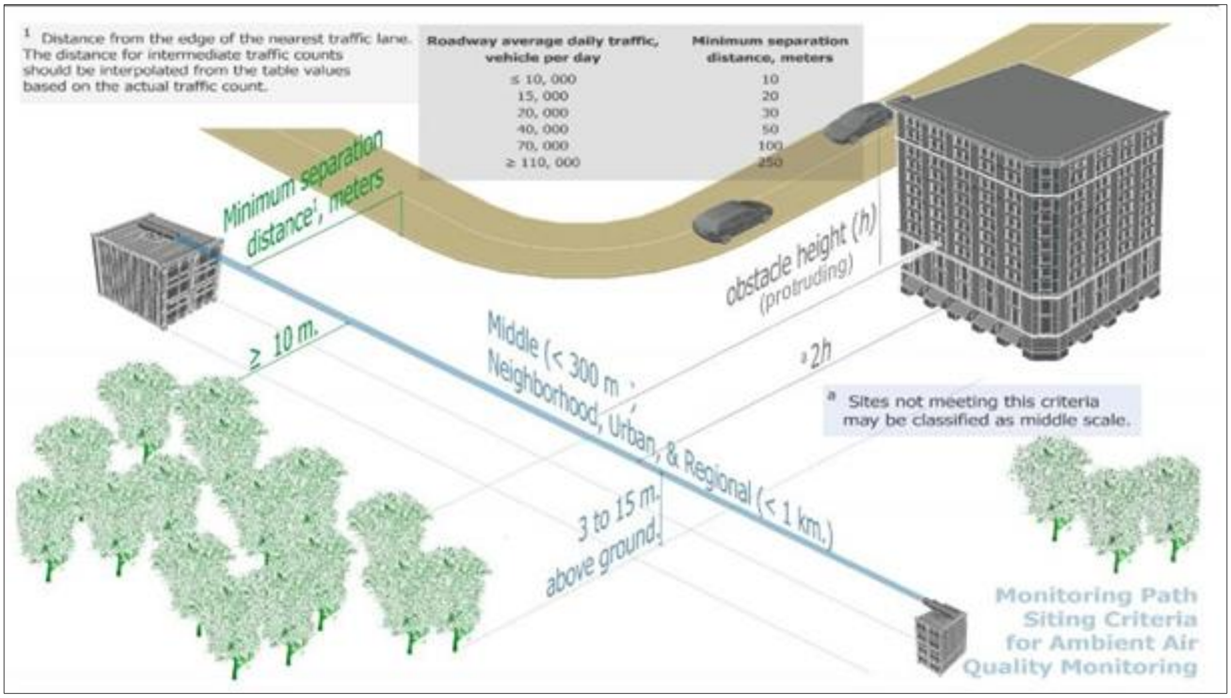



**Figure 16 – Siting Criteria for Open-path Stations**[18]

**Table 4 – Minimum Siting Standards for Open-path Stations**

| **Criteria** | **Minimum distance (meters)** |
|---|---|
| Path length | 100 |
| Path height | 3 |
| Spacing from supporting structure(s) | 1 |
| Spacing from obstructions | 2*h*; where *h* is equal to obstruction height less average height of monitoring path |
| Spacing from trees | 10 |
| Spacing from roads | 10 |
| Spacing from minor sources | 500 |

### 6.2.1 MAXIMUM PATH LENGTH

The monitoring path length must not exceed 1 kilometer for analyzers in neighborhood, urban, or regional scale. For middle scale monitoring sites, the monitoring path length must not exceed 300 meters. In areas subject to frequent periods of dust, fog,

[18] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

and rain, consideration should be given to a shortened monitoring path length to minimize loss of monitoring data due to these temporary optical obstructions.[19]

### 6.2.2 HORIZONTAL AND VERTICAL PLACEMENT

At least 80% of the monitoring path must be located between 3 and 15 meters above ground level.

At least 90% of the monitoring path must be ⩾1 meter vertically or horizontally away from any supporting structure, walls, parapets, penthouses, etc., and away from dusty or dirty areas.

If the significant portion of the monitoring path is located near the side of a building, then it should be located on the windward side of the building relative to the prevailing wind direction during the season of highest concentration potential for the pollutant being measured.[18]

### 6.2.3 SPACING FROM OBSTRUCTION

A monitoring path must be clear of all trees, brush, buildings, plumes, dust, or other optical obstructions, including potential obstructions that may move due to wind, human activity, growth of vegetation, etc.

At least 90% of the monitoring path must have unrestricted airflow and be located away from obstacles. The distance from the obstacle to the monitoring path must be at least twice the height that the obstacle protrudes above monitoring path. An exception to this requirement can be made for measurements taken in street canyons or at source-oriented sites where building and other structures are unavoidable. [18]

### 6.2.4 SPACING FROM TREES

At least 90% of the monitoring path must be at least 10 meters or further from the drip line of trees. [18]

### 6.2.5 SPACING FROM ROADS

This criterion is only applicable for $NO_2$ and $O_3$ monitoring. In siting an $O_3$ analyzer, it is important to minimize destructive interferences from sources of NO, since NO readily reacts with $O_3$. In siting $NO_2$ analyzers for neighborhood and urban scale monitoring, it is important to minimize interferences from automotive sources. Table 5 provides the required minimum separation distances between a roadway and at least 90 percent of a monitoring path for various ranges of daily roadway traffic. A sampling station located closer to a roadway than allowed by the Table 5 requirements should be classified as middle scale rather than neighborhood or urban scale, since the measurements from such a station would more closely represent the middle scale. The

[19] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

monitoring path of an open path analyzer must not cross over a roadway with an average daily traffic count of 10,000 vehicles per day or more. In calculating the percentage of a monitoring path over or near a roadway, one must consider the entire segment of the monitoring path in the area of potential atmospheric interference from automobile emissions. Therefore, this calculation must include the length of the monitoring path over the roadway plus any segments of the monitoring path that lie in the area between the roadway and the minimum separation distance, as determined from *Table 5*. The sum of these distances must not be greater than 10 percent of the total monitoring path length.

**Table 5 – Minimum Separation Distance between Roads and Monitoring Paths[20]**

| Roadway average daily traffic, vehicles per day | Minimum distance 1 (meters) |
|---|---|
| ≤1,000 | 10 |
| 10,000 | 10 |
| 15,000 | 20 |
| 20,000 | 30 |
| 40,000 | 50 |
| 70,000 | 100 |
| ≥110,000 | 250 |

### 6.2.6 SPACING FROM MINOR SOURCES

At least 90% of the monitoring path must be away from furnace or incineration flues or other minor sources of $SO_2$ or NO, because of their potential for greater exposure over the area covered by the monitoring path.

The separation distance should consider the height of the stack, type of waste or fuel burned, and the sulfur content of the fuel. It is acceptable, however, to monitor for $SO_2$ near a point source of $SO_2$ when the objective is to assess the effect of this source on the represented population.[19]

### 6.2.7 CUMULATIVE INTERFERENCES

The cumulative length or portion of a monitoring path that is affected by minor sources, obstructions, trees, or roadways must not exceed 10 percent of the total monitoring path length.[19]

## 6.3 SITE REPORT

Each fixed monitoring station shall have a site report, which should document at least the following:

1. Name;
2. Address;

[20] 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

3. Geographical Coordinates;
4. Inception Date;
5. Monitoring Objectives;
6. Measured Pollutants;
7. Scale Representativeness; (complete details for each pollutant)
8. Local Sources of Pollutants;
9. Detailed Siting Assessment (*see Annexes A and B*); and
10. Actual Pictures from the inlet, probe or the monitoring path towards all compass directions.

Site reports shall be reviewed at least annually and shall be updated when necessary.

# 7 AIR QUALITY MONITORING STATION DESIGN

This chapter provides details on the design of the shelter, structures, fences, area of the station, among others, specific for monitoring of complete criteria pollutants such CO, $SO_2$, $NO_2$, $O_3$, $PM_{10}$ and $PM_{2.5}$ with meteorological monitoring sensors.

## 7.1 GENERAL REQUIREMENTS

A monitoring station must consist of the following major structures:

1. Equipment shelter;
2. All structures erected, including but not limited to equipment hut, Air Quality Sample intakes, meteorological mast, supports for the solar radiation sensor, High-Volume Samplers, Wet/Dry Deposition Sampler, must be typhoon-proof.
3. All metal parts must be painted, anti-rust threated, and well insulated.
4. All construction materials used must be asbestos-free.

## 7.2 EQUIPMENT SHELTER

### 7.2.1 STRUCTURE

Continuous gaseous and particulate monitoring analyzers and ancillary equipment such as data logger, manifold, calibrators, etc., are to be housed in the equipment shelter.

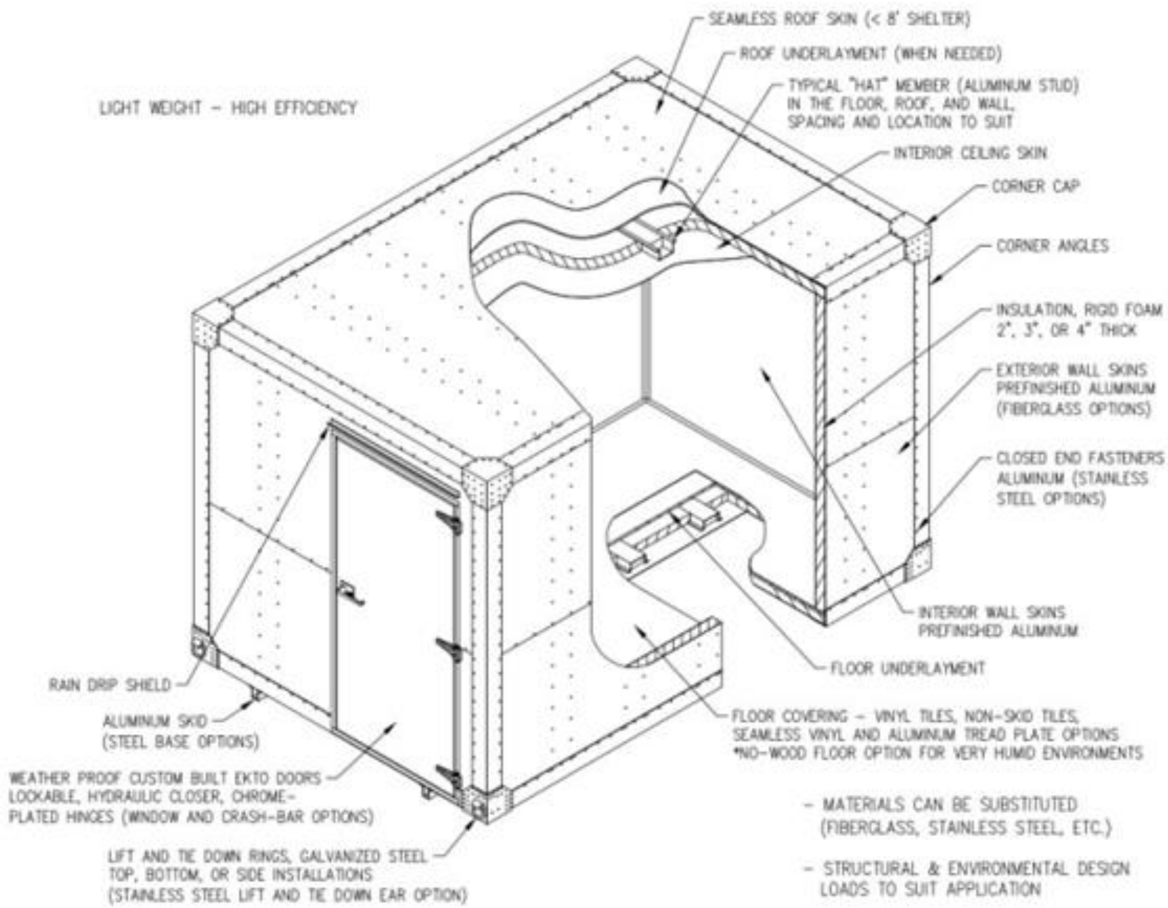



**Figure 17 – Shelter Design[21]**

### 7.2.2 ROOF PLATFORM SYSTEM

- Safety rails should be provided on the roof-top of the shelter or anchor points at suitable positions should be provided on the rooftop for hooking on safety belts;
    - With steel mesh matting and handles at the side and provisions to contain leaks; weatherproof floor design to take load of 250 kg/sq ft.
- Suitable opening(s) shall be provided on the rooftop of the shelter for air sample intake. Cat-ladder shall be provided on the external wall of the shelter to facilitate maintenance work to be carried out on the sample intake on the rooftop of the shelter.

[21] https://www.environmental-expert.com/products/ekto-lightweight-highly-insulated-enclosure-570947

### 7.2.3 OUTSIDE OF SHELTER

- Mild Steel 1.2 mm thickness with pre-coated paint only Inside Material construction
- 3m (L) x 2m (W) x 2.5m (H)
- Door size; 900 mm (W) x 200mm (H) with toughened glass
- Heavy duty fencing (mesh wire)

### 7.2.4 CONTAINER FOUNDATION

- Height 300mm from grounds
- **Pillars:** Nine concrete pillars of 300 mm above the ground level and below the ground level with 200 x 200 mm beam and between pillar bricks to be used for filling the space (concrete ratio of 1:2:4). Outer wall of the foundation to be plastered with 1:4, Cement: Sand ration and same must be painted with weatherproof coat.
- **Top of the flatform:** RCC mm with concrete ration of 1:1:2 and to plaster and painted with weatherproof paint.

### 7.2.5 AREA

The area of shelter shall be enough for placing the instruments in a tidy layout without obstructing the internal ventilation.

Enough clearance for access of the instruments in the front and rear shall be available even when the shelter door is closed. In addition, sufficient working circulation space, writing desk and consumable buffer storage area shall be available for efficient operation of the station.

It is expected that the floor area of an equipment shelter shall be at least 16 square meters for satisfactory operation.

### 7.2.6 INTERNAL FITTING AND LAYOUT

1. The equipment shelter shall be provided with anti-skid flooring, thermal insulation, false ceiling and shall be leakage-proof even during heavy downpours and typhoon;
2. The equipment shelter shall be electromagnetically shielded by inserting thin steel sheets within the walls, door and ceiling to prevent the interference of Electro Magnetic wave at radio frequencies to the air quality monitoring instruments inside the shelter;
3. Appropriate openings on the walls of the shelter shall be provided for air-conditioners;
4. The access door of the equipment shelter shall be of outdoor designed, must be waterproof and strong enough to withstand typhoon, and shall be opened towards the external;

5. A flood-drain shall be provided inside the shelter at one of the corners;
6. Instrument inside the equipment shelter should be mounted on standard 19" electronic racks. Sliding guides should be provided to enable the instrument to be drawn out for inspection and minor adjustments;
7. The rear access clearance of the equipment rack shall be at least 0.7m and the front access clearance shall be at least 1.0m.

## 7.3 ELECTRICITY SUPPLY FOR EQUIPMENT

1. The power supply to the equipment shelter must be of adequate design to meet all operating and starting conditions;
2. The supply for the equipment shall be split into two circuits, one for indoor equipment and one for outdoor equipment. All circuits must be protected by Earth Leakage Circuit Breaker (ELCB) or Residual Current Device (RCD);
3. At least ten sockets connected to the distribution board shall be installed inside the shelter for monitoring equipment. At least 4 sockets shall be installed near the equipment rack;
4. Adjacent to each mounting platform for sampler or outdoor equipment, a 15A waterproof socket with cover shall be installed inside a weather-proof enclosure;
5. All electrical wiring should be considered as permanent installation. All outdoor wiring shall be protected by conduits except armor cable, and waterproof plug and socket shall be used. Outdoor signal cables and telephone cables should be concealed in conduits. Current edition of Wiring Regulations should be followed. All sockets except the waterproof type shall be provided with switch and shall conform to standards applicable in Philippines.

## 7.4 ENVIRONMENT AND LIGHTING OF SHELTER

The indoor temperature of the shelter shall be maintained within 20 - 30°C (or depending on the required operations temperature of the instrument/s installed in accordance with its operations manual) by mechanical air conditioners, or a combination of air conditioners and heaters. The air circulation should be enough to even-out the temperature distribution inside the shelter.

One spare air-conditioner having same rating as the other units shall be installed as far as practicable. Air conditioners shall be operating in rotation to even out the wear and tear. The "ventilation" ports of all air-conditioners should be set open to allow some ventilation of fresh air.

Gaseous and particulate analyzers shall be operated at 20 - 30°C. Quality Assurance / Quality Control (QA/QC) activities for gaseous analyzers shall also be conducted at 20 - 30°C or depending on the prescribed operations temperature of the instrument/s installed in accordance with its operations manual. In almost all situation, data should be invalidated in case station temperature is outside 20 - 30°C, except for cases such as, the latest models of instruments which have USEPA designation outside 20 - 30°C (e.g. 15 – 40°C for CO and 5 - 40°C for $O_3$, $SO_2$ & $NO_2$ & etc).

It is necessary to monitor the shelter temperature continuously so that appropriate actions can be taken if it is outside the range as specified above. An electronic temperature sensor shall be installed inside the station and the output of the temperature system shall be connected to datalogger.

The sensor should be placed near the sampling manifold (or at a location which is likely to give the average room temperature) and should be far away from heat sources such as compressor or pump. Also, it should not be directly impinged by the cooled output of the air conditioner.

Adequate lighting facilities shall be provided within the shelter. The switch for operating the light shall be inside the shelter and near the entrance. Protective covers should be provided for the lighting. Emergency lighting shall be installed.

## 7.5 NETWORK CONNECTIVITY

1. The Monitoring Station shall be installed with (fiber) internet.
2. The minimum internet speed shall be 50 Mbps to enable real-time transfer of data and remote access to the Monitoring Station;
3. In case of wired connection, the Shelter must have adequate openings for the internet cables. Provided, that any openings made shall be properly enclosed to prevent leakages.

# 8 DETERMINING AREA REPRESENTATIVENESS OF AIR QUALITY MONITORING STATION

## 8.1 OVERVIEW OF NETWORK SITE ASSESSMENT FOR REDUNDANCY

In the case where ambient air monitoring objectives shifts over time (city classification has changed, urbanization has increased over the past 10 years, population rate increased) — situations which may induce air quality agencies to re-evaluate and reconfigure monitoring networks. As a result of these changes, air monitoring networks may have unnecessary or redundant monitors or ineffective and inefficient monitoring locations for some pollutants, while other regions or pollutants suffer from a lack of monitors. Air monitoring agencies should, therefore, refocus monitoring resources on pollutants that are new or persistent challenges, such as $PM_{2.5}$, air toxics, and ground-level ozone and precursors, and should deemphasize pollutants that are steadily becoming less problematic and better understood, such as lead and carbon monoxide (CO). In addition, monitoring agencies need to adjust networks to protect today's population and environment, while maintaining the ability to understand long-term historical air quality trends. Moreover, monitoring networks can take advantage of the benefits of new air monitoring technologies and improved scientific understanding of air quality issues. Existing monitoring networks should be designed to address multiple, interrelated air quality issues and to better operate in conjunction with other types of air quality assessments (e.g., photochemical modeling, emission inventory assessments). Reconfiguring air monitoring networks can enhance their value to stakeholders, scientists, and the general-public.

Here are a stepwise description and examples of steps involved in performing network assessments:

1. Prepare or update a regional description, discussing important features that should be considered for network design. Example: Topography, climate, population, demographic trends, major emissions sources, and current air quality conditions
2. Prepare or update a network history that explains the development of the air monitoring network over time and the motivations for network alterations, such as shifting needs or resources. Example: Historical network specifications (e.g., number and locations of monitors by pollutant and by year in graphical or tabular format); history of individual monitoring sites
3. Perform statistical analyses of available monitoring data. These analyses can be used to identify potential redundancies or to determine the adequacy of existing monitoring sites. Example: Site correlations, comparisons to the NAAQGV, trend analysis, spatial analysis, and factor analysis
4. Perform situational analyses, which may be objective or subjective. These analyses consider the network and individual sites in more detail, taking into account research, policy, and resource needs. Example: Risk of future NAAQGV exceedances, demographic shifts, requirements of existing state implementation plans (SIP) or maintenance plans,

density or sparseness of existing networks, scientific research or public health needs, and other circumstances (such as political factors)

5. Suggest changes to the monitoring network on the basis of statistical and situational analyses and specifically targeted to the prioritized objectives and budget of the air monitoring program. Example: Reduction of number of sites for a selected pollutant, enhanced leveraging with other networks, and addition of new measurements at sites to enhance usefulness of data.
6. Acquire the input of state and local agencies or stakeholders and revise recommendations as appropriate.

There are three broad categories of techniques for assessing technical qualities of monitoring networks: site-by-site, bottom-up, and network optimization. Site-by- site comparisons rank individual monitors according to specific monitoring purposes; bottom-up analyses examine data other than ambient concentrations to assess optimal placement of monitors to meet monitoring purposes; and network optimization analyses evaluate proposed network design scenarios. Within these broad categories, specific techniques are rated by their complexity on the following

## 8.2 SITE-BY-SITE ANALYSES

Site-by-site analyses are those that assign a ranking to individual monitors based on a particular metric. These analyses are good for assessing which monitors might be candidates for modification or removal. Site-by-site analyses do not reveal the most optimized network or how good a network is as a whole. In general, the metrics at each monitor are independent of the other monitors in the network.

Several steps are involved in site-by-site analysis:

1. Determine which monitoring purposes are most important
2. Assess the history of the monitor (including original purposes)
3. Select a list of site-by-site analysis metrics based on purposes and available resources
4. Weight metrics based on importance of purpose
5. Score monitors for each metric
6. Sum scores and rank monitors
7. Examine lowest ranking monitors for possible resource reallocation

The low-ranking monitors should be examined carefully on a case-by-case basis. There may be regulatory or political reasons to retain a specific monitor. Also, the site could be made potentially more useful by monitoring a different pollutant or using a different technology.

An example of a tool for site-by-site analysis is the Area served approach. Sites are ranked based on their area of coverage. Sites that are used to represent a large area score high in this analysis. Area of coverage (area served) for a monitor can be determined using the Thiessen polygons technique. Each polygon consists of the points closer to one particular site than any other site. This technique gives the most weight to rural sites and those sites on the edges of urban areas or other monitor clusters. Calculating Theissen polygons is one of the simplest quantitative methods for determining an area of representation around sites. However, it is not a true indication of which site is most representative of the pollutant concentration in a given area. Meteorology (including pollutant transport), topography, and proximity to population or emission sources are not considered, so some areas assigned to a particular monitor may actually be better represented by a different monitor.

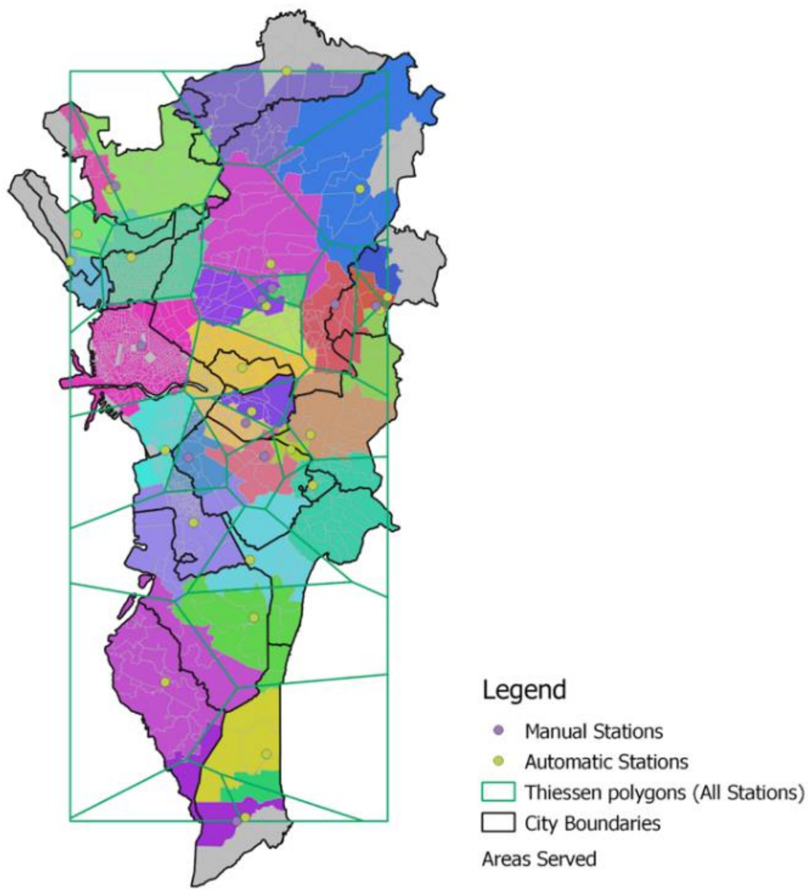



**Figure 18 - Example of Area served analysis for NCR stations using Thiessen Polygons**

## 8.3 BOTTOM-UP ANALYSES

Bottom-up methods examine the phenomena that are thought to cause high pollutant concentrations and/or population exposure, such as emissions, meteorology, and population density. For example, emission inventory data can be used to determine the areas of maximum expected concentrations of pollutants directly emitted (i.e., primary emissions). Emission inventory data are less useful to understand pollutants formed in the atmosphere (i.e., secondarily formed pollutants). Multiple data sets can be combined using spatial analysis techniques to determine optimum site locations for various objectives. Those optimum locations can then be compared to the current network. In general, bottom-up analyses indicate where monitors are best located based on specific objectives and expected pollutant behavior. However, bottom-up techniques rely on a thorough understanding of the phenomena that cause air quality problems. The most sophisticated bottom-up analysis techniques are complex and require significant resources (time, data, tools, and analytical skill).

## 8.4 NETWORK OPTIMIZATION ANALYSES

Network optimization techniques are a holistic approach to examining an air monitoring network. These techniques typically assign scores to different network scenarios; alternative network designs can be compared with the current (base-case) design. An example of a network optimization analysis is an iterative 10-step process (Cimorelli A.J., 2003):

1. Select the set of scenarios (i.e., different hypothetical network designs) to be ranked
2. Define decision criteria for scoring each network design
3. Gather the data necessary to calculate scores for the decision criteria
4. Index decision criteria to a common scale
5. Weight the criteria based on relative importance
6. Produce initial results (ranking of scenarios)
7. Iterate – adjust scenarios, decision criteria, and criteria weighting as new information and understanding are developed
8. Obtain feedback from stakeholder deliberation
9. Finalize network optimization scenario results
10. Recommend changes

# 9 REFERENCES


1. USEPA 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
2. USEPA 40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring
3. EMB Air Quality Monitoring Manual 1994
4. EMB guidelines for Air Dispersion Modelling (MC 2008-003)
5. DENR Administrative Order (DAO) 2000 – 8, IRR of RA8749
6. The Philippine Clean Air Act of 1999 (RA8794)
7. Cimorelli A.J., Chow A.H., Stahl C.H., Lohman D., Ammentorp E., Knapp R., and Erdman T. (2003) Region III ozone network reassessment. Presented at the Air Monitoring & Quality Assurance Workshop, Atlanta, GA, September 9-11. Available on the Internet at <http://www.epa.gov/ttn/amtic/files/ambient/pm25/workshop/atlanta/r3netas.pdf> last accessed September 9, 2005.
8. Knoderer C.A. and Raffuse S.M. (2004) CRPAQS surface and aloft meteorological representativeness (California Regional PM10/PM2.5 Air Quality Study Data Analysis Task 1.3). Web page prepared for the California Air Resources Board, Sacramento, CA, by Sonoma Technology, Inc., Petaluma, CA. Available on the Internet at http://www.sonomatechdata.com/crpaqsmetrep/ (STI-902324-2786).
9. O'Sullivan D. and Unwin D.J. (2003) Geographic Information Analysis, John Wiley & Sons, Inc., Hoboken, New Jersey. U.S. Environmental Protection Agency (2001) National assessment of the existing criteria pollutant monitoring networks O3, CO, NO2, SO2, Pb, PM10, PM2.5 - Part 1. Outputs from the National Network Assessment Introduction and Explanation, July 21. Available on the Internet at http://www.epa.gov/ttn/amtic/netamap.html.
10. U.S. Environmental Protection Agency (2007) AMBIENT AIR MONITORING NETWORK ASSESSMENT GUIDANCE : Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks. EP-D-05-004 Work Assignment No. 2-12

**Annex A**

# PRE-ASSESSMENT ON EXISTING OPEN-PATH MONITOR SITING

Station: ____________________ Date: ____________
Location: ____________________ Assessor: ____________

*Site 1 (Emitter or Transceiver)*
*Latitude* ____________
*Longitude* ____________
*Altitude* ____________

*Site 2 (Receiver or Reflector)*
*Latitude* ____________
*Longitude* ____________
*Altitude* ____________

| CRITERIA | EXISTING MEASUREMENTS | REMARKS |
|---|---|---|
| **Monitoring Path Length** | m. | |
| **Distance from Obstruction** | m. | |
| *Protruding height of the nearest obstruction* | m. | |
| **Distance from Trees** | m. | |
| **Horizontal Placement** | | |
| *Distance from the nearest supporting structure* | m. | |
| **Vertical Placement** | | |
| *Distance from the nearest supporting structure* | m. | |
| *Height above ground of the Emitter or Transceiver* | m. | |
| *Height above ground of the Receiver or Reflector* | m. | |
| **Spacing from Roads (for $NO_2$ and $O_3$)** | m. | |
| *Roadway average daily traffic* | vehicles / day | |
| **Other Interferences** | | |
| (please enumerate) | (measurements in meters) | |

**Initial Findings:**

**Initial Recommendations:**

**Other Notes:**

## QUICK ASSESSMENT SKETCH

**Quick Modification Checklist**

| Criteria | Need Modifications? | |
|---|---|---|
| | Yes | No |
| Monitoring Path Length | | |
| Distance from Obstruction | | |
| *Supporting Structures* | | |
| *Emitter or Transceiver Placement* | | |
| *Receiver or Reflector Placement* | | |
| Spacing from Roads | | |

Annex B

# PRE-ASSESSMENT ON EXISTING PARTICULATE MATTER MONITOR SITING

Station: ____________________ Date: ____________________

Location: ____________________ Assessor: ____________________

***Geo-coordinates:***

*Latitude* ____________________

*Longitude* ____________________

*Altitude* ____________________

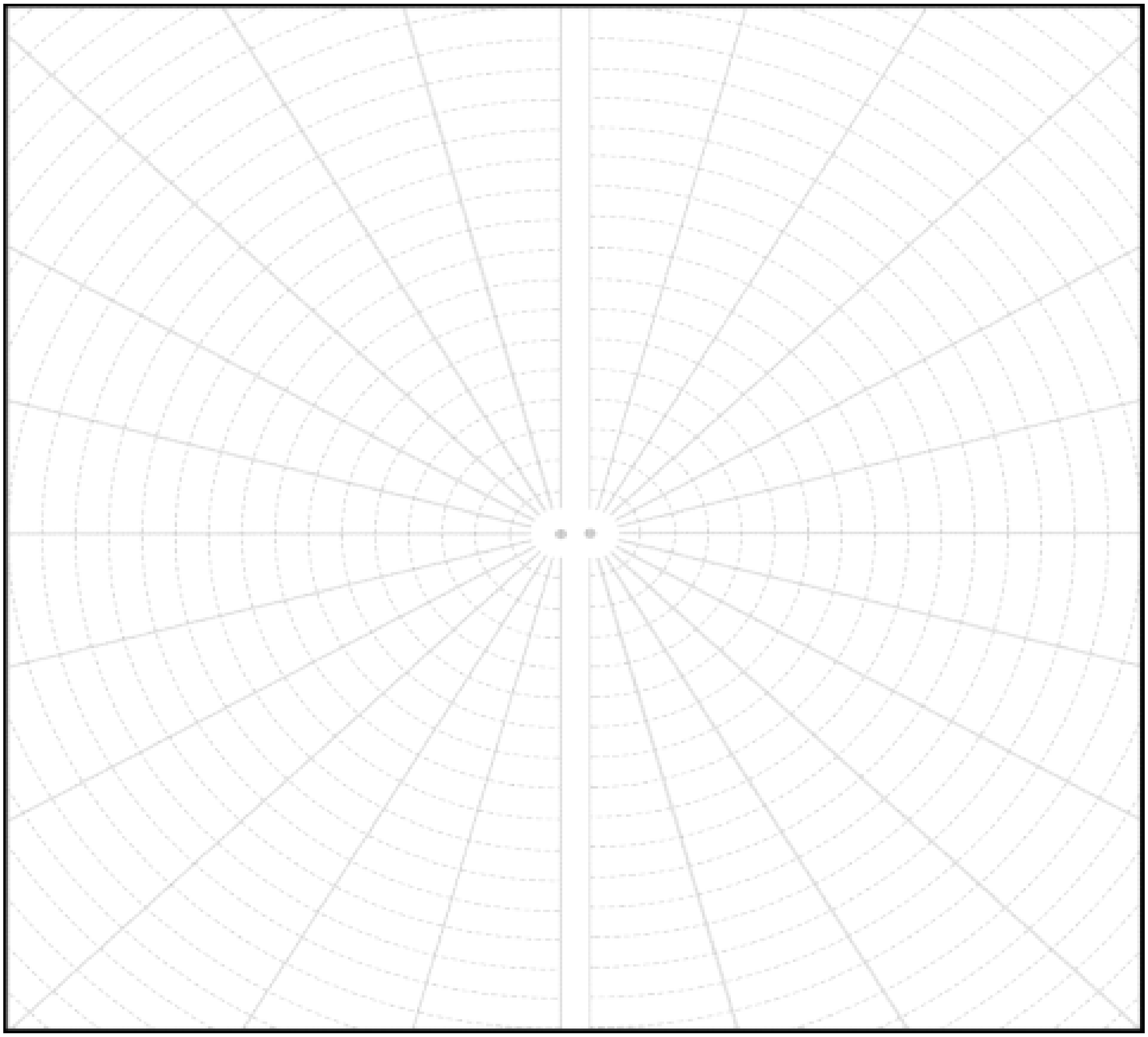
| CRITERIA | EXISTING MEASUREMENTS | REMARKS |
|---|---|---|
| **Distance between Co-located Inlets** | m. | |
| **Inlet Height** | | |
| *Above ground* | | |
| *PM10* | m. | |
| *PM2.5* | m. | |
| *Above supporting structure* | | |
| *PM10* | m. | |
| *PM2.5* | m. | |
| **Shelter Dimensions** *(L x W x H)* | x x m. | |
| **Meteorological Mast Height** | m. | |
| **Distance from Trees** | m. | |
| **Distance from Flyover** | m. | |
| **Spacing from Roads** | m. | |
| *Roadway average daily traffic* | vehicles / day | |
| **Other Interferences** | | |
| (please enumerate) | (measurements in meters) | |

**Initial Findings:**

**Initial Recommendations:**

**Other Notes:**

## QUICK ASSESSMENT SKETCH



| Quick Modification Checklist | | |
| --- | --- | --- |
| Criteria | Need Modifications? | |
| | Yes | No |
| Distance of Co-located Inlets | | |
| Inlet Height | | |
| Shelter Dimensions | | |
| Distance from Obstructions | | |
| Distance from Flyover | | |
| Spacing from Roads | | |

## Acknowledgements

**Manual for Siting and Design of Air Quality Monitoring Stations in the Philippines**

**Project Team Environmental Management Bureau – DENR**

Engr. William P. Cuñado, Director
Engr. Vizminda A. Osorio, OIC - Assistant Director
Engr. Jundy T. Del Socorro, Chief - Air Quality Management Section (AQMS)
Engr. Marcelino N. Rivera, Jr., OIC – Environmental Quality and Management Division

**Technical Committee**

Mr. Joel A. Tugano
Engr. Chadbert Nikko Aquino
Atty. Manuel Martin Escasura
Engr. Paul Nathan B. Vallar
AQMS Ambient Team

ALL The Regional Offices of EMB
The EMB Policy Technical Working Group (EPTWG)

**University of the Philippines-Diliman College of Science Institute of Environmental Science and Meteorology**

Mylene G. Cayetano, Ph.D

**United Stated Environmental Protection Agency (USEPA)**

Ms. Gina Bonifacino
Mr. Justin Harris