Terms of Reference

Environmental Expert in Air Quality Monitoring Networks and Source Apportionment
Technical Implementation Unit (TIU)
Component 1: Enhancing the Air Quality Management (AQM) & Response System
Greater Cairo Air Pollution Management and Climate Change Project

I. Background:

As part of the "Sustainable Development Strategy (SDS): Egypt Vision 2030",[1]the country committed to halving its fine particulate matter (PM_{10}) air pollution by 2030. Significant improvements have been made towards that goal in recent years. In fact, Cairo's PM_{10} concentration fell by about 25 percent over the past decade. Despite these improvements, the city's pollution levels are still several times higher than the WHO recommended concentrations and higher than national guidelines resulting in a significant public health toll and degradation of quality of life of the population, especially among the poor. Recently, the Greater Cairo (GC) Cost of Environmental Degradation (COED) attributed the highest environmental cost – by far – to air pollution, with a mean estimate equivalent to 1.35 percent of national GDP in 2017. Conversely, the GC COED attributed to waste (net of air pollution damages, via the burning of waste) is half that of air pollution's COED equivalent to 0.68 percent of national GDP in 2017, which includes the opportunity losses from composting, recycling, methane capture, etc. Moreover, recent studies on COVID-19 show that there is an increased likelihood of contracting the disease in places with high levels of ambient pollutants.[2]

Climate change models project Egypt's mean annual temperature to increase between 2 ºC and 3 ºC by 2050 and an increase in the duration of long-lasting heatwaves. Hot sandstorms known as khamasin blow millions of tons of grit from the Sahara to the North African coast and increases in local temperatures of up to 20 ºC are projected to increase in frequency and intensity. By 2050 the intensity and seasonality of heavy rains, as well as the probability of droughts will increase. Long-lasting heatwaves likely will increase in duration of between 9 to 77 days by 2085. The GC area is vulnerable to each of these climate impacts, as well as to river and urban flooding, water scarcity and wildfires. The impacts can be severe, particularly for public health and agriculture. Climate change will put additional pressures on citizens' health, in the form of increases in the prevalence and severity of cardiopulmonary conditions through heat and sandstorms, potential increases in vector-borne diseases, through decreased nutrition and food security and reduced water quality. Further, it has been demonstrated that extreme heat events are linked to worsening air pollution.[3]

[1] http://www.cabinet.gov.eg/English/GovernmentStrategy/Pages/Egypt%E2%80%99sVision2030.aspx and https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Egypt%20Vision%202030%20%28English%29.pdf.

[2] Larsen, Bjorn. 2019. Egypt: Cost of Environmental Degradation: Air and Water Pollution. The World Bank. Washington, D.C.; and Back of the envelop calculations for cost of solid waste environmental degradation performed by the Team.

[3] Markandya and Chiabai, Valuing Climate Change Impacts on Human Health: Empirical Evidence from the Literature, Int. J. Environ. Res. Public Health, 6, 759–86, 2009.

In response to this situation, the Government of Egypt (GOI) is seeking to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo. The Ministry of Environment is in that respect implementing, with the support of the World Bank, the "Greater Cairo Air Pollution Management and Climate Change Project".

The Project aims specifically to reduce emissions that contribute to air pollution concentrations, thus leading to air quality improvements, and to simultaneously mitigate climate change. Air pollutants include PM_{10} and $PM_{2.5}$, while climate pollutants include both longer lived greenhouse gases (GHGs) such as CO_2, as well as Short-lived Climate Pollutants (SLCPs) that include black carbon, methane and several short-lived HFCs.

Successful Integrated Climate and Air Quality Management Planning (IC-AQMP) requires a comprehensive understanding of baseline ambient air concentrations, including Short-Lived Climate Pollutants (SLCPs) and greenhouse gases (GHGs).

The Project is composed of the following components:
Component 1: Enhancing the Air Quality Management (AQM) & Response System.
Component 2: Support the operationalization of SWM Master Plans in GC.
Component 3 Vehicle Emission Reduction.
Component 4 Communication & Stakeholders Engagement.
Component 5: Project Management and Monitoring & Evaluation.

(For more information: https://projects.worldbank.org/en/projects-operations/project-detail/P172548)

This assignment is requested in the context of Component 1 of the Project, as described here:

Component 1: Enhancing the Air Quality Management & Response System.
This component will support the enhancement of the Air Quality Management (AQM) decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination. Component # 1 comprises two subcomponents:

- **Subcomponent 1.1:** Reduction of air pollution and GHGs.
- **Subcomponent 1.2:** Strengthening resilience to air pollution.

These two subcomponents are to be achieved through several "Sub-tasks" (bundled into fewer subcontracts that achieve the same intent). Information on the 2 Subcomponents, and the Sub-tasks is mentioned in **Annex # 1**.

The Consultant's assignment is related to the following two Sub-tasks:

- Establishment of a SLCP/GHG Monitoring Network for GCA–to support in providing recommendations on the deployment, operation and maintenance of proposed network, (structured in a scoping and subsequent implementation phase).This network should integrate seamlessly with and support existing AQ monitoring networks (ambient & industrial) in GCA (including routine AQ monitoring sites in GCA as well as the recently designed source apportionment network and the telemetry monitoring system for point

source of industrial facilities), thus an initial step shall involve conducting a network assessment to review EEAA's comprehensive AQ monitoring objectives and, QC/QA and requirement for enhancement road map. Implementation activities will include design and deployment of network components (including source apportionment and PM2.5/BC/CO2 monitoring components), but also analysis, data management, and quality assurance of GCA monitoring program.

The Project shall contract a Consulting Firm to provide "Technical support for providing complete assessment of EEAA existing air quality monitoring networks, and recommendations for establishing, deployment, operation, maintenance of new SLCP/ GHG monitoring network and its integration with the existing EEAA network ».
ToR for hiring the Consulting Firm is attached as **Annex # 2**.

- Provision of operational support for the newly developed source apportionment (SA) monitoring network and chemical speciation analysis operated by EEAA/Cairo University - including knowledge transfer and capacity building for Egyptian colleagues as appropriate. This includes aspects of manual sampling, collection, transfer and storage, chemical speciation analysis, receptor modeling and reporting over calendar years 2023-2025, inclusive.

  The Project shall contract a Consulting Firm to provide "Technical support for EEAA newly developed source apportionment monitoring network and chemical speciation analysis operated by EEAA/Cairo University.
  ToR for hiring the Consulting Firm is attached as **Annex # 3**.

Project implementation arrangements:
A Project Coordination Unit (PCU) has been established at the MoE. The PCU ensures that the Project is implemented in accordance with the Legal Agreement signed between the GoE and the World Bank, the Project Appraisal Document (PAD), the Project Implementation Manuals (Project Operational Manual, M&E Manual, etc.).

Four Technical Implementation Units (TIUs) have also been established to oversee the implementation of all components. The TIU for Component 1 is chaired by the Head of the Environmental Quality Sector of the Egyptian Environmental Affairs Agency (EEAA) and includes members of the different departments of the sector (Ambient Air Quality, Vehicle Emissions, Early Warning, Industrial Facilities Emission)

II. Objective of the Assignment:

The Project is seeking to hire an Environmental Expert for Component 1 of the Project referred to hereafter as "the Consultant" to assist the Environment Quality Sector, EEAA and TIU of Component 1 in implementing the 2 Tasks (mentioned above) under Component # 1, and provide support to advance EEAA's existing air quality and climate change management and planning efforts.

This position is open for local Consultants.

III. Scope of Work and Specific Tasks:

The Consultant shall assist the Environment Quality Sector, EEAA and TIU of Component 1 in implementing the 2 Tasks (mentioned above) under Component # 1, and provide support to advance EEAA's existing air quality and climate change management and planning efforts.

The scope of work of the Consultant includes the following tasks:

1. Assist with supervision/contract management of the consulting firm contracted by the project to provide "Technical support for providing complete assessment of EEAA existing air quality monitoring networks, and recommendations for establishing, deployment, operation, maintenance of new SLCP/ GHG monitoring network and its integration with the existing EEAA network. This includes close supervise and follow-up contracts implementation with the contracted consulting firms to ensure that all deliverables are in accordance with the TORs and of acceptable quality, implemented on schedule as per the agreed workplans and milestones, and within approved budgets.
2. Assist with supervision/contract management of the consulting firm contracted by the project to provide "Technical support for EEAA newly developed source apportionment monitoring network and chemical speciation analysis operated by EEAA/Cairo University. This includes close supervise and follow-up contracts implementation with the contracted consulting firms to ensure that all deliverables are in accordance with the TORs and of acceptable quality, implemented on schedule as per the agreed workplans and milestones, and within approved budgets.
3. Assist in supporting EEAA, TIU of Component # 1 and PCU in the procurement process of the equipment related to the Task 1 (mentioned above) under Component # 1. The Consultant will provide support during the different stages of the procurement process, including but not limited to the review of TORs, preparation of technical notes and clauses for the preparation of the bidding documents, review of technical and financial proposals of bidding companies, preparation of evaluation reports, and other related tasks as requested by the EEAA/TIU.
4. Any other tasks relevant to the assignment as requested by the Head of the Component 1 Technical Implementation Unit, and the Lead Advisor.

The Consultant will work closely with Component 1 Technical Implementation Unit, and shall be available for meetings and appointments as requested by the Head of the Component 1 Technical Implementation Unit, and the Lead Advisor.

The Consultant will be expected to assist in presenting results to the project management and stakeholders during the contract period.

IV. Qualifications:

- Master's degree or above in environment science, or engineering (Chemistry).
- At least 10 years of relevant work experience in air quality monitoring and networks operation.
- Proven track record of experience deploying, quality assuring and maintaining gas phase monitors, fine particle manual (filter) samplers, continuous monitors and low-cost sensors.
- Knowledge and familiarity with principles of analytical chemistry, receptor modeling and source apportionment analysis.

- Previous working experience with international or regional specialized consultancy firms working in the field of air quality management (policy development, institutional strengthening, technical and operational, etc.).
- Previous working experience with development professionals.
- Broad access to both academic and private sector expertise as well as experience with funding agencies that can contribute knowledge and know-how to EEAA
- Experience working with capacity constraints experienced by low- and middle-income countries in undertaking complex data analysis and environmental assessments.
- Good written communication skills.
- Good knowledge of computer proficiency, including MS Office products (Word, Excel, PowerPoint) and web-based management systems.
- Fluency in written and spoken English required.

V. REPORTING

The Consultant will report to the Lead Advisor of TIU for Component 1 and under his supervision.

VI. Level of Effort and Contract duration

The contract is a full-time, time-based contract for the duration of 1 year. The assignment may require occasional travel inside Egypt.

The assignment is renewable based on an annual performance evaluation conducted by the Head of TIU for Component 1, and the Lead Advisor.

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Annex # 1

Greater Cairo Air Pollution Management and Climate Change Project

Brief on the Project :

The Government of Egypt (GoE) is currently implementing **Greater Cairo Air Pollution Management and Climate Change Project** (the Project) financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in GC,i.e., Cairo, Giza and Qalyubia Governorates and is being implemented with Ministry of Environment (MoE) in close collaboration with Ministry of Local Development (MoLD), Qalyubia Governorate, Cairo Transport Authority (CTA) and other stakeholder agencies. The Project focuses on two main sources of air pollution: solid waste management and vehicle emissions in GC region and includes the following five main components:

Component 1: Enhancing the Air Quality Management (AQM) and Response System: This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

Component 2: Support the Operationalization of Solid Waste Management (SWM) Master Plans in GC: This component aims to support operationalization of Governorate SWM master plans, which lay down the full range of necessary actions and investments needed for each governorate to improve SWM services in accordance with the specificity of each Governorate. In view of the complexity and magnitude of SWM system in GC, the Project follows a phased and gradual approach to achieve tangible results on the ground. This approach involves providing technical support at the central level to the Waste Management Regulatory Authority (WMRA) and the MoLD and specific investments, technical, financial and project development support to SWM actions at the local level to the Qalyubia Governorate.

Component 3: Vehicle Emission Reduction: This component aims to support activities aimed at reducing vehicle emissions from public transport sector. This shall be achieved through procurement of about 100 electric buses and the infrastructure required to operate and maintain these buses. The component will also support the CTA in acquiring the needed knowledge and experience in operating and scaling up electric bus fleet in Cairo. The Project will also upgrade facilities at CTA, including retrofitting existing bus depots with electric charging stations, power supply and related safety equipment; training CTA staff such as bus drivers and mechanics on operating and maintaining the new e-equipment.

Component 4: Communication and Stakeholders Engagement: This component aims at ensuring that all stakeholders, in an inclusive manner, are actively involved in the design, implementation and monitoring of all Project activities and the Project is implemented following

a full consultative participatory approach that is meant to build a constructive relationship between the stakeholders and the GoE. This component is complementary to the comprehensive Stakeholders Engagement Plan (SEP) developed as part of the environmental and social risk management.

Component 5: Project Management and Monitoring and Evaluation (M&E): This component will support the establishment of Project Coordination Unit (PCU) at MoE and four Technical Implementation Units (TIU) for each of the first four components.

Component 6: Enhanced E-Waste and HCW management for Reduction of uPOPs: It is an additional finance (AF) to the parent project, this new activity focuses on reduction of unintended persistent organic pollutants (uPOPs) aligns with the "GEF Project Design and Review Considerations in Response to the COVID-19 Crisis and the Mitigation of Future Pandemics".

Brief on Component 1: Enhancing the Air Quality Management & Response System.

This component comprises two subcomponents:

- **Subcomponent 1.1:** Reduction of air pollution and GHGs. This subcomponent will support the carrying out of a program of TA activities on reduction of air pollution and GHGs, namely: (a) development of an Integrated Climate and Air Quality Management Plan (IC-AQMP) including a time-bound action plan for its implementation; (b) strengthening Air Quality Management (AQM) regulatory and policy tools through (i) developing a mobile source emissions inventory including road and nonroad sources, and integrating it with existing inventories and (ii) continuous monitoring of short lived climate pollutants, greenhouse gases, and carbon dioxide monitoring; (c) development and rolling out of a specialized AQM and green jobs skills training program in universities and ministries including curricula such as chemical engineering, atmospheric science, environmental economics and environmental health, renewable energy interventions, energy efficiency and environmental economics, and resource efficiency/circular economy interventions; and (d) strengthening policy dialogue by carrying out assessments of the environmental health and the economic benefits of priority climate and air quality interventions, including cost-benefit and cost-effectiveness of emission abatement investments and capacity-building initiatives such as the trainings program.

- **Subcomponent 1.2:** Strengthening resilience to air pollution. This subcomponent will strengthen resilience to air pollution through:(a) improving air quality forecasting tools through development of a chemical transport model-based approach and its integration with local air quality monitoring data and dissemination of the forecasting information; (b) establishing institutional response mechanisms for high pollution days such as definition of criteria and protocols for identification of air quality action days and development of emergency plans and applicable decision protocols for said air quality action days; and (c) strengthening the technical capacity of the National Committee for Crisis Management and Risk Reduction for implementation and enforcement of the protocols.

These two subcomponents are to be achieved through ten "Sub-tasks" (bundled into fewer subcontracts that achieve the same intent):

1. Establishment of a SLCP/GHG Monitoring Network for GCA–to support in providing recommendations on the deployment, operation and maintenance of proposed network, (structured in a scoping and subsequent implementation phase).This network should integrate seamlessly with and support existing AQ monitoring networks (ambient & industrial) in GCA (including routine AQ monitoring sites in GCA as well as the recently designed source apportionment network and the telemetry monitoring system for point source of industrial facilities), thus an initial step shall involve conducting a network assessment to review EEAA's comprehensive AQ monitoring objectives and, QC/QA and requirement for enhancement road map. Implementation activities will include design and deployment of network components (including source apportionment and PM2.5/BC/CO2 monitoring components), but also analysis, data management, and quality assurance of GCA monitoring program.

2. Establishment of an integrated Emission Inventory Database for GCA and Egypt – to provide operational support in refining the existing emission inventory consisting of a point and area source inventory for GCA, a biogenic and geogenic inventory for Egypt and a UNFCCC compliant GHG inventory for Egypt to create a unified and comprehensive national inventory database that includes a mobile source inventory per the existing mobile source inventory development roadmap. The resulting unified database should enable policy tracking, international reporting, and chemical transport modeling. The data base structure should enable reporting interfaces that enable data reporting from various users (e.g., governorate level reporting of traffic and vehicle registration data, industrial reporting of point source emission data, etc.) to report data into the national system.

3. Development of an Integrated Climate and Air Quality Management Plan (IC-AQMP "Action" Plan)– to provide operational support to develop, assess, and evaluate policy options under a multi-level governance process to identify and justify elements of the GC Action Plan (including technical analysis, economic assessment and facilitation of consensus building process).

4. Development Curricula , Sustainable training at Local Universities and license system – to provide operational support for the development and roll-out of a new environmental resource management curriculum at GCA universities. The outcome should result in enhanced training and knowledge – at both the undergraduate and graduate level – around principles, basics and updates of environmental science, and AQM planning specifically, to ensure a pipeline of trained professionals for EEAA, as well as better prepared students to address other green skills development needed for Egypt as a whole. This should be planned in collaboration with University of Cairo, either alone or in partnership with Helwan University, and Aim-shams University, to ensure that Cairo is producing a steady supply of students with skills needed for environmental management and the green economy. In order to enhance the quality of the professional market of skilled professionals within Egypt, the Consultant should propose a rigorous international license and accreditation process.

5. Support Sustainable Development Within the Egyptian Government– to provide operational support to improve capacity of ministry staffs and sustainable development units - via executive skills training - to undertake integrated climate and air quality management planning and implementation of mitigation actions.

6. Implementation of Micro- and Macroeconomic Assessment of Action Plan– to provide operational support to provide a sector-specific detailed economic analysis of actions identified by IC-AQMP working group (see III above) comparing implementation costs against health, agriculture, and energy benefits of interventions, as well as macroeconomic benefits of reduced health spending, alternative patterns of investment and quality of life improvements, for labor force, tourism, recreation, etc.

7. Development of advanced Air Quality Forecasting system–to provide operational support to develop an enhanced AQ forecasting program (structured into a scoping and subsequent implementation phase) that builds on existing forecasting capacity for both poor air quality days and climatically extreme events. This work would likely involve an international vendor to provide support and training with local implementation partners who might carry on forecasting work at conclusion of project.

8. Development of AQ Public Awareness Website– to provide operational support to create a public information portal that provides access to information on (a) general background on air pollution/ public action (b) current conditions/AQ index and local observations and data and (c) forecasts with self-protective actions for public/ sensitive populations.

9. Establishment and Implementation Support for an Institutional Response Mechanism-to provide operational support to facilitate an intra-governmental stakeholder process to identify appropriate responses to declared "AQ Action Days" and implementation arrangements to be carried out by various government and private stakeholders (e.g., industries, schools, public health authorities, media, sensitive populations, etc.)

10. Provision of operational support for the newly developed source apportion (SA) monitoring network and chemical speciation analysis operated by EEAA/Cairo University -including knowledge transfer and capacity building for Egyptian colleagues as appropriate. This includes aspects of manual sampling, collection, transfer and storage, chemical speciation analysis, receptor modeling and reporting over calendar years 2023-2025, inclusive.

Annex # 2

TERMS OF REFERENCE

Technical support for providing complete assessment of EEAA existing air quality monitoring networks, and recommendations for establishing, deployment, operation, maintenance of new SLCP/ GHG monitoring network and its integration with the existing EEAA network

I. Background

As part of the "Sustainable Development Strategy (SDS): Egypt Vision 2030",[4]the country committed to halving its fine particulate matter (PM_{10}) air pollution by 2030. Significant improvements have been made towards that goal in recent years. In fact, Cairo's PM_{10} concentration fell by about 25 percent over the past decade. Despite these improvements, the city's pollution levels are still several times higher than the WHO recommended concentrations and higher than national guidelines resulting in a significant public health toll and degradation of quality of life of the population, especially among the poor.Recently, the Greater Cairo (GC) Cost of Environmental Degradation (COED) attributed the highest environmental cost – by far – to air pollution, with a mean estimate equivalent to 1.35 percent of national GDP in 2017. Conversely, the GC COED attributed to waste (net of air pollution damages, via the burning of waste) is half that of air pollution's COED equivalent to 0.68 percent of national GDP in 2017, which includes the opportunity losses from composting, recycling, methane capture, etc. Moreover, recent studies on COVID-19 show that there is an increased likelihood of contracting the disease in places withhigh levels of ambient pollutants.[5]

Climate change models project Egypt's mean annual temperature to increase between 2 ºC and 3 ºC by 2050 and an increase in the duration of long-lasting heatwaves. Hot sandstorms known as khamasin blow millions of tons of grit from the Sahara to the North African coast and increases in local temperatures of up to 20 ºC are projected to increase in frequency and intensity. By 2050 the intensity and seasonality of heavy rains, as well as the probability of droughts will increase. Long-lasting heatwaves likely will increase in duration of between 9 to 77 days by 2085. The GC area is vulnerable to each of these climate impacts, as well as to river and urban flooding, water scarcity and wildfires. The impacts can be severe, particularly for public health and agriculture. Climate change will put additional pressures on citizens' health, in the form of increases in the prevalence and severity of cardiopulmonary conditions through heat and sandstorms, potential increases in

[4] http://www.cabinet.gov.eg/English/GovernmentStrategy/Pages/Egypt%E2%80%99sVision2030.aspx and https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Egypt%20Vision%202030%20%28English%29.pdf.

[5] Larsen, Bjorn. 2019. Egypt: Cost of Environmental Degradation: Air and Water Pollution. The World Bank. Washington, D.C.; and Back of the envelop calculations for cost of solid waste environmental degradation performed by the Team.

vector-borne diseases, through decreased nutrition and food security and reduced water quality. Further, it has been demonstrated that extreme heat events are linked to worsening air pollution.[6]

In response to this situation, the Government of Egypt (GOI) is implementing the Greater Cairo Air Pollution Management and Climate Change Project (hereafter "The Project") financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo,i.e., Cairo, Giza and Qalubiah Governorates[7], and is implemented by the Ministry of Environment through its Egyptian Environmental Affairs Agency (EEAA) and its Waste Management Regulatory Authority (WMRA) and in collaboration with other partners. A Project Coordination Unit oversees overall project implementation and ensures that fiduciary requirements are met.

The Project aims specifically to reduce emissions that contribute to air pollution concentrations, thus leading to air quality improvements, and to simultaneously mitigate climate change. Air pollutants include PM_{10} and $PM_{2.5}$, while climate pollutants include both longer lived greenhouse gases (GHGs) such as CO_2, as well as Short-lived Climate Pollutants (SLCPs) that include black carbon, methane and several short-lived HFCs.

Successful Integrated Climate and Air Quality Management Planning (IC-AQMP) requires a comprehensive understanding of baseline ambient air concentrations, including Short-Lived Climate Pollutants (SLCPs) and greenhouse gases (GHGs).

The requested services covered by these terms of reference are **to support implementation ofComponent # 1 of the Project, on Enhancing the Air Quality Management (AQM) and Response System, implemented by EEAA.** This componentaims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

II. Objective of the Assignment

The objective of this assignment is to hire a qualified consulting firm, referred to hereafter as "the Consultant" to evaluate existing AQ monitoring networks in GC with respect to current and new monitoring objectives, and to assist EEAA in procuring, siting, deploying, calibrating, operating and maintaining additional instruments for monitoring greenhouse gases (GHGs) and short-lived climate pollutants (SLCPs).

[6]Markandya and Chiabai, Valuing Climate Change Impacts on Human Health: Empirical Evidence from the Literature, Int. J. Environ. Res. Public Health, 6, 759–86, 2009.

[7] More details on the Project Components are provided in Annex 1.

The consultant will also work with EEAA to establish a data management system to validate and quality assure these data, and incorporate into the larger EEAA data management framework allowing them to jointly address air pollution and climate mitigation in GC and Egypt.

III. Scope of Work and Detailed Tasks:

The Consultant is requested to conduct the following tasks:

Complete assessment of EEAA existing air quality monitoring networks, and Recommendations and supervision supportfor establishing, deployment, operation, maintenance of new SLCP/ GHG monitoring network and its integration with the existing EEAA networkas follows:

Detailed Tasks:

1. **Review and Assessment of EEAA Existing Air Quality Monitoring Network:**
   The existing EEAA monitoring networks include routine $PM_{2.5/10}$ monitoring sites for compliance purposes that also measure NOx, O3, Pb, NH_3, SO_2, and other gaseous species. EEAA and partners also maintain a recently established PM Source Apportionment network. Also, EEAA has a unique network for monitoring the industrial facilities emission from stacks (telemetry system). Under the current assignment, EEAA also would like to identify opportunities for adding SLCP and GHG monitoring capacity, besides helping EEAA in formulating the basic guidelines for fence monitoring for fugitive emission from major sources especially industrial facilities**.** The consultant will work with EEAA teams (both within the Agency and at Center for Environmental Hazards Mitigation of Cairo University (CU-CEHM)) that are currently monitoring several criteria air pollutants in and around GC and implementing a source apportionment Roadmap to conduct speciated chemical measurements of fine particle pollution.

   EEAA has a robust, existing AQ monitoring network that includes numerous continuous and gravimetric PM_{10} monitoring sites with several gaseous pollutant monitors as well as a few $PM_{2.5}$ monitoring sites. Recently, 4 sites at Kaha, El Tahrir Square, El Sheikh Zayed and Misr El Gedida have been outfitted with pairs of samplers for source apportionment sample collection. The network review will consider the expanding range of AQ monitoring objectives (including SLCP/GHG monitoring), and develop recommendations for a revised network monitoring strategy that enables streamlined and efficient monitoring (e.g. through a “core” supersite network supplemented with a constellation of compliance monitoring sites or alternative strategies).

   The review shall also include assessment of the sites, the labs, assessment of the IT infrastructure, and Quality Control & Quality Assurance protocols.

Review shall include the assessment of the existing telemetry emissions monitoring network, site visiting, assessment of the IT infrastructure, and market research, and Quality Control & Quality Assurance protocols.

Review shall include the assessment of the existing air quality early warning system, and the IT infrastructure of the system, market research, and Quality Control & Quality Assurance protocols, and developing Terms of Reference (ToR) for advanced early warning system according to EEAA requirement.

2. **Add SLCP/GHG Monitoring Capacity to the Network:**
   Through this project, EEAA intends to add a number of sites (in consultation with the Consultant) that will continuously monitor the black carbon fraction of $PM_{2.5}$(through siting of paired aethalometers collocated with continuous regulatory grade $PM_{2.5/10}$ monitors) as well as basic meteorological measurements. The typical multi-wavelength aethalometers used to measure BC are also able to detect CO_2, so plans should include that addition. The consultant will need to work with EEAA to understand existing gaps in $PM_{2.5}$ monitoring, understand key sources of black carbon and CO_2 and design a siting plan and monitoring strategy that will enhance the existing monitoring network (including the recent Source Apportionment samplers and any proposed additions to that network) to provide the most robust information on baseline concentrations of SLCPs and GHGsin and around GC.

3. **Provide support on the procurement, deployment, calibration and testing of new SLCP (i.e. black carbon) monitors:**
   The consultant will support EEAA to select and procure appropriate equipment; develop a deployment plan consistent with the siting plan developed under Task 1; supervise and assist in deployment, set up and testing of equipment; develop SOPs including calibration, operation and maintenance of equipment and ensure that initial data collection occurs per SOP.
   The Consultant shall be responsible for preparing the technical specifications, and help with the preparation of the bidding documents that will satisfy the requirements of EEAA and following the World Bank Procurement Regulations, assist the Project Coordination Unit and EEAA in responding to bidders, support the evaluation process, equipment receipt and testing. He shall supervise the installation process, and the integration with the existing network infrastructure.

4. **Establish a quality management system (QMS) for the new equipment:**
   The consultant will work with EEAA to establish data quality objectives, quality assurance and quality control procedures for the new equipment to ensure that observations meet international best practice, resulting in high quality repeatable measurements of black carbon, $PM_{2.5}$, PM_{10}, CO_2 and basic meteorological parameters at each site. The Consultant shall also superviseimplementation of the QC/QA system.

5. **Support a data management system for EEAA monitoring data:**

The consultant will work with EEAA to supportestablishing a system that will accept real-time data from thesites monitoringSLCPs and GHGs; enable data analysts at EEAA or their subcontracted vendors to validate and quality assure the data, and then archive the data with an interface giving the option of public access to real-time data or a calculated air quality index (AQI) as well as for input into AQ forecasting systems being developed by another vendor.The Consultant shall also supervise implementing the data management system.

6. **Knowledge transfer, and train EEAA and their partners in the use, operation, maintenance of monitoring equipment**:
   The consultant will work with EEAA and the relevant partners (e.g., Cairo University's CEHM) to ensure that at the conclusion of the contract, their staffs are able to continue all SLCP and GHG monitoring sites selection, operations, including calibration of instruments, collection of data, validation and analysis of data, routine maintenance of instruments, reporting of data into AQI and forecasting systems.

IV. Administrative and Reporting Arrangements

The Consultant will work under the supervision of and report to the Head of the Environmental Quality Department, in his capacity as the Head of the Technical Implementation Unit of Component 1 of the Project, and/or his designee and with the Lead Advisor of the Component. Contract management and other administrative responsibilities are overseen by the Project Coordinator of the Greater Cairo Air Pollution Management and Climate Change Project, or his designee.

The consultant will closely work with EEAA staff members of the TIU, and will collaborate as needed with other partners that are also supporting EEAA staff with AQM planning such as Cairo University.The Consultant will also liaise, in consultation with EEAA, with other consulting firms to perform meteorological modeling and with other ministries/agencies that may be able to host monitoring sites.

V. Duration of the Assignment

The consultant will work to complete deliverables between **August 1, 2023 and September 30, 2024** within 14 months of the start of contract. This work will require reporting to theEEAA as outlined above.

VI. Deliverables

Serial No.	Deliverable	Time from ContractSignature
1	Inception Report	1 month
2	Roadmap Report	3 months
3	Reports on assessment of EEAA Networks & Data Management Plan & SLCP/GHG network Specs development &Plan for development, procurement, deployment and operation of SLCP/GHG network including QMS	3 months
4	Training Plan	4 months
5	Supporting the Tendering process: Documents including technical specifications for procuring the new monitoring equipment, evaluation and selection of vendors	5 months
6	Provide support to the PCU for finalizing procurement of the new monitoring equipment	9 months
7	Deployment of all monitoring equipment. Network operational and streaming data to operational data management system& Conduct training sessions according to the training plan	10 months
8	Data Report including quality assurance results	12 months
9	Final Report	14 months

Annex 3

TERMS OF REFERENCE

Provide technical support for EEAA newly developed source apportionment monitoring network and chemical speciation analysis operated by EEAA/Cairo University

I. Background

As part of the "Sustainable Development Strategy (SDS): Egypt Vision 2030",[8]the country committed to halving its fine particulate matter (PM_{10}) air pollution by 2030. Significant improvements have been made towards that goal in recent years. In fact, Cairo's PM_{10} concentration fell by about 25 percent over the past decade. Despite these improvements, the city's pollution levels are still several times the WHO recommended concentrations and higher than national guidelines taking as these high levels aretaking their toll on the health and quality of life of the population, in particular poor people. Subsequently, the Greater Cairo (GC) Cost of Environmental Degradation (COED) attributed to air pollution is by far the highest in the country, with a mean estimate equivalent to 1.35 percent of national GDP in 2017. Conversely, the GC COED attributed to waste (net of air pollution damages, via the burning of waste) is half the air pollution's COED and results in a mean estimate equivalent to 0.68 percent of national GDP in 2017 which includes the opportunity losses from composting, recycling, methane capture, etc. Moreover, recent studies on the COVID-19 show that there is an increased likelihood of contracting the disease with high levels of ambient pollutants.[9]

Climate change models project Egypt's mean annual temperature to increase between 2 ºC and 3 ºC by 2050 and an increase in the duration of long-lasting heatwaves. Hot sandstorms known as khamasin blow millions of tons of grit from the Sahara to the North African coast and increases in local temperatures of up to 20 ºC are projected to increase in frequency and intensity. By 2050 the intensity and seasonality of heavy rains, as well as the probability of droughts will increase. Long-lasting heatwaves likely will increase in duration of between 9 to 77 days by 2085. The GC area is vulnerable to all of these, as well as to river and urban flooding, water scarcity and wildfires. The impacts are severe, particularly for public health and agriculture. Climate change will put additional pressures on citizens' health, in the form of increases in the prevalence and severity of

[8] http://www.cabinet.gov.eg/English/GovernmentStrategy/Pages/Egypt%E2%80%99sVision2030.aspx and https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/Egypt%20Vision%202030%20%28English%29.pdf.

[9] Larsen, Bjorn. 2019. Egypt: Cost of Environmental Degradation: Air and Water Pollution. The World Bank. Washington, D.C.; and Back of the envelop calculations for cost of solid waste environmental degradation performed by the Team.

cardiopulmonary conditions through heat and sandstorms, potential increases in vector-bornediseases, through decreased nutrition and food security and reduced water quality.

Further, it has been demonstrated that extreme heat events are linked to worsening air pollution.[10]

In response to this situation, the Government of Egypt (GoE) is implementing the Greater Cairo Air Pollution Management and Climate Change Project (hereafter "The Project") financed by The World Bank. The Project seeks to reduce air and climate emissions from critical sectors and increase resilience to air pollution in Greater Cairo,i.e., Cairo, Giza and Qalubiah Governorates[11], and is implemented by the Ministry of Environment through its Egyptian Environmental Affairs Agency (EEAA) and its Waste Management Regulatory Authority (WMRA) and in collaboration with other partners. A Project Coordination Unit oversees overall project implementation and ensures that fiduciary requirements are met.

The project aims specifically to reduce emissions that contribute to air pollution concentrations, thus leading to air quality improvements, and to simultaneously mitigate climate change. Air pollutants include PM_{10} and $PM_{2.5}$, while climate pollutants include both longer lived greenhouse gases (GHGs) such as CO_2, as well as Short-lived Climate Pollutants (SLCPs) that include black carbon, methane and several short-lived HFCs.

Successful Integrated Climate and Air Quality Management Planning (IC-AQMP) requires a detailed assessment of these emissions in ways that enable decision makers to (i) understand the many sectors that contribute to a city's air pollution problems, (ii) track the effectiveness of policies and strategies over time to establish an accountability framework for both climate mitigation and AQM planning and (iii) utilize these data to conduct periodic international reporting and to process emissions estimates for dispersion modeling, critical to AQ forecasting.

The Ministry of Environment has developed a roadmap for conducting an updated Source Apportionment Study (SAS) for GC. Implementation of the roadmap and completion of the proposed SAS aims to support Egypt in developing a realistic strategy and plans for managing air pollution in the Greater Cairo region.Ambient air pollution will be managed through reductions of the proportion and concentration of suspended solid particles in the air of the main cities in Greater Cairo, Egypt. This study will utilize a framework to establish an advanced network to monitor the components of suspended solid particles with diameter less than 10 and 2.5 micrometers, respectively. These relatively modern techniques are currently being added to the existing monitoring, analysis and management system for GC, adding capacity in the field of chemical speciation analysis and mathematical modeling using specialized models.

The "Center for Hazard Mitigation, Environmental Studies and Research"at Cairo University was involved in developing the roadmap and will be responsible for implementing the SAS (in its

[10]Markandya and Chiabai, Valuing Climate Change Impacts on Human Health: Empirical Evidence from the Literature, Int. J. Environ. Res. Public Health, 6, 759–86, 2009.

[11] More details on the Project Components are provided in Annex 1.

capacity as the body contracted by EEAA to operate and maintain the EEAA national network for monitoring ambient air pollutants). The Ministry of Environment has carried out the monitoring and chemical analysis. The training were conducted as lectures by foreign experts in source apportionment from both the Cyprus Institute and the French National Institute for Industrial Environment and Risks (Ineris).

Online lectures were implemented to explain the methods and methodologies that will be used in analyzing the samples through which the study will be conducted, including the following topics:

- Introduction to aerosol impacts, chemical composition, and sources;
- PM Receptor Modeling: Techniques and Applications;
- Other types of source apportionment methodologies and some of their main inputs;
- Overall presentation of Experimental strategy in Cairo;
- Experimental strategy;
- Some general recommendations and site selection criteria to be considered when sitting-up a PM source apportionment study using receptor models;
- Speciation of organic fractions does matter for PM source apportionment;
- Anions-Cations and carbohydrates analysis by IC;
- X-RAY SPECTROMETRY EDXrf and WDXrf for filter analysis;
- EC - OC analysis by thermo-optical method;
- Metals analysis ICP-MS;
- Chemical Profiles Databases;
- Positive Matrix Factorization (PMF) for source identification and apportionment; and
- New tools for improved PMF.

The monitoring equipment for the source apportionment study has already been procured by EEAA for the "Center for Hazard Mitigation, Environmental Studies and Research" to collect the filters required for the chemical analyses, which included 2 Ion Chromatographs (ICs)for ion separation, X-ray analysis via XRF to determine metals and other elements, and OC-EC thermal-optical reflectance for quantitatively determining the fraction of elemental carbon to organic carbon.Training was conducted through lectures on the proper use and maintenance of this equipment to get staff acquainted with the methodologies and scientific methods that is being used in the implementation of the study.

Sample collection stations have been installed in 4 locations in Egypt (Qaha, Tahrir square, El Sheikh Zayed, Masr El Gedida), with each location equipped with 4 devices to monitor each of the PM size fractions with two different filter media, (two samplers for PM_{10} and two samplers for $PM_{2.5}$ with one sampler for each size fraction collecting on quartz filters and one collecting on Teflon filters). Samples are being collected at those sites every three days, i.e. ten cycles in one month for those samples to be analyzed on the aforementioned chemical analyzers. The collection of samples began on March 21, 2022, in preparation for the chemical analysis of the particulate matter samples accumulated on the collected filters. Approximately 1100 samples have already been collected and stored from the four sites in the GC SA network.

The requested services covered by these terms of reference are **to support implementation ofComponent # 1 of the Project, on Enhancing the Air Quality Management (AQM) and Response System, implemented by EEAA.** This component aims to support the enhancement of the AQM decision support system in GC through a strengthened AQM infrastructure (monitoring and analytical), capacity building activities, developing emergency response plans and raising public awareness through information dissemination.

II. Objective of the Assignment

The objective of this assignment is to hire a qualified consulting firm, referred to hereafter as "the Consultant" to provide technical support for the newly developed source apportionment (SA)monitoring network and chemical speciation analysis operated by EEAA/Cairo University - including knowledge transfer and capacity building for Egyptian colleagues as appropriate.

III. Scope of Work and Detailed Tasks:

The Consultant is requested to provide technical support for the newly developed source apportionment (SA)monitoring network and chemical speciation analysis operated by EEAA/Cairo University, including knowledge transfer and capacity building for EEAA and "Center for Hazard Mitigation, Environmental Studies and Research"/ Cairo University colleagues as appropriate. This includes aspects of manual sampling, collection, transfer and archival storage, chemical speciation analysis, receptor modeling and reporting over calendar years 2022-2024, inclusive. **EEAA is not looking to replace the current implemented approach being implemented in the source apportionment monitoring network**(Annex # 2 Detailed Implementation Approach). Rather, the team is looking for support to ensure best practices are being utilized and to enhance capacity for the existing approach.

Detailed Tasks:

The Consultant is requested to review and assess the existing capacity & approach of the methods and methodologies that are being used in EEAA Source Apportionment monitoring network.

The Consultant shall carry out a physical training program (**on job training; not online**) for the staff of EEAA, and the "Center for Hazard Mitigation, Environmental Studies and Research" / Cairo University on the methods and methodologies that shall be used in analyzing the samples collected by EEAA Source Apportionment monitoring network (both those which have already been collected and stored as well as those yet to be collected). The training shall include the following:

1. Sample collection, weighing, transfer and storage:

- The consultant should review the protocols in place and being used for filter media preparation, blank correction, sample collection and transfer and storage at the Cairo University Laboratory.
- The consultant should review sampler operation and maintenance to ensure that the manual samplers will be fit for purpose over the lifetime of the network.

2. Using analytical instruments, and handling of data:
   - Using Ion chromatography instrument for --- carbohydrates, especially handling of data from the instrument;
   - Using Ion chromatography instrument for --- anions and cations; and
   - Using XRF instrument, and how to modify the measurement method to be suitable for the measurement conditions in Egypt.
   - Using EC-OC instrument, and how to modify the measurement method to be suitable for the measurement conditions in Egypt.

3. PMF Modeling for Air Pollutants:
   The Consultant shall provide introduction to PMF Modeling for Air Pollutants. This introduction should provide an overview of the principles and techniques of PMF modeling for air pollutants. Topics to be covered should include the fundamentals of PMF modeling, the types of pollutants that can be modeled, and the advantages and limitations of this approach.

4. Data Collection, Validation and Preparation:
   The training to be conducted by the Consultant on the PMF Modulehas to cover the steps involved in collecting and preparing data for PMF modeling. Topics to be covered should include data sources, data quality control and quality assurance, data cleaning/validation, and data transformation.

5. Model Development:
   The training to be conducted by the Consultant on the PMF Moduleshould cover the steps involved in developing a PMF model for air pollutants from the four-site network. Topics to be covered should include model selection, parameter estimation, model validation, and sensitivity analysis.

6. Application of PMF Models:
   The training to be conducted by the Consultant on the PMF Module shouldcover the application of PMF models to real-world problems related to air pollution in GC. Topics to be covered should include case studies from Egypt's results, as well as best practices for using PMF models in policymaking and decision-making processes.

7. Advanced Topics in PMF Modeling:

The training to be conducted by the Consultant on the PMF Module should cover advanced topics related to PMF modeling for air pollutants, such as source apportionment techniques and uncertainty analysis methods.

IV. Administrative and Reporting Arrangements

The Consultant will work under the supervision of and report to the Head of the Environmental Quality Department, in his capacity as the Head of the Technical Implementation Unit of Component 1 of the Project, and/or his designee and with the Lead Advisor of the Component. Contract management and other administrative responsibilities are overseen by the Project Coordinator of the Greater Cairo Air Pollution Management and Climate Change Project, or his designee.

The consultant will closely work with EEAA staff members of the TIU, and will collaborate with Cairo University.

VI.Duration of the Assignment

The Consultant will work to complete deliverables between **1st August 2023** and**31st January 2025** within **18 months** of the start of contract. This work will require reporting to the EEAA as outlined above.

VII. Deliverables

Serial No.	Deliverable	Time from Contract Signature
1	Inception Report &Roadmap Report&Training plan	1 month
2	Conduct on job trainingprogram for the staff of EEAA, and the "Center for Hazard Mitigation, Environmental Studies and Research" / Cairo Universityon the methods and methodologies that are used in sites selection, samples collection, analyzing the samples collected by EEAA newly developed Source Apportionment monitoring network. This includes aspects of manual sampling, collection, transfer and storage, chemical speciation analysis for the different instruments, receptor modeling, processing, and reporting.	4 months
3	End of year 2023 Progress Report.	5 months
4	Conduct 4 on-site missionsto follow up on the progress of the source apportionment monitoring network (one mission every calendar quarter).	5 - 17 months
5	Final Report.	18 months

The consultant staff will be available for meetings and appointments per the schedule of the EEAA. The consultant will be expected to present results and provide Progress Report to EEAA every 3 months during the contract period.

Air samplers

No	Instrument	Model	Principles of Operation
1	ARA Sampler	N-FRM	The N-FRM Sampler is specifically designed to meet the US-EPA operational specifications for PM_{10} and $PM_{2.5}$ air sampling. To meet the EPA specifications, the N-FRM Sampler is designed to operate at 16.7 LPM and collect 24-hour samples to compare to EPA National Ambient Air Quality Standards. The ARA N-FRM Sampler is a microprocessor-controlled portable air sampler, which can be operated manually or programmed to collect scheduled samples. As specified by the EPA, all critical air sampling parameters are continuously monitored and logged as time indexed 5-min averages to validate the sample. These parameters include: flow rate, temperature, barometric pressure, and accumulated volume. Other sampler related performance parameters are also logged. If the N-FRM Sampler is equipped with the Real-Time Particulate (RTP) Profiler and meteorological sensors, then PM_{10}, $PM_{2.5}$, wind speed, and wind direction are also included in the data record. The N-FRM sampler can be easily deployed. It can be mounted on a variety of structures using our universal mounting bracket that can be screwed, clamped, or attached to utility poles, trees, fence posts, etc. Another option is to use a freestanding tripod. The N-FRM Sampler is equipped to operate from either AC or DC power sources. In the DC mode, the sampler operates from an internal battery pack. A charged battery pack is capable of operating the sampler for about 30-40 hours. This robust capacity allows the sampler to be used in cold weather and high altitude applications. A charger is supplied so the batteries can be re-charged in approximately one hour.

Chemical Analysis Instruments

No	Instrument	Model	Methodology
1	Rigaku WD-XRF	supermini 200	XRF for metal elements requires Teflon filters, and the measurements are performed after finishing the gravimetric analysis one the same Teflon filter as follows: - For storage at cold conditions (at least below 5°C), ice boxes for the Teflon filters is used. Element to be determined are (Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, Rb, Sr, Sn, Sb, Ba, Pb). - Certified control filters are to be used for quality control. - The filter is removed from the box and placed in the sample holder of the instrument using forceps. - Holder containing sample filter is covered with the Mylar film. - Eight samples can be measured in the same run. - Each sample measurement consumes about 25 minutes. - After finishing measurement, instrument software is used to manipulate data, and get the final data in the form of $\mu g/m^3$. - Samples are measured again, so two reading is available for each sample. - Data are collected in the excel sheet.
2	Sunset® total carbon analyzer	Lab OC-EC Aerosol Analyzer	- Quartz filters shall be pre-heated at 500 degrees Celsius during 24hours, and then stored in very clean conditions, to minimize contaminations; square part of the filter of length 1.5 cm is punched and used for analysis in the analyzer. - For calibration and quality control, blank filter is analyzed to Check any laboratory contamination; referent filter from air sample with 10 punches analyzed (criteria 10%) to check the analytical repeatability; filter spiked with organic solution (glucose, criteria 10%) - To check the calibration; calibration of thermocouple measuring temperature in the oven each time a maintenance is achieved on the oven. - No existing EC or OC standard reference material, but automatically calibration by injection of CH_4 at the end of each sample analysis; Linearity from spiked filter (glucose or sucrose) every 6 months (and after replacing CH4-containing gas cylinder).

			- Each filter is measured twice where each sample consumes about 40 minutes; the data is handled using instrument software to get both elemental carbon and organic carbon, and sum gives total carbon in µg/m_3 which is collected in the excel sheet.
3	930 Compact IC Flex for carbohydrates –940 professional IC Vario for cations and anions.	Metrohm®	Ccarbohydrates, anions and cations analyses are performed for a second punch from the quartz filter as follows: - Standard solutions 5 points (at Least) are prepared: 0.01 -10mg/L, equivalent to 0.2 -200 µg are prepared. Work from 2 calibrations, Low calibration (LOQ1 mg/L) and High calibration (1 mg/L 10 mg/L), for each compound, LOQ is typically of about 10 µg/L or 0.2 µg. Blank filter is analyzed to check any laboratory contamination. Injection of a standard every 10 samples: (criteria 15%) to check the analytical drift; injection of an independent standard (criteria 10%) to check the calibration; injection of the first standard at the end of the analytical run (criteria 30%) to check the LOQ. - Punch of the filter of area (1.5×1 cm2) is used; the species to be analyzed are extracted from the filter punch using ultrapure distilled water; filter punch is placed in vial with 20 mL ultrapure distilled water, followed by sonication (using FB15067 Fisher brand® sonicator) for 10 minutes and shaking (Fisher brand® shaker) for one hour. - The supernatant liquid is filter using syringe filter, and be analyzed for carbohydrates at first, followed by anions and cations analysis. Analyses are performed twice for each sample. - The sample consumes about 50 minutes for both carbohydrates with anions and cations; data is handled using instruments software, and data is collected in the excel sheet.
4	Balance	AND BM-5	- Before sampling, For Teflon filters, two consecutive weighing (m_{b1} and m_{b2}) will be carried out with 12 h time interval and an average filter mass ($m_{b,mean}$); The difference between (m_{b1} and m_{b2}) will be < 40 µg. Set a sampling timeframe corresponding to 8:00 AM to 8:00 AM (24 h).Visit site to collect filter, for storage at cold conditions (at least below 5°C using two ice boxes for Teflon filters, just after the sampling is achieved. - After sampling, at least two weighing (ms, 1 and ms, 2) should be carried out with 24-htime interval. The difference between the last two results shall be lower than

			60 μg. If this condition is not eventually fulfilled, the result is declared invalid. The sampled filter mass is the average of the last two consecutive weighing (mc, mean). - The final PM mass collected on the filter is the difference between mms, mean and mc, mean Certified standard masses and control filters are to be used for quality control. - Before weighing, the filters are stabilized for at least 48 hours under controlled conditions (temperature and relative humidity ranges of 19-21°C and 45-50%, respectively).

Positive matrix factorization (PMF):

It is a recent development in the class of data analysis techniques called factor analysis, in which the fundamental problem is to resolve the identities and contributions of components in an unknown mixture. PMF has been used extensively for source apportionment of ambient particulate matter(PM), where the goal is to resolve the mixture of sources that contributes to PM samples.

PMF is especially applicable to working with environmental data because it:
(1) Incorporates the variable uncertainties often associated with measurements of environmental samples and
(2) Forces all of the values in the solution profiles and contributions to be nonnegative, which is more realistic than solutions from previously used methods like principal components analysis.

Modern-day sampling networks provide time-resolved speciated ambient aerosol data that include trace and crustal elements, ions, organic(OC) and elemental carbon (EC) fractions, and PM concentrations. PMFhasbeenusedtoidentifyandapportionsourcesofairbornePMbyanalyzing these species (or a subset) measured at many locations around Cairo.

Profiles and contributions of PM from primary sources, such as motor vehicles, residential and industrial fuel combustion, biomass burning, soil dust, and sea salt are typically identified by PMF analyses in these studies. Secondary sources, such as atmospheric oxidation of sulfate and nitrate and heterogeneous gas-to-particle conversion reactions on soil dust surfaces, have also been identified with PMF.
Despite the extensive use of PMF, there exists considerable variation in the procedures followed and decisions made to apportion sources of ambient PM using PMF.

The modeling procedures may be divided into three broad steps:
(1) Preparing data to be modeled,
(2) Processing the data with PMF to develop a feasible and robust solution, and
(3) Interpreting the solution. Specific decisions, such as the creation of data uncertainties, selection of the best number of factors, and treatment of outliers, need to be made when carrying out these steps.
In our work for PMEH we will determine which steps are common and which are unique for Cairo.