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ACTIVITY REPORT

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VOLUME I
An Assessment and Source Apportionment of Airborne Particulate Matter in Cairo, Egypt

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Charles E. Rodes
Mahmoud M. Nasralla
Philip A. Lawless

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PREFACE

This report summarizes a receptor modeling study conducted collaboratively between USAID's Environmental Health Project and the Egyptian National Research Centre in the metropolitan area of Cairo from December 1994 through November 1995. The initial results of the project were described in a preliminary report provided to USAID/Cairo in May 1995. That report was not widely distributed because of its preliminary nature, and the key descriptive elements are being repeated in this final report.

The overall study objective was to apportion airborne particle mass concentrations in Cairo to the local air pollution source categories as an input to a planned risk-management activity. The bases for the apportionment were ambient air samples collected at neighborhood receptor locations in Cairo, combined by a computer model with signature samples collected from selected Cairo air pollution sources. Although a limited number of ambient particle size specific samples were collected, they currently represent the only health-related particle samples available to characterize the Cairo air pollution problem. The complexities of the air pollution problems in Cairo suggested that this project should be considered a pilot effort. The apportionment technology has been transferred to Egyptian scientists for future study.

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A Particulate Matter Characterization Considerations for the Cairo Modeling Study
B Cairo Receptor Modeling Study Work Plan
C Sources of Receptor and Signature Samplers
D Detailed Analytical Data and 10-Year Meteorological Summaries
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ACRONYMS

Ag	Silver
Al	Aluminum
As	Arsenic
Au	Gold
Ba	Barium
Br	Bromine
BSS	British Smoke Shade (reading or sampler name)
C	Carbon
Ca	Calcium
Cd	Cadmium
C_e	elemental carbon (also called soot carbon)
Cl	Chlorine (or chlorides)
CMB	Chemical Mass Balance
Co	Cobalt
Coarse	Coarse Particle Size Fraction (2.5 to 10.0 micrometers)
Cr	Chromium
Cu	Copper
C_v	volatile carbon (also called organic carbon)
DRI	Desert Research Institute (Reno, Nevada)
EHP	Environmental Health Project
EC	Elemental Carbon
EPA	U.S. Environmental Protection Agency

EQI	Environmental Quality International (Cairo)
Fe	Iron
Feb	February
Fine	Fine Particle Size Fraction (0 to 2.5 micrometers)
Ga	Gallium
Hg	Mercury
IC	Ion Chromatography
In	Indium
IQ	intelligence quotient
K	Potassium
km	kilometers
La	Lanthanum
m	meters
m^3	cubic meters
μg	micrograms
$\mu g/m^3$	micrograms per cubic meter
μm	micrometers
MDL	Minimum Detection Limit
Mn	Manganese
Mo	Molybdenum
N	North
NE	Northeast
Ni	Nickel
NRC	National Research Center (Cairo)

OC	Organic Carbon
P	Phosphorus
Pb	Lead
Pd	Palladium
PM_{10}	Particulate Matter less than 10.0 micrometers
Rb	Rubidium
RTI	Research Triangle Institute (Research Triangle Park, N.C.)
S	South
S	Sulfur
Sc	Scandium
Si	Silicon
Sn	Tin
SO_4	sulfates
Sr	Strontium
Ti	Titanium
TSP	Total Suspended Particulates
U	Uranium
URG	University Reserach Glassware (Carrboro, N.C.)
USAID	U.S. Agency for International Development
V	Vanadium
XRF	X-Ray Fluorescence
Y	Yttrium
Zn	Zinc
Zr	Zirconium

EXECUTIVE SUMMARY

Background

This report describes a collaborative effort by the Environmental Health Project (EHP) and the National Research Centre (NRC) of Egypt to transfer technology and simultaneously characterize and determine the sources of airborne particulates in Cairo. The study has involved the collection of particulate air pollution samples, followed by the application of a computer-based model that apportions the collected particles according to the contributing source categories. This effort was conceived as a first step in the development of a particle source control program for the Cairo area, based on the health risks identified for particles in the 1994 Cairo Comparative Risk Assessment (Sessions et al. 1994a and 1994b).

Approach

Receptor samples were collected at selected locations in the Cairo metropolitan area. These locations were either on second or third floor roof locations to provide neighborhood-scale, air mass characterizations, as opposed to lower-level sites, which are more heavily impacted by automobile emissions and surface dust re-entrainment. Collection of the particle samples in aerodynamically sized fractions emulated the deposition of particles into specific regions of the respiratory system, thereby providing data more closely linked to the assessment of health risk. The fractions selected for this assessment were the 0–2.5 μm Fine fraction (penetrating to the alveolar regions of the lung), the 2.5–10 μm Coarse fraction (penetrating to the upper airways), and the sum of these two fractions, the total 0–10 μm fraction, referred to as the PM_{10} fraction. A limited number of Total Suspended Particulate (TSP) samples were also collected to relate the receptor samples to historical data.

Receptor modeling mathematically relates chemical signatures of pollutants from known source categories with the signatures from analyzed particulate air samples collected at selected receptor exposure locations. The source signatures are chemical fingerprints of each source category. The receptor samples are analyzed for signatures that are composite fingerprints from a mixture of source categories. Prior to this study, specific signatures did not exist for Cairo, and a parallel program to identify the most significant sources, collect the samples, and provide the analyses was completed. For the purposes of this study, the source categories identified (as particle contributors) for Cairo included paved roadway dust, unpaved roadway dust, desert dust, agricultural dust, nondiesel (petrol) automobile exhaust, heavy duty diesel (bus) exhaust, cement production, lime production, light oil (Solaar) combustion, heavy oil (Mazut) combustion, iron and steel production, secondary lead smelting (battery reclamation), and vegetative/trash burning.

Characterization

Receptor air samples were collected for limited periods (one to three weeks) at various locations:

- A City Centre location on Ramses Street
- The roof of a residence in Maadi
- The roof of a laboratory in Helwan
- The roof of a government building in Shoubra El-Kheima
- A background site on the roof of a school 20 km northeast of central Cairo near the desert.

The results from sample analyses showed that daily PM_{10} mass concentrations, as expected, varied widely by geographic location, with meteorology playing an important role.

The mean TSP concentrations at the receptor sites during the study ranged from 300 to 700 $\mu g/m^3$, typical of the levels reported historically in Cairo. The PM_{10} mass concentrations were approximately one-third of the TSP levels at the urban locations, ranging from 120 to 200 $\mu g/m^3$. The residential area of Maadi had the lowest concentrations, while the site in Helwan had the highest. The Cairo PM_{10} concentrations can be compared with the U.S. annual average and single day standard levels of 50 and 150 $\mu g/m^3$, respectively. During periods of elevated wind speeds (> 24-hour averages of 30–35 km/hr), the PM_{10} level increased by as much as a factor of two, apparently from re-entrained surface dust. The PM_{10} concentrations at the background site were 50–70 $\mu g/m^3$ during periods of normal wind speeds. The Fine fraction was 30–40% of the PM_{10} at the City Centre site, but only 20–30% at the other sites.

During the study sampling periods, winds were predominantly from the north. This provided a link between the sources in the northern areas of Cairo (primarily Shoubra El-Kheima) and the receptor sites but reduced substantially the ability to generalize the influence of sources in the south (Helwan area). The most prevalent chemical analytes (each contributing more than 1% of the particle mass) collected at the City Centre site during north winds were organic carbon, elemental carbon, sulfates, chloride, calcium, silicon, sulfur, nitrates, iron, lead, aluminum, and potassium. The ordered list of major analytes for north winds for the other sites was very similar. The primary difference was in the extended lists of minor elements. Sulfate and nitrate analyses were not performed for all Cairo sites, but they would be expected to provide similar results since they are primarily from atmospheric conversion reactions rather than from localized sources. Day-to-day variations in receptor sample analytes suggested that the most consistent model output would be obtained by compositing two or more days with similar predominant wind directions for each site.

Apportionments

The analyte chemical signatures from each of the sources sampled were not always uniquely distinctive; they sometimes consisted of mixtures of sources that in two cases required mathematical decomposition. These included paved roadway dust (determined to be primarily a mixture of unpaved roadway dust and desert dust), and heavy duty diesels (primarily heavy duty diesels with some contributions from unpaved roadway dust, desert dust, and automobiles). An unexplained problem with the Solaar oil combustion samples produced organic and elemental carbon concentrations that were obviously in error. This weakened the models ability to separate the contributions of the three oil combustion signatures (heavy Mazut oil combustion, light Solaar oil combustion, and heavy duty diesels). Substantial filter sample overloading also occurred at most sources because of the uncontrolled nature of the sources. These heavy loadings posed substantial analytical problems for the X-ray fluorescence (XRF) metals analyses and increased uncertainty in the signature.

The substantially different source contributions to the receptor particle mass at each site as a function of particle size (Fine versus Coarse particle fractions) provided excellent model fits by individual fraction but only modest fits for the composite PM_{10} fraction. As expected the model fits tended to be weaker for the Coarse particles, since these particles do not transport as readily or over extended distances as do Fine particles.

At the City Centre site during north winds, the most prevalent contributions to Fine particle (< 2.5 μm) mass as shown in

Figure ES-1 were from the oil combustion sources (a total of ~62%), followed by ambient sulfates from atmospheric conversion of sulfur dioxide, an unidentified chloride source, petrol-fueled automobiles, paved roadway dust, and lead smelters. The Coarse particle (2.5 to 10 μm) apportionment at the City Centre was primarily paved roadway dust and an unknown chloride. As noted previously, paved roadway dust is actually a mixture of other dusts.

The Fine particle mass apportionment for north winds at the Maadi site (see Figure ES-2) showed a smaller influence from industrial sources, with ambient sulfates being the largest contributor, followed by vegetative burning, re-entrained unpaved roadway dust, heavy oil combustion, iron and steel production, petrol-fueled automobiles, and lead smelters. The Coarse particle apportionment consisted of re-entrained unpaved roadway dust, followed by lime production and desert dust, iron and steel production, and cement production. The lime production source category appeared to be an artifact source that was conjectured to actually be re-entrained surface dust, consisting of a mixture of Maadi soil and cement production dust.

The Fine fraction mass for the industrial Helwan area site was composed of vegetative burning, followed by heavy oil combustion, ambient sulfates, re-entrained desert dust, iron and steel production, and lead smelters and petrol-fueled automobiles. Only 66% of the Coarse particle fraction in Helwan could be predicted, with re-entrained unpaved roadway dust, desert dust, and an unknown chloride comprising the apportionment. Similarly, the Fine fraction apportionment for the industrial Shoubra El-Kheima site was vegetative burning, followed by heavy oil combustion, iron and steel production, re-entrained paved roadway dust, ambient sulfates, and lead smelters and petrol-fueled automobiles. The Coarse particle fraction for Shoubra El-Kheima was almost completely paved roadway dust, with some contributions from iron and steel production and cement production.

An apportionment for lead (Pb) was conducted at the City Centre site because of the relatively high Pb concentrations in the receptor samples (a mean of ~2.5 $\mu g/m^3$) and

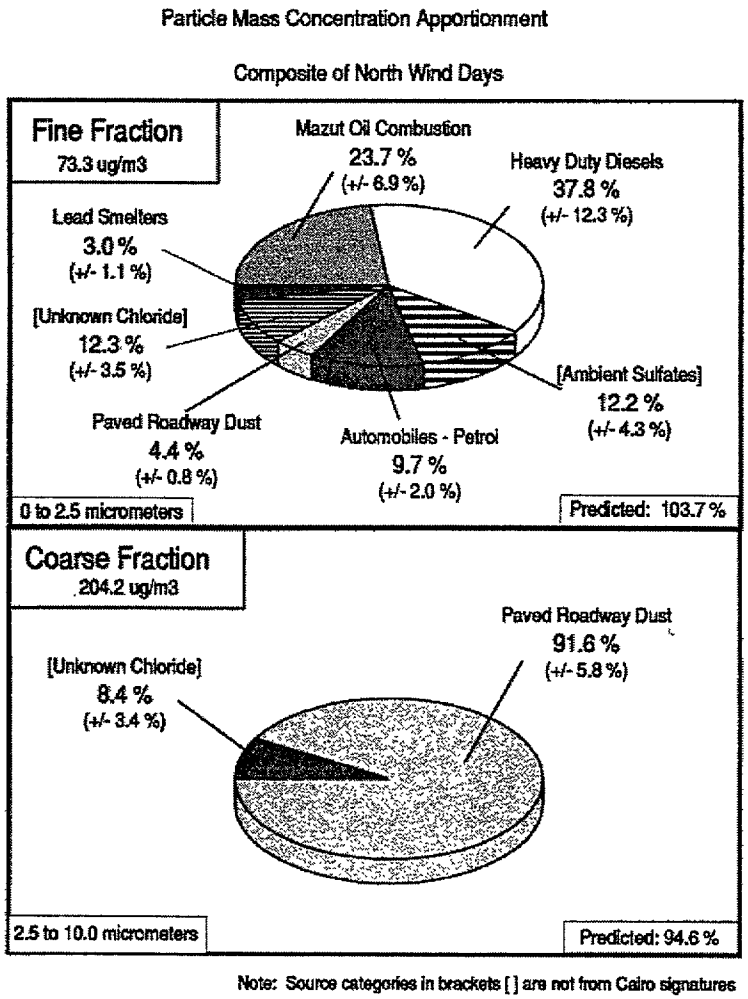


Figure ES-1 Cairo City Centre Source Apportionment

the paved roadway dust (~0.4% by mass). The Fine fraction apportionment for Pb showed that lead smelters provided the greatest contribution, followed by petrol-fueled automobiles, with minor contributions from heavy oil combustion and paved roadway dust (both <1%). The Coarse particle apportionment attributed the majority of the Pb to petrol-fueled automobiles (~54%) and paved roadway dust (~45%), with a minor contribution from heavy oil combustion (~1%). Only 59% of the Coarse particle Pb could be predicted.

A number of uncertainties were identified in this report because of mixed source categories, an inaccurate Solaar oil combustion signature, and analytical problems with the overloaded source signature filters. Despite these factors, the overall quality of the model estimates was assessed to be very good for Fine particles, good for Coarse particles, and fair for the PM_{10} fraction.

The objective of transferring equipment and technology to permit Egyptians to conduct subsequent receptor model studies was accomplished, with sampling and analytical equipment procured for the National Research Centre and training provided to National Research Centre and Tebeen Metallurgical Institute personnel to operate the equipment. A hands-on, two-day seminar was conducted in Cairo to train interested Egyptian government officials on how to use the CMB 7 receptor model to conduct apportionments.

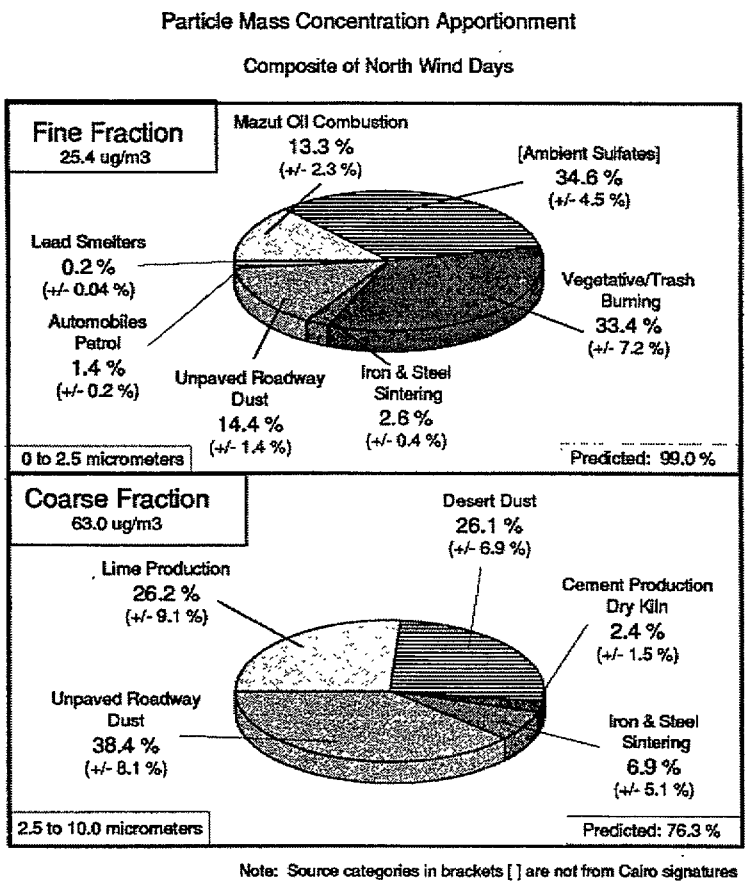


Figure ES-2. Maadi Source Apportionment

Recommendations

Specific recommendations were made on steps that could be taken to improve the current apportionment, improve the accuracy of future receptor modeling studies in Cairo, and improve the Egyptian capabilities to conduct independent future studies. These recommendations included:

- procuring a dedicated meteorology system for receptor model studies
- procuring a carbon analysis system for determining both elemental (soot) carbon and organic carbon
- modifying the source signature sampler to more accurately capture Coarse particle carbons
- repeating the collection of samples that either were heavily overloaded or that included a mixture of more than one source category

- collecting additional receptor samples to better characterize source contributions when winds are from the south
- adding receptor sites in other locations in Cairo (e.g. Giza City) to represent a broader range of population exposures
- collecting City Centre receptor samples at street level

Conclusion

This study has served as a starting point for understanding the contributors to the high airborne particulate levels observed in Cairo. In the absence of a source emissions inventory, the source-receptor modeling approach was successful in identifying several key categories of sources to be considered in developing an overall management strategy for reducing particulate, especially the Fine fraction.

At the City Centre, these included heavy-duty diesels, Mazut oil combustion (probably confounded by and inclusive of Solaar oil combustion), ambient sulfates (from sulfur dioxide emissions), gasoline-fueled automobiles, paved roadway dust, and lead smelters (roughly in order of decreasing magnitude). At other sites, vegetative/trash burning was very significant, while industrial sources such as iron and steel production processes were important at a local level.

1 BACKGROUND

1.1 Health-Based Risks

The U.S. Agency for International Development (USAID) Mission in Cairo, Egypt, sponsored a comparative risk analysis (Sessions et al. 1994a and 1994b) to apply a systematic approach to evaluating the environmental problems in greater Cairo and provide a relative risk ranking. This report described the procedures used to establish the relative risk ranking and discussed the uncertainties in the input data. Table 1-1 shows the relative rankings and indicates that total airborne particulate matter was in the highest risk category, along with Pb in all media (air, water, soil, food). The report estimated that the reduction of the particulate matter in Cairo air to natural background levels would reduce the number of excess deaths attributed to particulate matter by 3,000 to 16,000 per year. Similarly, the reduction of Pb in Cairo air to natural background levels would reduce the number of excess deaths from cardiovascular illness attributed to lead by 6,300 to 11,100 per year and improve children's IQ scores by 4.25 points.

The report noted that it could not dictate the priority that should be given to controlling each problem area (a risk management output). It also observed that source control strategies must consider control

Table 1-1
Relative Health Risks from Environmental Problems in Greater Cairo

Higher Risks	Particulate Matter Air Pollution Lead (in all media—air, drinking water, food, surface dust) Microbiological Diseases from Environmental Causes
Middle Risks	Microbial Food Contamination Ozone Air Pollution
Middle/Lower Risks	Sulfur Dioxide Air Pollution Carbon Monoxide Air Pollution Indoor Air Pollution Drinking Water Contamination by Chemicals Drinking Water Contamination by Microbiological Agents Solid and Hazardous Wastes
Lower Risks	Toxic Air Pollutants Other Water Pathways: Direct Contact, Irrigation, Fish Consumption
Uncertain Risks	Nitrogen Dioxide Air Pollution Metals in Foods Pesticides in Foods (middle risk if available data are accurate; less risk if not)

Source: Sessions et al. (1994a)

costs, technical feasibility, political concerns, public opinion, legal authority, and other factors.

Although a risk analysis is only an estimate, the report clearly shows that risk management steps must be taken to reduce the health risks from airborne particulates in Cairo. It was also apparent that given the magnitude and implications of a control strategy development, any parallel data that can be collected to reduce some of the uncertainties identified in the risk assessment would be of substantial benefit. An example would be collecting particle concentration data at several population exposure sites by the smaller size fractions identified as relevant in existing international health-based standards. In 1994 USAID/Cairo proposed that a study be initiated to assist in defining the risk management options for the Cairo metropolitan area by relating the contributions of potential particulate sources to the population exposure.

1.2 Receptor Modeling Approach

A direct approach to health risk reduction in Cairo involves developing a risk management strategy that initially identifies the contributing sources, provides estimates of their relative contributions to the population exposure, and determines whether the sources are natural (such as wind blown desert dust), manmade (such as auto or bus exhaust), or both (such as re-entrained Pb dust from paved roads). A diagram of the health risk characterization paradigm is shown in Figure 1-1, with the elements this study addresses identified in shaded boxes. (Throughout this report, all figures appear at the end of the chapter in which they are first referenced. Figure 1-1 is found on page 5.) A more robust approach to risk characterization would begin with an initial identification of the sources that are most likely to be contributing to Cairo air concentrations. Both short- and long-term plans would then be developed. These plans would incorporate a receptor modeling study to initially identify the relative contributions of each source category and a dispersion modeling study to determine the expected reductions in ambient concentrations if sources are modified or removed. As noted by the Sessions et al. (1994b) report, however, there is currently no inventory available of source emissions rates for Cairo, making immediate application of dispersion modeling impractical. Although dispersion models are a more versatile predictive tool and should be utilized in any overall program, they require collection of a significant amount of input data, followed by model validation, to be useful. Receptor modeling is a more direct, cost-effective, and expedient approach for defining the starting point of a control program, especially when the source emission inventory data base is sparse.

The present report describes an analysis of receptor and source particle data Environmental Health Project obtained as part of a receptor modeling program for the Cairo metropolitan area. It has been prepared to provide an initial understanding of the particulate problems in Cairo. The initial source identification and characterization steps for this project were reviewed in mid-1994. This review resulted in a work plan for a receptor modeling study to be conducted for metropolitan Cairo during early 1995 as the most expedient and cost-effective means of collecting the information needed. In the short term, it was proposed that significant and rapid reductions in total particulate matter air concentrations may be possible by application of educated control strategies. This would be especially true for significantly contributing categories with only a few major point sources in the greater Cairo area.

Receptor modeling is a source apportionment technique that mathematically relates chemical signatures of pollutants from known source categories with the signatures from analyzed particulate air samples collected at selected receptor exposure locations. The

source signatures are essentially chemical fingerprints of each source category. The receptor samples are analyzed for signatures that are composite fingerprints from a mixture of source categories. The conceptual diagram of the application of receptor modeling in Figure 1-2 shows the collection of signature samples at the sources expected to be significant contributors to the receptor samples. The receptor samples are collected at locations in the metropolitan area selected to represent population exposure. The sampling periods are selected to maximize the probabilities that significant transport occurs between the identified sources and the selected receptor sites. Conceptually, if transport is not occurring between the selected source and receptor location, the process of receptor modeling will not be successful. Since the local meteorology is the predominant transport driving force, the wind direction and speed must be favorable during the sampling periods selected. Additionally, some sources tend to operate less consistently than others (for example, batch operations), influencing the probability that the sources of interest were actually functioning (and at normal capacity) during the sampling period. The receptor samples for this study were collected over relatively short sampling periods and analyzed when the transport from sources to receptors was felt to be better.

While receptor studies use the same sampling methods as ambient air characterizations, source signature samples for receptor modeling do not produce mass emission rates (mass per time) typically made in source sampling. Source signatures for receptor model input need only represent the fractional (unitless) contribution of each chemical constituent to the total mass in the source emission stream. This does not necessarily require the more rigorous iso-kinetic (matched point velocity) sampling normally accomplished in source sampling for particles, except to ensure that the correct particle sizes are being captured. Only the representative fractional contributions of individual elements and compounds to the total are identified as the signature for the source.

The strategy for the collection of receptor samples reduces their usefulness as routine air monitoring samples. Air monitoring samples typically attempt to characterize the metropolitan concentration levels both temporally (sampling periodically over days, months, and years) and spatially (across the metropolitan area). The receptor data do, however, provide an indication of the concentrations of particle mass and chemical species found in selected particle size fractions. Since the samples collected in this study are some of the first samples collected in the Cairo metropolitan area by particle sizes relative to their health consequences, the data are enlightening. The number of samples that comprise each sample set and the sampling period during the year should be considered, however, when interpreting the data provided for a specific site.

Representative receptor sampling locations and time intervals were selected based on the location of the sources of interest, the way the sources operate, the local meteorology, transformation processes that may occur between sources and receptors, the population density and the likelihood of population exposure. Once samples were collected and analyzed, a mathematical modeling exercise was conducted by computer using the source and receptor sample chemical signatures as inputs. Some knowledge of the variabilities inherent in each measurement was also considered.

It was assumed that the source signature samples represent the source output fingerprints at all times during the year and at all locations in Cairo. These are usually reasonable assumptions, but they may pose problems for model applications when only one receptor sampling day is used. The receptor model output is an estimate of the fraction of the particulate mass (or selected

metal) concentration that can be attributed to each input source category. As with all computer simulations, the more accurate and representative the input data, the more accurate the fractional apportionment.

Particles are a much more complex environmental contaminant regime than are simple gas phase components. This results primarily from the size distribution of particles that exists in the air. Large particles (greater than about 2 μm) originate and behave physically and chemically differently than smaller ones. To provide the strongest link between a particle receptor modeling effort and health, the particle sizes must be collected (at both sources and receptors) in a manner that considers the health consequences described in the risk assessment. This is accommodated by sampling particle size ranges that deposit in specific locations in the human respiratory system. In addition, particles can be formed, lost, or transformed during transport to the receptor, by chemical or physical processes. A common atmospheric formation process is the conversion of sulfur dioxide to sulfates and acid aerosols. The most prevalent loss mechanism is settling of the largest particles—typically those above about 50 μm in diameter. An important transformation process is the agglomeration of smaller particles onto larger particles during the transport period, gradually increasing the general size distribution. Volume II, Appendix A describes the characteristics of particles suspended in ambient air that are an important consideration of this report.

Although total body burden for metals such as Pb can be important, health assessments for particles as a function of size fraction (see the U.S. Environmental Protection Agency's (EPA's) Air Quality Criteria for Particulate Matter, 1996) suggest that 0–10 μm (referred to as PM_{10}) should be a primary size fraction of interest. This fraction defines the particles that penetrate to the thoracic region and deposit in the upper airways and deep lung. The particle size cutpoint at 2.5 μm divides the particles that deposit in the upper airways from those that penetrate to the deep lung. This also is an approximate dividing point between Fine and Coarse particles in the atmosphere. Thus three particle size fractions are considered: a 0–2.5 μm Fine fraction, a 2.5–10 μm Coarse fraction, and a composite 0–10 μm PM_{10} fraction.

An important consideration of an apportionment is the natural background dust contribution to the ambient concentrations. Cairo is surrounded by desert areas and periodically experiences periods of high winds. This natural component contributes to the minimum attainable airborne particulate level, if all other sources were removed. Much of the windblown dust background has been recognized to be composed of large particles, and to capture the largest airborne particles, a total particle sampler has been used. The TSP fraction sampler has been used historically in Cairo. This sampler collects particles as large as 30 to 40 micrometers. The health implications of particles between 10 and 30 μm are significantly smaller than those for particles less than 10 μm. To place the contributions of these larger particles in perspective, parallel sampling for TSP was conducted briefly in the Cairo.

The historical transport of desert dust across the city is a complication for the model in that the dust on the roadways contains a significant portion of desert and soil dusts. This posed a potential collinearity problem for the model since several source categories contained signatures that could not be identified separately.

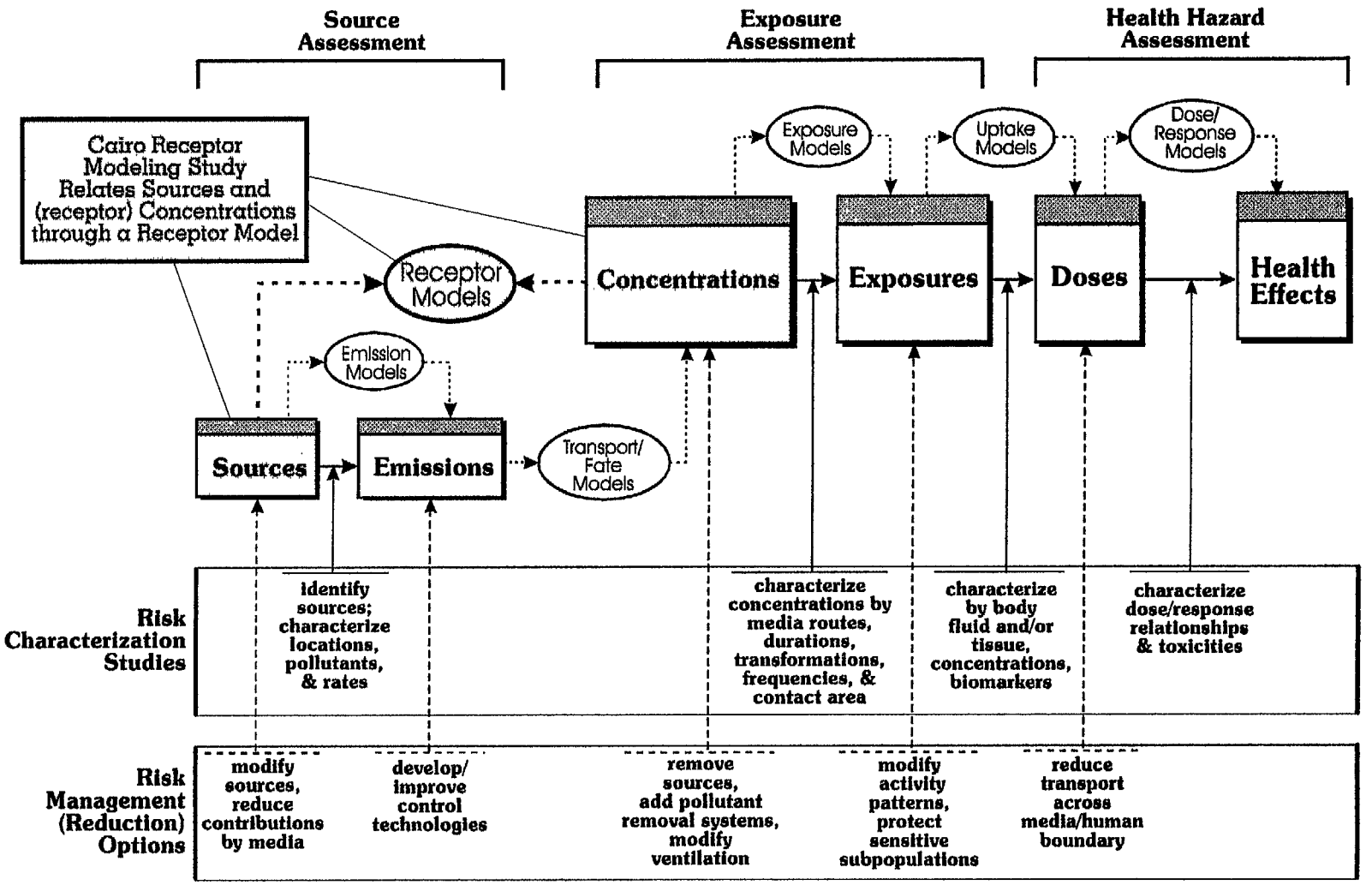


Figure 1-1. Elements of the Risk Characterization Paradigm Addressed by This Study

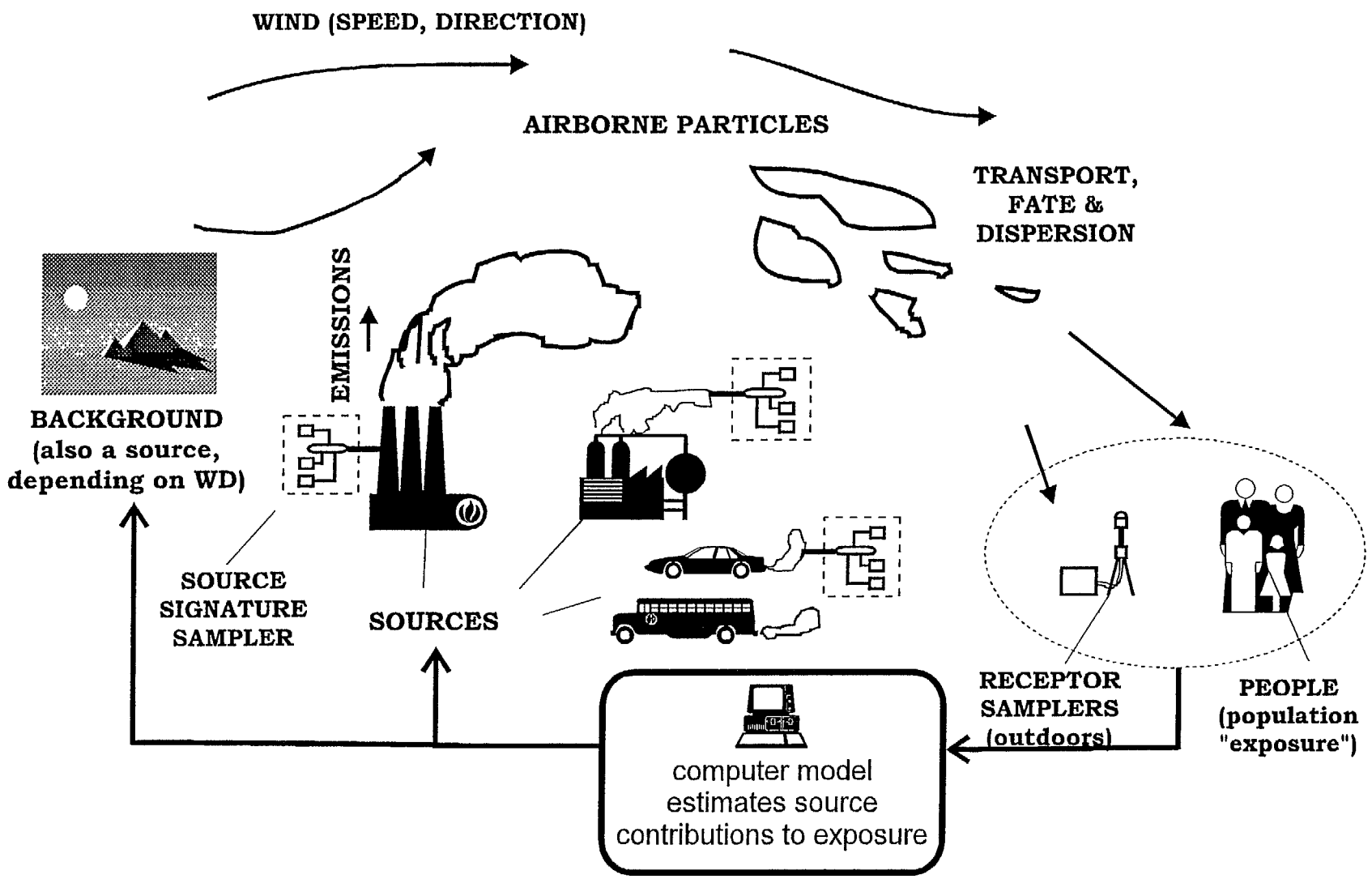


Figure 1-2. Receptor Modeling Study Conceptual Diagram

2 OBJECTIVES

The primary objectives of the Cairo Air Receptor Modeling Study were to:

- conduct a receptor modeling analysis study to characterize and attribute Cairo airborne particulate, including Coarse (2.5–10 μm), Fine (0–2.5 μm) and PM_{10} particle size fractions to selected natural and anthropogenic sources and
- improve the Egyptian capability (at the National Research Center and the Environmental Affairs Agency) to replicate the receptor monitoring and modeling activities in subsequent periods and at other locations.

3 APPROACH

3.1 Organization

A diagram of the study organizational structure is given in Figure 3-1. This diagram illustrates the integration of EHP, an Egyptian subcontractor, and the Egyptian National Research Centre. The EHP activities included direction of subcontractor technical support, direction of in-country activities in Egypt, and procurement of monitoring and analysis equipment. The set-up of the samplers, filter weighing lab, and a computer system was provided in-country by a U.S. subcontractor, along with training of the Egyptian sampler operating personnel. (Appendix E contains the names, organizational affiliations, and addresses of key personnel involved in this activity.)

The primary U.S. subcontractor providing the work plan and supporting the field activities was the Research Triangle Institute (RTI) (located in Research Triangle Park, North Carolina). Additional administrative support for the receptor modeling study was provided by a local Egyptian subcontractor, Environmental Quality International (EQI). These services included shipping and receiving, logistical and training assistance, and equipment and personnel transportation. Receptor and signature sample collections were performed by staff from the NRC and the Tebeen Institute for Metallurgical Studies. EHP consultants procured the sampling hardware; an analytical balance to weigh filters on-site; they also supplied Teflon, quartz, and glass fiber filters (pre- and post-weighed as necessary). They also arranged for the analytical subcontractors in the United States to evaluate the sample filters.

The application of the receptor computer model for the current report was conducted jointly by RTI and Desert Research Institute under subcontract to EHP. In-country training of Egyptians on receptor modeling fundamentals was conducted jointly by RTI and Radian Corporation (located in Houston, Texas) personnel. Analysis subcontracts were set up to analyze Teflon filter samples for metals by XRF at Desert Research Institute (DRI) in Reno, Nevada; sulfates and nitrates on Teflon filters by ion chromatography (IC) at RTI; and organic carbon (OC) and elemental carbon (EC) by thermal decomposition at Sunset Laboratories in Forest Grove, Oregon. The NRC laboratory provided filter weighing capabilities. An initial attempt to use high volume PM_{10} samplers (Graseby-Andersen Model 1200), in addition to PM_{10} dichotomous samplers. This was abandoned early in the study because (a) the Model 1200 sampler inlets could not deal with the exceptionally high particle concentrations found at some of the Cairo locations and (b) ambient sulfur dioxide was apparently converting to sulfate on the filter during collection.

As part of the total plan to transfer receptor modeling activities to Egyptian scientists, EHP procured (April 1996) an atomic absorption spectrometer to analyze filters for metals and an ion chromatography to analyze filters for sulfates and nitrates for delivery directly to National Research Centre in Cairo. The Egyptians are now able to conduct all phases of receptor modeling except elemental and organic carbon analysis. The latter analyses must be obtained at a U.S. laboratory until the technology is translated

into commercially available equipment and operating procedures.

3.2 Work Plan

A technical work plan was prepared at the beginning of the study and is found in Volume II, Appendix B. This plan describes the proposed aspects of the study as of December 2, 1994, and was reviewed by USAID prior to initiation of the field work. The receptor sampling was broken into a preliminary period when a limited subset of samples were collected at a City Centre site through February 1995, and a more extended period at a variety of sites through the summer of 1995. Reporting data for Period 1 were directed toward a preliminary apportionment prepared for USAID/Cairo in May 1995. Dust samples were collected from roadway surfaces (paved and unpaved), deserts, and agricultural locations, and analyzed and reported as source signatures. A reassessment of the most significant Cairo particle sources suggested that the most appropriate signatures were from cement production, ferro-alloy production, secondary lead smelters, petrol-fueled automobiles, Solaar oil combustion, heavy duty diesel buses, heavy oil combustion, lime kilns, and vegetative/trash open burning.

3.2.1 Sampling Locations

Initial receptor sampling for Period 1 was conducted at the City Centre site the NRC to characterize central Cairo. Nasralla et al. (1992) provided additional background information on this site and other air sampling locations in Cairo, as well as historical TSP concentration data. The location of the City Centre site in the metropolitan area is shown on the map in Figure 3-2. The other sampling locations are also noted. The NRC and EHP jointly selected all sampling locations.

The City Centre main site, located on the roof of a three-story office building in the central business district, is reasonably unobstructed for PM_{10} sampling and high enough to minimize undue influence from "ground cloud" street dust. The City Centre site is approximately 5 km south-southwest of the industrial complex in Shoubra El-Kheima, and 15 km north-northwest of the industrial complex in Helwan. The major east-west thoroughfare across Cairo—the 6th October Highway—is located approximately one block north of the City Centre site. Although a large building separates the heavily traveled 6th October Highway from the site, a significant automotive contribution to this receptor location was expected.

A residential receptor sampling was established in Maadi on the roof of a three-story private residence. Although the majority of the streets in this area are paved, the road in front of this residence was unpaved. The population density of Maadi is much lower than City Centre but closer to the Helwan industrial area. The wind seldom came from the south during any sampling period conducted in 1995; most periods indicated a northerly flow (from the direction of the City Centre).

Industrial sampling sites were located in Shoubra El-Kheima and Helwan to determine the mass and analyte concentration levels within close proximity (a few kilometers) of the local sources. The Helwan site was the roof of the three-story Tebeen Metallurgical Institute laboratory. The Shoubra El-Kheima site was the roof of a small two-story municipal office building on the southern edge of the industrial district. Private dwellings are also found proximal to these sites.

Background sampling was conducted on the third floor roof of the Thebes School, a site approximately 20 km east-northeast of the Cairo City Centre area. This site is approximately 150 meters from the nearest road and was immediately adjacent to the northeastern desert. Other than the desert, there were few visible sources within several kilometers, although the generator that provided power to the school may have

provided some additional signature components from (oil) combustion emissions.

3.2.2 Receptor Sample Collection

The primary receptor site air sampling consisted of duplicate collocated PM_{10} dichotomous samplers (see Figure 3-3) purchased from Graseby-Andersen (Atlanta, Georgia) and operated at selected sites in Cairo by NRC personnel. Two PM_{10} high-volume samplers and a TSP high-volume sampler (provided by NRC) were also collocated initially with the dichotomous samplers. It was apparent early in the ambient sampling schedule that the PM_{10} high-volume samplers could not cope with the very high concentrations of coarse particles found in the Cairo ambient air. Overloading of the particle separator (see graph in Volume II, Appendix C, relating PM_{10} concentrations collected by the dichotomous sampler and the high-volume sampler methods) for these samplers resulted in their use being terminated after several months. On average, the PM_{10} high-volumes were 15 $\mu g/m^3$ higher than the dichotomous samplers, due to inaccurate particle sampling. The high-volume PM_{10} sampling method was initially considered important in this study to simulate the filter substrate previously used at NRC. Because of the inherent sampling errors of the PM_{10} high-volume sampler, it was concluded that the dichotomous sampler was more appropriate for routine sampling, and use of the PM_{10} high-volumes was discontinued.

After initial set-up at an urban, City Centre location, several days of training (see Figure 3-4) were conducted at the field site to transfer technology from RTI to NRC personnel. Training on filter weighing in the laboratory was also conducted. The dichotomous samplers collect particles at a flowrate of 1 m^3/hr from the air onto filters in two size ranges: a 0–2.5 μm Fine fraction and a 2.5–10 μm Coarse fraction. Diagrams and sources for the Graseby-Andersen receptor samplers and University Research Glassware (URG) source signature samplers used in this study are provided in Appendix C. Teflon filter pre- and post-weighings, to determine mass concentrations, were conducted at the NRC laboratory using a 5-place Mettler analytical balance. One of the dichotomous samplers was operated with 37 mm Teflon filters (both size fractions), with the filters analyzed for mass, water soluble sulfates and nitrates by IC and metals by XRF. The other dichotomous sampler used 37 mm prefired quartz filters (both size fractions) for sample collection, which were analyzed for OC and EC. The quartz filters were not pre- or post-weighed. Filters and shipping cassettes were provided for transport to the laboratories in the United States for subsequent chemical analysis.

Additional air sampling to provide comparability with historical measurements consisted of including the existing TSP hi-vol. The TSP sampler used 8 inch by 10 inch glass fiber filters for mass concentration and operated at 1.4 m^3/minute. Samples were collected for 12-hour periods (6 a.m. to 6 p.m.) on an (approximate) every other day operating schedule, with sampler operation controlled by a clock timer and then switched at 24-hour period.

The start and end dates for each receptor site sampling period are given in Table 3-1. Also given are the number of sample sets NRC operators collected at each site. A total of 61 sets were collected, with all periods analyzed for particle mass concentration by sampling size fraction. Detailed sampling information for each receptor sample set are given in Volume II, Appendix D, individually for the dichotomous samplers and the high-volume samplers. The initial sampling period at the City Centre site during February 1996 was used for operator training, followed by duplicate sampling to establish precision. A set of 15 additional sampling days was conducted during late February and early March at the City Centre site. The samplers were then moved to the background location during

Table 3-1. Cairo Receptor Modeling Study Mass Concentration Sampling

Sample Period #	Sampling Date: Start End	Receptor Sampling Site	Days	Mean Mass Concentrations in ug/m3					Comments
				Dichotomous Sampler			Hi Vol		
				Fine	Coarse	PM10	PM10	TSP	
1	27-Jan-95 8-Feb-95	City Centre	5	81.4	83.7	165.1	164.8	na	Training
2	15-Feb-95 23-Mar-95	City Centre	15	72.4	118.9	191.3	201.4	674.9	
3	27-Mar-95 30-Mar-95	Background (Thebes School)	4	24.9	65.7	90.6	121.1	293.0	
4	12-Apr-95 7-May-95	Maadi	13	32.6	93.6	126.2	133.2	360.5	
5	31-May-95 6-Jun-95	Helwan (Tebeen Institute)	5	51.1	163.9	215.0	230.4	596.4	
6	1-Aug-95 7-Aug-95	Shoubra El-Kheima	6	59.8	129.7	189.5	na	na	
7	19-Aug-95 30-Aug-95	City Centre	6	54.4	68.1	122.4	na	na	
8	6-Sep-95 26-Sep-95	Background (Thebes School)	7	27.9	45.8	73.7	na	na	

Total Sampling Days 61

March for four days, before being located in Maadi to collect 13 sampling sets in April and May. One week of sampling was conducted in Helwan and then in Shoubra El-Kheima during June and August, respectively. The samplers were then moved back to the City Centre for one week, followed by a week of sampling at the background site.

A total of 183 Teflon filters from dichotomous samplers, 42 PM_{10} hi-vol glass fiber filters, and 37 TSP hi-vol glass fiber filters were collected, providing 262 receptor site mass concentration determinations. The individual mass concentrations by size fraction for each day are given in Appendix D. The Teflon filters were paired with 183 quartz filters from which carbon analyses were possible. From the 61 sampling days with complete sets of filters characterized for mass concentrations, 21 were selected for chemical analysis for metals and carbon content. Analytical procedures are summarized in Table 3-2.

3.2.3 Source Signature Sample Collection

NRC selected 15 Cairo source categories as potentially the most significant contributors to the particulate air pollution problem. The samples were of two types: bulk dusts collected as sweepings and air samples collected by a special sampling system from a source emission stream. A summary of the signature sample categories is shown in Table 3-3, along with the location of the sources in the metropolitan area. The surface dust samples represented were paved roadways, unpaved roadways, desert, and agricultural soil. A total of four different[1] 50–100 gram desert samples were composited into one desert sample. Nine different[2] paved roadway (sweepings) samples were composited into one Cairo paved road sample. Two different[3] unpaved road samples were composited into one Cairo unpaved road sample. A single agricultural sample was collected from a farm field, approximately 20 km north of the city. After sizing with a 38 micron sieve to remove extraneous material, each composite sample was re-dispersed into the air in a closed chamber, and 0–2.5 μm and 2.5–10 μm samples were collected on Teflon and quartz filters. These samples were sent to the labs for analysis for metals and carbon in the same manner as the receptor samples.

The source signature air sampling system was obtained from University Research Glassware (URG) in Carrboro, North Carolina, and was used to collect air samples from 12 additional sources. Figure 3-5 shows the sampling system set up in the Attaba Square bus station to collect samples heavily influenced by diesel buses over a four-hour period. The source categories selected for sampling with the URG system were petrol-fueled automobiles, cement product (by-pass stack), cement production (wet kiln), heavy duty diesel (buses), heavy Mazut oil combustion, iron and steel manufacturing (sintering), iron and steel manufacturing (converter), iron and steel manufacturing (arc furnace), secondary lead (Pb) smelting, light Solaar oil combustion, lime kilns, and vegetative/trash burning. These sources each provide an exhaust stream (either contained in a flue or fugitive) that can be sampled by inlet probe of the signature sampling system for deposition onto particle size-specific Teflon and quartz filters. The URG system (see figure in Appendix C) has a PM_{10} cyclone inlet that provides a size-selective sample to a distribution manifold. A dilution air stream is

[1] NE desert near background site, desert east of Nasr City, western desert near Giza, desert beyond Mokhatum Hills, and the desert beyond Abu Roadi Hills.

[2] Dokki Square, Attaba Square, City Centre Ramses St., Abdul St., Embaba, Raba St. (Nasr City), El Fostat, Shoubra St., and Heliopolis.

[3] Manshiat (Nasr City) and Faisal (near Giza).

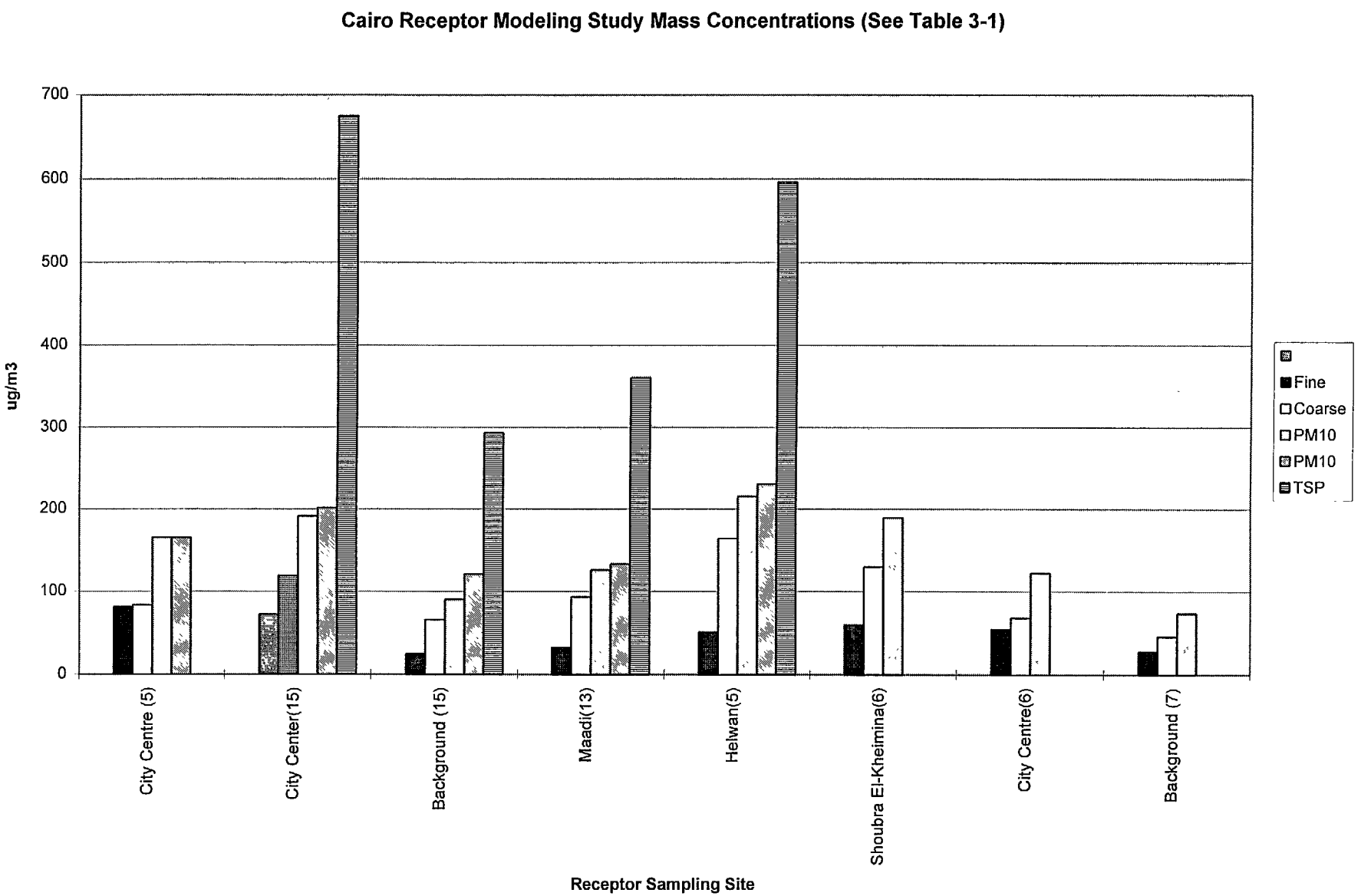

Cairo Receptor Modeling Study Mass Concentrations (See Table 3-1)
ug/m3
700
600
500
400
300
200
100
0
City Centre (5)
City Center(15)
Background (15)
Maadi(13)
Helwan(5)
Shoubra El-Kheimina(6)
City Centre(6)
Background (7)
Receptor Sampling Site
Fine
Coarse
PM10
PM10
TSP

Table 3-2. Analytical Procedures for Receptor and Source Signature Samples

Measurement	Analytical Technique	Filter Substrate
size-specific mass	gravimetric electronic balance (5 place)	Teflon
elements/metals	X-Ray Fluorescence (XRF)	Teflon
total organic and total elemental carbon	Thermal Decomposition	Quartz
water-soluble total sulfates and total nitrates	Ion Chromatography (IC)	Teflon or Quartz

Table 3-3. Cairo Source Signature Samples Collected

	Source Category	Sample Type	Collection Location
1	Agricultural Soil Dust	bulk dust	Farm field N of Cairo
2	Automobiles - Petrol	air sample	Confined space sampling
3	Cement Production - Bypass Stack	air sample	Helwan cement plant
4	Cement Production - Wet Kiln	air sample	Helwan cement plant
5	Desert Dust	bulk dust	Multiple desert composite
6	Heavy Duty Diesel (Bus)	air sample	City Centre bus station
7	Heavy Oil (Mazut) Combustion	air sample	Shoubra El-Kheima glass plant boiler
8	Iron and Steel (Sintering)	air sample	Helwan iron and steel plant
9	Iron and Steel (Converter)	air sample	Helwan iron and steel plant
10	Lead (Pb) Smelter	air sample	Helwan secondary lead (Pb) smelter
11	Light Oil (Solaar) Combustion	air sample	City Centre bakery
12	Lime Kiln	air sample	Shoubra El-Kheima lime plant
13	Paved Roadway Dust	bulk dust	Multiple roadway composite
14	Unpaved Roadway Dust	bulk dust	Multiple roadway composite
15	Vegetative/Trash Burning	air sample	Controlled burn at the NRC

Note: Iron and steel - arc furnace samples were also collected, but were determined to be too heavily loaded (plus particle mass lost in transit) for chemical analyses.

provided at the manifold inlet to reduce the water vapor concentration below the condensation limit for combustion sources. Two sample streams were withdrawn from the manifold, restricted to particle sizes less than $PM_{2.5}$ by cyclones, and then passed into filter holders to deposit the suspended solids into either a Teflon or quartz filter. Although there is a PM_{10} and a $PM_{2.5}$ Teflon filter for metals analysis, there is currently only a $PM_{2.5}$ quartz filter channel. For most sources, the carbon (organic or elemental) is below 2.5 μm and the PM_{10} channel provides no additional information. Some of the uncontrolled sources encountered in Cairo, however, may have produced some carbonaceous particles larger than 2.5 μm that were not sampled. This added a small (but unquantified) error to some of the signatures, especially for the vegetative/trash burning. As noted in Table 3-3, the samples collected for the iron and steel - arc furnace were determined to be overloaded and unsuitable for subsequent chemical analyses.

One of the most challenging tasks NRC staff faced was gaining access to the sources to collect the samples. Authorities were often reluctant to allow the sources to be sampled. Sampling from diesel buses in a realistic setting proved difficult because of safety concerns for the passengers and security concerns for the fragile sampling hardware. In some cases, several weeks were required to secure the approvals necessary to gain access to the source.

For each source, three consecutive sample sets were collected to provide at least one acceptable representative set of samples. The following were the most frequent sampling problems encountered:

- Conducting sampling when the source was not in stable operation
- Collecting filters that were too heavily loaded for the XRF metals analysis
- Being required to sample at a point in the process that provided mixed signatures

The latter requirement proved difficult to overcome for several of the sources sampled. It was often difficult to sample a process (such as lead smelter emissions) without including the Mazut oil burner emissions as well. To account for the substantial bus-to-bus differences in emissions from Cairo buses, the bus samples were collected in an indoor bus station over an extended period. The pavement dust re-entrained by the moving buses from the floor of the bus station combined with the in-leakage of outside automobile exhaust to provide a mixed heavy duty diesel signature. The diesel bus signature used in the modeling was subsequently corrected for these background signatures prior to adding it to the source library.

The petrol-fueled automobile was collected by sampling near the tailpipes of several automobiles with the engines operating in an enclosed garage. The cement production samples were collected at the largest of the Helwan cement plants, in both the main drying kiln flue and the bypass flue. The heavy Mazut oil combustion sample was collected from the boiler flue of a glass plant in Shoubra El-Kheima. The iron and steel manufacturing samples were collected from the main steel mill in Helwan and represented three different processes: sintering, converter, and arc furnace. The secondary lead smelter samples were collected from one of the batch kilns at the largest smelter in Helwan. A lime production batch kiln flue was sampled in Shoubra El-Kheima. The vegetative/trash burning signature was collected during a controlled open burn of randomly collected trash and vegetation, with the sampling system located downwind and immediately adjacent.

Although the signature sampling system was quite complex to operate, NRC staff (with assistance from personnel at the Tebeen Metallurgical Institute in Helwan) became proficient in its set-up and operation by the end of this project. More importantly, an understanding was ultimately developed for the sampling strategies required to collect

representative and unambiguous samples that maximize the potential for successful receptor model application.

3.2.4 Meteorological Data

Meteorology is an important consideration for a receptor monitoring study. If the wind direction is unfavorable and a minimum wind speed does not exist, transport from the sources to the receptors is unlikely. The weaker the physical link between sources and receptors, the weaker the predictive power of the model. For some emissions, such as sulfur compounds, the atmospheric reaction products formed from gases during transport (SO_2 –> SO_4) must also be considered. Since the major industrial sources tend to be either north or south of the Cairo City Centre site, the most favorable wind directional arc sectors (±_30 degrees) to link these sources to this site are from the north at 345–045 or from the south at 165–225. Figure 3-2 illustrates these relationships on a macro scale. On a micro scale, influences such as the emissions from automobiles on the adjacent Ramses Street (south side) and 6th October Highway (north side) must also be considered.

Historical data revealing the probability of favorable meteorology can be used to determine when to sample at a specific location. A 10-year summary of wind direction and wind speed data for Cairo is given in Appendix D. These historical data suggest that from April through October, winds come most frequently from the north. During the sampling periods for the current study, winds from the south occurred less than 5% of the time. Favorable wind speeds for transport (between 5 and 20 km/hr) occurred with equal probability during all months. The majority of low wind speed periods (and almost all calms) occur at night from 12 midnight to 6 a.m. The most favorable sampling period for collecting receptor samples was from 6 a.m.–6 p.m. This time period, however, was often inconvenient for loading and unloading samplers by the technicians. After the initial City Centre and background site 12-hour sampling periods, the sampling interval was changed to an interval from 12 a.m.–12 p.m.

Wind direction data collected during the sampling periods were used, if available, to determine which receptor samples to send to the laboratories for chemical analysis. To minimize the cost of purchasing of equipment, meteorological monitors were not operated as part of this study, but the data were obtained from Egyptian government meteorologists. This posed some problems, however, in that the summarized meteorology data were often not available for weeks after the collection of the receptor samples. To expedite the reporting process, most collected receptor samples were selected blind and sent on for chemical analyses without knowing whether the meteorology was favorable. This reduced considerably the utility of some analyzed samples and missed several samples that should possibly have been analyzed.

3.2.5 Sample Analyses

The application of receptor modeling to particles requires that air samples be obtained by specific particle size fraction and collected on specific filter types for specific analyses. The collected particle samples are then analyzed for mass concentration in $\mu g/m^3$ by dividing the mass collected by the quantity of air sampled. These samples are then analyzed for selected elements[4], OC and EC, and if feasible, water soluble sulfates and nitrates in $\mu g/m^3$. Dividing each chemical species by the mass concentration in $\mu g/m^3$ provides the fractional contribution to the total mass. For the source samples, the identical suite of analyses provide reasonably unique fingerprint signatures. For

[4] Metals reported for this report include Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Sc, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cd, In, Sn, Ba, La, Au, Hg, Ti, Pb, and U (38 elements in atomic number order).

the receptor samples, the chemical signatures represent the composite contributions from many sources.

Table 3-2 described the analytical procedures employed for this report. Figure 3-1 identifies the laboratories providing these analyses and the lead analysts. The Teflon filters were analyzed for metals by XRF prior to analysis by IC for sulfates and nitrates. However due to time and resource constraints, it was not possible to analyze all of the samples by IC. This was accommodated for sulfates by assuming that the sulfur concentration (determined by XRF) could be multiplied by 3 to estimate the sulfate component. Nasralla et al. (1992) reported that this approximate rule-of-thumb is reasonably accurate for Cairo. There was no similar means of estimating nitrates.

Receptor Samples

From the 61 receptor sample sets collected, 21 were selected for chemical analysis. These samples are described in Table 3-4. The primary criteria for selection were that all filters in a daily set (Fine and Coarse Teflon, Fine and Coarse quartz) were valid, a consistent wind direction existed (more than 80% of the time within ± 30 degrees), and an average wind speed exceeding 5 km/hr existed for the period. The latter criterion was met for all sampling days. During the 61 days of sampling in Cairo, most days experienced winds from the north. This suggested that, for the collected samples, the point sources in the Helwan area south of Cairo had minimal influence on any of the sites (except Helwan), while the sources in Shoubra El-Kheima had a significant influence on the City Centre and perhaps Maadi.

Source Signature Samples

At least one sample set from each of the 15 source categories given in Table 3-3 was analyzed for metals and carbon content. Single sample composites for desert dust, paved roadway dust, unpaved roadway dust, and agricultural soil were analyzed. Two sample sets were analyzed from the secondary lead smelter and the heavy duty diesels (buses) to provide an indication of between-sample variability. The duplicate sets were composited into individual signature files for the model application.

3.2.6 Model Application

The receptor model used for this study is the CMB 7 developed for EPA and described in detail by Watson et al. (1990). The model is not a statistical model but constructs a series of linear equations relating the concentration of each chemical species at the receptor location with the expected fractional contributions from each source category. The equations are solved by a computer algorithm simultaneously to minimize the effective variance. The model output provides a fractional contribution of each source category to the collected receptor sample (or composite of samples). The model also computes the fraction of the receptor sample that cannot be identified and attributes the unknown to a possible source type. Excessive uncertainty in the input data can also produce an over-prediction (> 100%) of the receptor sample, especially when one analyte is substantially out of balance with the expected signatures. The most accurate apportionments are obtained by the following methods:

- Applying a greater number of chemical species in the analytical scheme
- Selecting the most favorable meteorological conditions to move the particles from the sources to the receptor site
- Using specific particle size fractions in which certain analytes are predominant
- Controlling the receptor and source measurement precision and representativeness.

Table 3-4. Cairo Receptor Sample Sets Selected for Chemical Analyses

Sample Set	1995 Sampling Date	Site	Sampling Duration, hrs	Wind Direction	Start Hour
1	15-Feb	City Centre	12	N	0600
2	17-Feb	City Centre	12	N	0600
3	19-Feb	City Centre	12	N	0600
4	21-Feb	City Centre	12	N	0600
5	23-Feb	City Centre	12	N	0600
6	26-Feb	City Centre	12	N	0600
7	12-Mar	City Centre	12	N	0600
8	14-Mar	City Centre	12	S	0600
9	16-Mar	City Centre	12	W	0600
10	27-Mar	Background	16	N	0600
11	28-Mar	Background	18	N	0600
12	29-Mar	Background	20	S	0600
13	13-Apr	Maadi	24	N	0000
14	22-Apr	Maadi	24	N	0000
15	29-Apr	Maadi	24	N	0000
16	31-May	Helwan	24	N	0000
17	3-Jun	Helwan	24	N	0000
18	4-Jun	Helwan	24	N	0000
19	6-Jun	Helwan	24	N	0000
20	1-Aug	Shoubra El-Kheima	24	N	0000
21	5-Aug	Shoubra El-Kheima	24	N	0000

The use of XRF provides analyte concentrations for up to 44 metals, although many are typically below the detection limits. Since carbon species are often the most prevalent single attribute, elemental carbon and organic carbon concentrations must be determined for each sample. Sample days are characterized by the predominant wind direction for each receptor site and composited by direction to improve the modeling precision and representativeness and minimize analytical costs. The application of Fine and Coarse size fractions readily separates two important atmospheric particle modes (see Appendix A). Measurement precision can be readily determined, but the representativeness of the source signature data to the entire geographic area is often difficult to determine.

Selected aspects of the computer modeling for this report were conducted in parallel efforts on personal computers at both RTI and DRI. A team approach helped reach a consensus on how to address such problems as mixed source signatures and excessive analytical uncertainties due to filter overloading. DRI used the existing CMB 7 model (Watson et al., 1990), while RTI used a modified version that provides more flexibility in apportioning individual analytes such as lead (Pb). The RTI version uses the same mathematical solution algorithms as does the CMB 7 model so that computational results will be identical with the same input data. The model solutions require minimal computer memory but benefit from the faster processor speeds of 486 and Pentium-based machines. The NRC was also provided with a computer system with necessary model software to analyze the receptor and source data with the model.

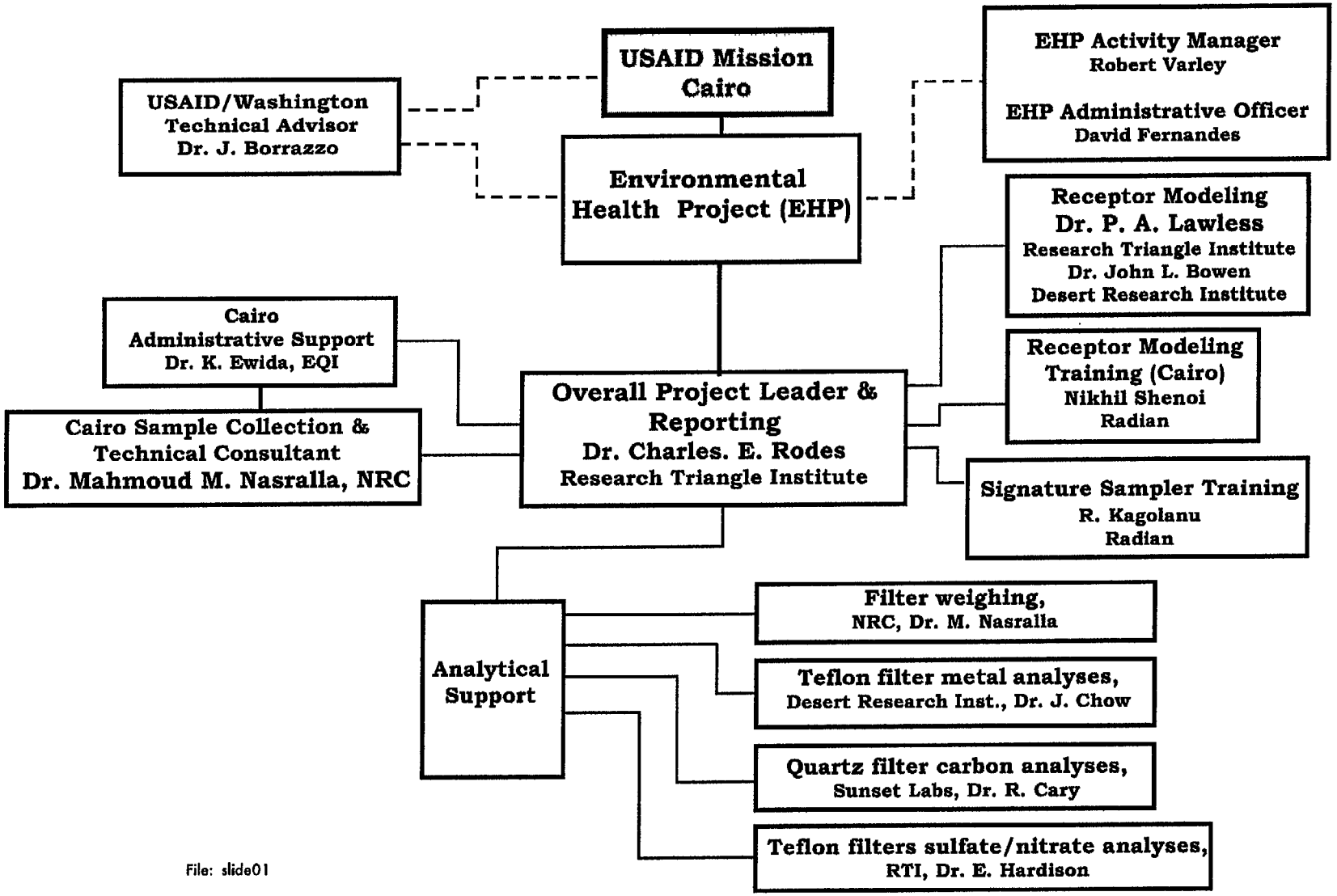


Figure 3-1. Cairo Receptor Modeling Study Organization and Responsibilities

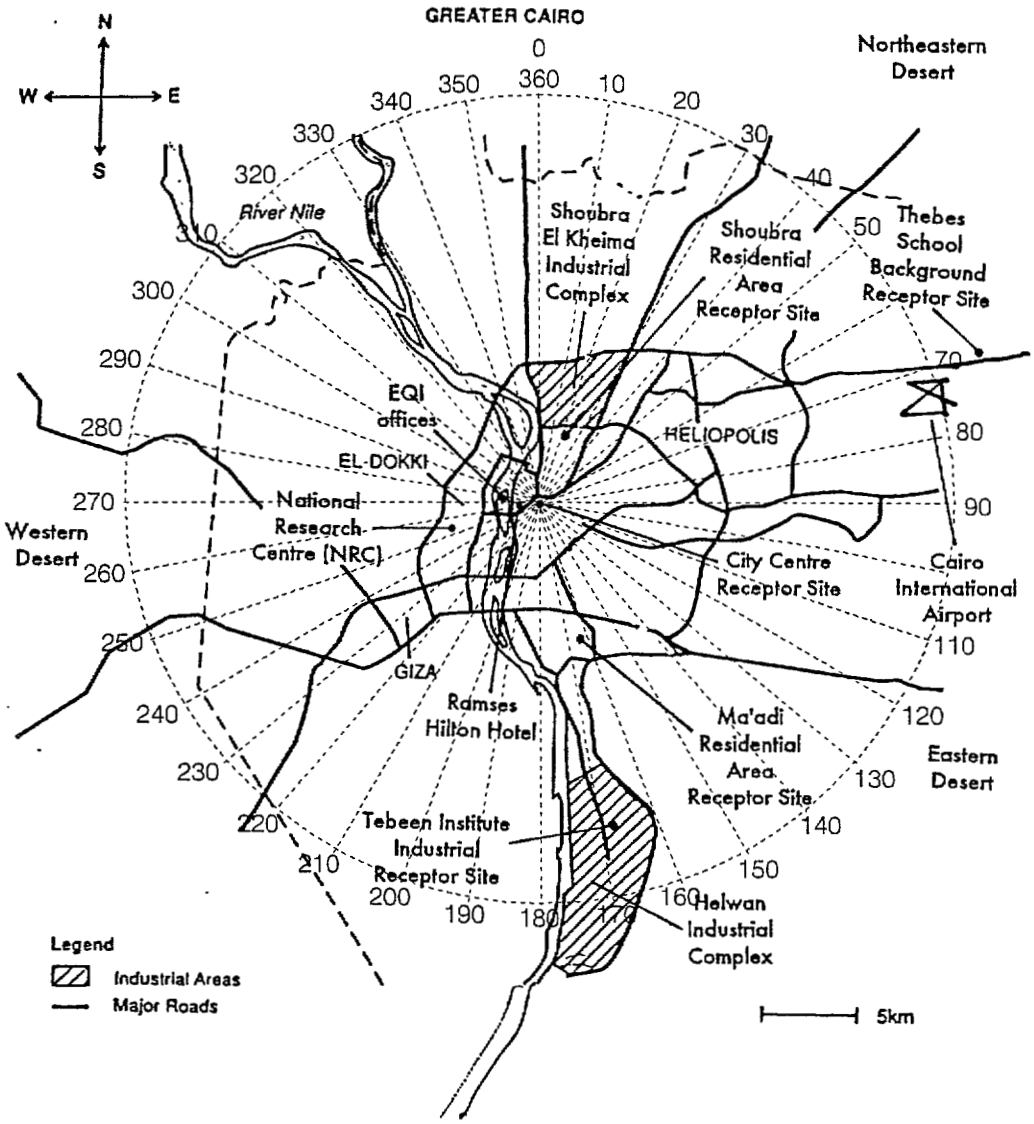


Figure 3-2. Metropolitan Area Map of Cairo, Egypt Showing Study Landmarks - Compass Overlay on City Centre Receptor Site

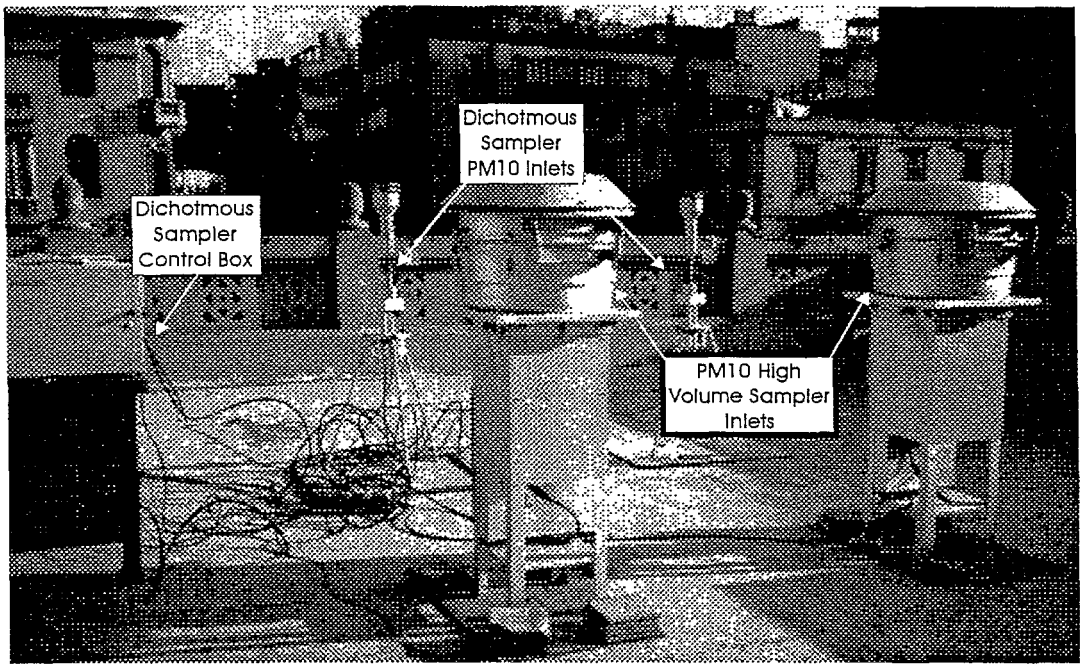


Figure 3-3. Receptor Samplers at Cairo City Centre Roof Location on Ramses Street

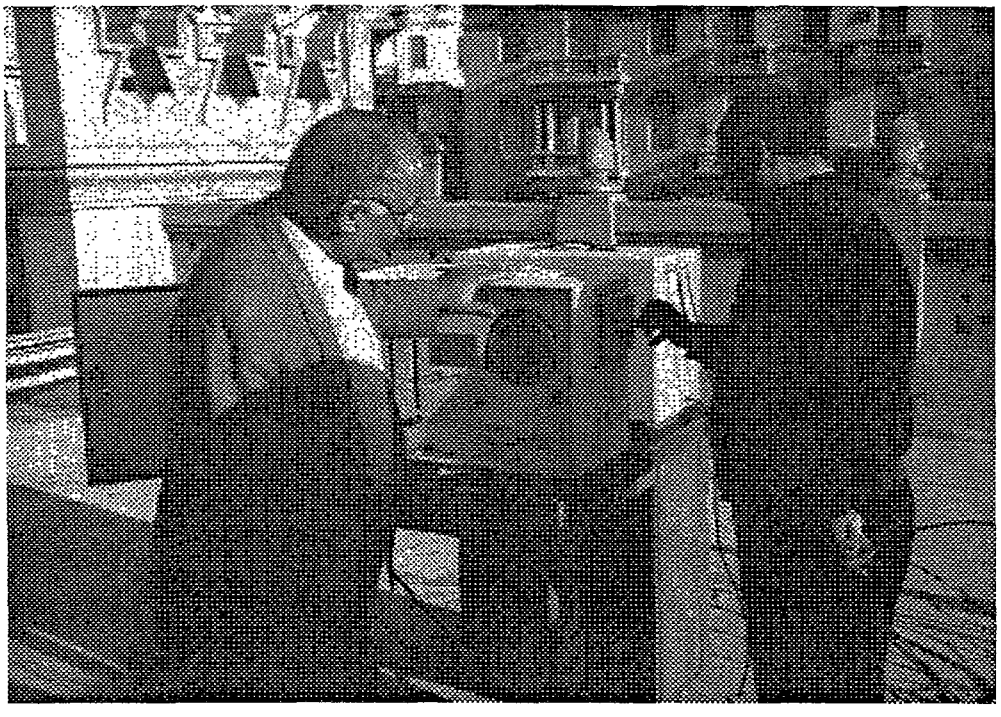


Figure 3-4. Dichotomous Sampler Adjustment During Operator Training at the Cairo City Centre Site

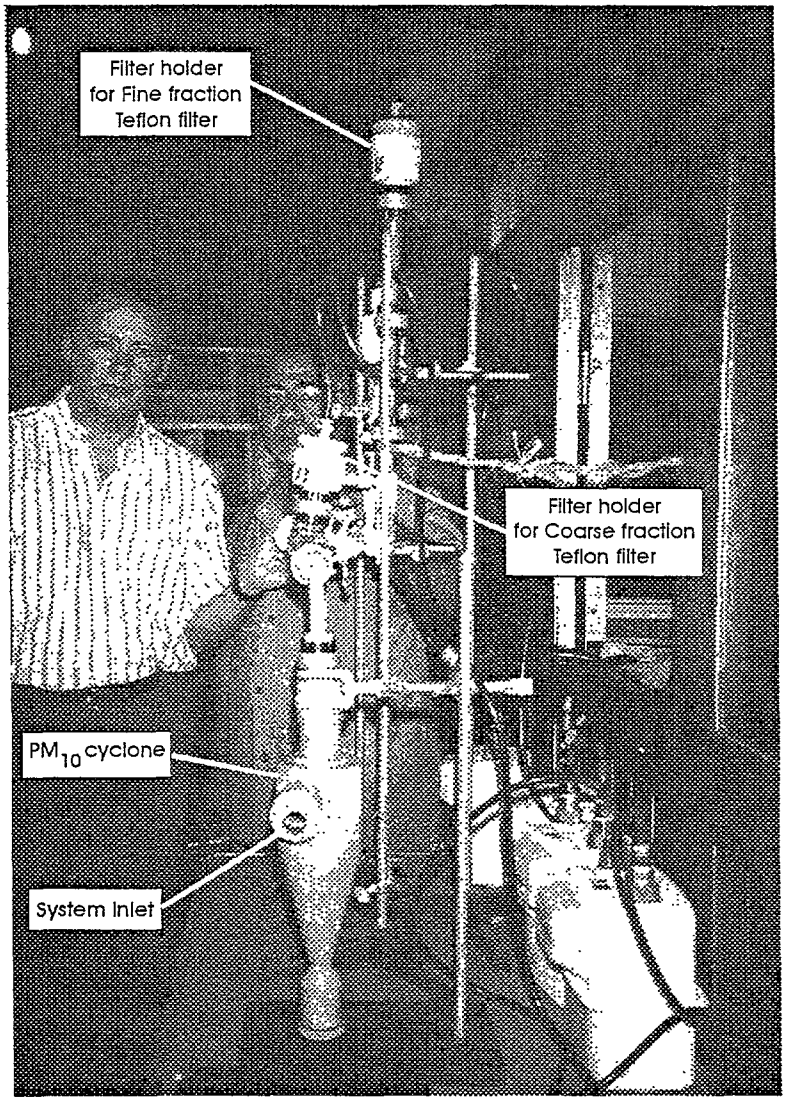


Figure 3-5. Source Signature Sampler Operating in a Cairo Bus Station to Obtain Heavy Duty Diesel Samples

4 RESULTS

4.1 Receptor Sample Data

4.1.1 Mass Concentrations

The mass concentration data summary for the five Cairo sites characterized in this study are shown in Table 3-1, with a more detailed table giving ranges and standard deviations provided in Appendix D. These concentration data could be considered reasonably representative of the site types and calendar year 1995 for the Cairo metropolitan area. The TSP means ranged from 293–674 $\mu g/m^3$, typical of the data reported by Nasralla et al. (1992) for Cairo. The smaller (and more health-related) PM_{10} fraction means were measured as 74–91 $\mu g/m^3$ at the background site and 122–191 $\mu g/m^3$ at the more urban locations. This can be compared to the average PM_{10} concentration reported by Rodes and Evans (1985) for eight U.S. cities of only 34.8 $\mu g/m^3$. The Fine fraction (particles <2.5 μm) at the Cairo background site averaged 25–28 $\mu g/m^3$, while the urban sites ranged from a low of 33 $\mu g/m^3$ in Maadi to a high of 81 $\mu g/m^3$ at the City Centre. This particle size fraction is the most important since it typically contains the highest proportion of metals and carcinogens and is linked to non-specific health effects such as increased mortality. The U.S. average for the Fine fraction for eight cities was reported by Rodes and Evans (1985) to be 24.5 $\mu g/m^3$. The U.S. standards for PM_{10} particle concentrations are 50 $\mu g/m^3$ for an annual average or 150 $\mu g/m^3$ for a 24-hour period. There are currently no U.S. or World Health Organization (WHO) standards for the Fine and Coarse fractions, although EPA is proposing to establish a standard for the Fine fraction.

The proportions of particulate mass concentration as a function of frequency of occurrence are shown in Figure 4-1 for the City Centre and Maadi sites. The data show that the median concentrations at the City Centre were approximately 155 $\mu g/m^3$ for 12-hour periods, while the median at Maadi was 95 $\mu g/m^3$ for 24-hour periods. The 90th percentile data show that 10% of the time the City Centre concentrations exceeded 250 $\mu g/m^3$ and the Maadi concentrations exceeded 160 $\mu g/m^3$.

Plotting the mass concentration data from the Maadi site against the mean wind speeds (see Figure 4-2) suggested that substantial re-entrainment of surface dusts occurred when the mean wind speeds exceeded an approximate threshold range of 35–40 km/hr. These high wind events elevate the Fine and Coarse fractions for several days. Mean wind speeds exceeding 35 km/hr occur infrequently in Cairo, and typically only in the spring. In general, the wind speeds exceed means of 25 km/hr only 1% of the time; however, re-entrained dust may remain suspended from each event for several days. The data for the Maadi-study were collected in late spring (April/May), increasing the probability of these higher wind speeds.

Vehicle traffic on unpaved roadways can also create the turbulent energy levels required to re-entrain surface dust into the air. A significant finding was that the paved roadway dust in Cairo is composed of a mixture of desert and unpaved roadway dusts.

4.1.2 Receptor Analyte Concentrations

The concentrations of analytes collected on the 21 sets of selected dichotomous sampler filters were determined by Fine, Coarse, and PM_{10} sampling fractions. These data were then grouped by the predominant wind direction (north) and ranked by analyte prevalence as shown in Table 4-1. The single south wind day at the City Centre site (on March 14, 1996) was also a high wind day, with mean wind speeds exceeding 30 km/hr. These elevated winds substantially increased the contributions of soil analytes to the samples. Note that the analyte fingerprints for all of the sites are relatively similar when the most significant (bold analytes exceeding 1%) are compared. The Maadi residential site does not appear substantially different from the Helwan location when compared qualitatively. The most extensive list of statistically significant analyte identifications came from the Shoubra El-Kheima site showed the complexity of the emissions from the nearby industries.

The presence of marker analytes are characteristic features of certain sources and transformation processes. They include

- the characteristic ratio of Pb to Br, resulting from leaded gasoline formulation;
- the presence of K from vegetation and wood combustion;
- the presence of V and S from certain types of oil combustion
- the presence of crustal (soil) element [Si, Ca, Fe, Al] primarily in Coarse particles and combustion products [S, OC, EC] primarily in Fine particles; and
- the elevation of sulfate (SO_4) concentrations resulting from atmospheric transformation of sulfur dioxide (SO_2) produced from fossil fuel combustion.

The mean analyte concentrations by receptor site are given in Table 4-2 and indicate that some of the species concentrations are quite different between sites. As an example, elemental (soot) carbon, which is an emission product of poorly tuned diesel trucks and buses (among other sources), was 29 $\mu g/m^3$ at Shoubra El-Kheima, 13 $\mu g/m^3$ at the City Centre site, 6 $\mu g/m^3$ at Helwan, and only 0.9 $\mu g/m^3$ at Maadi. The Maadi level is essentially the same as that at the background site. Note that these data reflect only the limited number of sampling days given in Table 3-1. Elemental carbon is a significant absorber of visible light and plays an important role in visibility degradation. Silicon levels, often associated with the desert sand, are lowest at the background site because of the minimal processes (wind speed gusts) to re-entrain the particles into the air. Only the City Centre site samples were analyzed for sulfates, but the elevated levels on several days indicated particularly polluted days. Only a small amount of the S in the air was noted in any form other than sulfates (S is one-third the molecular weight of SO_4). The mean 12-hour concentration of Pb at the City Centre site for this study was 2.5 $\mu g/m^3$, which is very similar to the 3 $\mu g/m^3$ annual mean reported for Cairo by Ali et al. (1986) for 24-hour samples.

To examine the daily variations in analyte concentrations (relative to each other) at the City Centre site, the graphs shown in Figures 4-3 and 4-4 were drawn. Figure 4-3 shows the relative changes in selected Fine fraction analyte concentration, plus the changes in the ratio of Pb/Br. Figure 4-4 provides the same analytes and days for the Coarse particle fraction. Since leaded gasoline combustion produces a relatively constant ratio of approximately 2.6 (assuming freshly generated particles), excursions above this level indicate sources of Pb other than automobiles. Although Pb degrades slowly in the air or soil, Br appears to be readily degraded within 1-2 weeks from environmental (sunlight) exposure. Re-suspended Pb from surface dusts may have originated from either petrol-fueled automobiles or Pb smelters (which produce no measurable Br). The Cairo Pb/Br Fine fraction

Table 4-1. Cairo Receptor Site PM_{10} Signature Analytes by Wind Direction

Site	Wind Direction	Signature Analytes	No. of Days Sampled
City Centre	N	**OC, EC, Cl, Ca, Si, S, Fe, Pb, Al, K,** Zn, Br, Ti, Cu, Mn, Ba, Sr, Ni	7
City Centre	S	**Ca, OC, Si, EC, Cl, Fe, Al, S, K, Pb**, Zn, Ti, Br, Sr, Mn, Ba, Cu, Sb, Sn, V, Cr, Ni, Zr, Rb	1
City Centre	W	**OC, CA, Si, EC, Cl, Fe, S, Al, K**, Pb, Br, Zn, Ti, Ba, Sr, Mn, Cu, Cr, Ni, Zr	1
Maadi	N	**Ca, OC, Si, Fe, Al, S, Cl, K,** EC, Ti, Zn, Pb, Sr, Mn, Ba, Br, Cu, V, Cr, Ni, Rb	3
Helwan	N	**OC, Ca, Si, EC, Cl, Fe, Al, S, K,** Zn, Pb, Ti, Sr, Mn, Cu, Ba, Br, V, Cr, Sn, Zr, Ni, Rb	4
Shoubra El-Kheima	N	**OC, EC, Si, Ca, Fe, Cl, Al, S, K, Zn**, Pb, Ti, Mn, Ba, Sn, Sr, Br, Cu, V, P, Sb, Ni, Cr, Zr, Rb, Hg, U, Mo	2
Background	N	**OC, Si, Ca, S, EC**, Al, Fe, Cl, Pb, K, Ba, Ti, Zn, Cu, Mn, Sr, Br, Zr, Ni	2
Background	S	**Ca, Si, Cl, OC, Fe, Al, K, S,** EC, Ti, Pb, Ti, Pb, Zn, Mn, Sr, Ba, Br, Zr, Cr, Ni, Rb, Y, Se	1

Notes: Analytes are listed in order of decreasing PM_{10} mass fraction.
Bold analytes exceed a 1.0 % contribution by mass; EC - elemental carbon; OC - organic carbon

Table 4-2. Prevalence of Analytes by Site as Concentrations and Percentages

Receptor Site	Analyte	PM_{10} Concentration $\mu g/m^3$,	% of PM_{10} Mass
City Centre north winds 7 day composite	OC	26.4	13.4
	SO_4	16.5	8.4
	EC	13.1	6.7
	Cl	11.2	5.7
	Ca	10.7	5.5
	Si	6.7	3.4
	S	4.8	2.5
	NO_3	3.4	1.7
	Fe	2.9	1.5
	Pb	2.5	1.3
	Al	1.9	1.0
	K	1.2	0.6
Maadi north winds 3 day composite	Ca	15.9	9.6
	OC	12.1	7.3
	Si	9.3	5.6
	Fe	3.6	2.2
	Al	2.9	1.8
	S	2.8	1.7
	Cl	2.1	1.3
	K	1.1	0.7
	EC	0.9	0.5
Helwan north winds 4 day composite	OC	20.9	9.1
	Ca	19.4	8.5
	Si	11.8	5.2
	EC	6.3	2.8
	Cl	5.3	2.3
	Fe	4.5	2.0
	Al	4.3	1.9
	S	3.5	1.6
	K	2.8	1.2
Shoubra-El Kheima north winds 2 day composite	OC	113.3	57.9
	EC	28.9	14.8
	Si	14.0	7.2
	Ca	11.6	5.9
	Fe	5.9	3.0
	Cl	4.5	2.3
	Al	3.8	2.0
	S	3.2	1.7
	K	2.2	1.1
	Zn	1.2	0.6
Background north winds 2 day composite	OC	7.0	15.4
	Si	3.4	7.5
	Ca	2.8	6.1
	S	2.0	4.4
	EC	1.1	2.4

Note: Sulfates and nitrates not available for Maadi, Helwan, or the background site

ratios for Paved Roadway Dust, Unpaved Roadway Dust, Desert Dust, and Agricultural Soil were 5.16, 11.30, 7.55, and 32.14, respectively. On February 19, 1995, the levels of SO_4 increased substantially, reflecting the increased levels of atmospheric reactions. The Pb/Br ratio on this day exceeded 10.0, suggesting that either the North winds were providing influences from Pb sources in Shoubra El-Kheima, or were re-suspending nearby surface dusts. On March 14, 1995, high winds from the south showed dramatic increases in the soil analytes of Si, Ca, and Fe. Although there is an indication of elevated SO_4 levels on February 19, only the elevated Pb/Br ratio suggests a strong influence from Pb sources other than automobiles. As expected, the soil elements on March 14 are elevated in this size fraction.

4.1.3 Receptor Sampling Quality Control Data

The ability to weigh filters reproducibly before and after sampling is a primary contributor to the overall ability to collect precise receptor samples for particles. An analytical balance was supplied to NRC to weigh the dichotomous sampler Teflon filters, and training was provided in its operation. Filters were post-weighed by NRC personnel in Cairo and by EHP consultants at RTI in North Carolina to estimate the relationship between laboratory precisions. Reference 50 mg weights were used to standardize the accuracy of each balance. Six Coarse and six Fine fraction filters were weighed by both labs and their weights compared. The labs agreed on the results with a mean difference of -0.21%. The absolute mean difference, expressed in micrograms, was less than the quoted minimum detection limit given by the balance manufacturer (20 μg).

The precision of collocated receptor samplers for mass concentration was determined by operating paired dichotomous samplers and paired PM_{10} high-volume samplers at the City Centre site for four 12-hour sampling periods. The dates were January 27, February 2, February 6, and February 8, 1995. The paired concentrations indicated an excellent ability to operate the two sampler types in a reproducible manner. The errors in $\mu g/m^3$ were 3.01, 10.96, and 4.38 for the Fine, Coarse, and PM_{10} dichotomous sampler fractions, respectively. This corresponded to coefficients of variation of Fine - 4.26%, Coarse - 13.76%, and PM_{10} - 2.96%. The higher value for the Coarse particle fraction is expected because random losses of a few large particles during sampling and filter handling are much more probable for this fraction. Overall, these precisions were excellent.

The comparable data for the PM_{10} high-volume sampler is an error of 9.03 $\mu g/m^3$ and a coefficient of variation of 6.05%. The larger error in the high-volume sampler data resulted primarily from an inability to adequately precondition the glass fiber filter to the proper moisture equilibrium prior to weighing.

To conduct an extended study, the long-term accuracy of the flowrate calibration of particle air samplers is critical to consistent air sample collection. The flowmeter calibration accuracies of the dichotomous samplers was determined at the end of the study by recalibration against orifices validated by certified low and high flowrate reference flow device (laminar flow elements). This audit showed that the total flow channels were +2.6% and +2.8% high, while the coarse flow channels were -3.2% and -3.9% low. These accuracies showed excellent stability and were well within the ±10% allowable error for this study.

4.2 Source Signature Data

The analytes for each signature sample were compiled into fingerprint files, similar to those constructed for the receptor samples. The basic difference between the source and receptor profiles is that the source profiles have units of mass fraction percent. Table 4-3 shows the most significant analytes, with those

comprising more than 1% of the mass in bold. Detailed signatures are provided in Appendix D. The similarities among the dust sample signatures are apparent, with Ca and Si being the greatest contributors to all four dust types. The cement plant signatures from two different stacks show Ca, Cl, K, and S as the most significant analytes. A significant finding was the additional presence of Rb in the cement signatures, helping to distinguish these sources from other Ca and Cl crustal signatures. A complicating problem was the interfering combustion signature composited with the cement dust in the dry kiln samples.

The oil combustion signatures (heavy duty diesel, Mazut, and Solaar) are very similar, with OC, EC, and S as the three most prevalent analytes. The Mazut oil is distinguished by the presence of V. The Solaar oil signature appeared to be faulty in that the OC and EC components comprised less than 1% of the total. This is highly unlikely and suggests either a sampling or analytical problem for these samples. Using the signature in this configuration produced almost no identified Solaar combustion in Cairo (an incorrect output). The typical similarities in heavy duty diesel and Solaar signatures suggest that part of the apportionments attributed to only heavy duty diesels are actually a composite of the two source types. All three oil combustion signatures contain a significant S component, adding to the SO_2 burden in Cairo air (with subsequent SO_4 formation). Collection of a new set of Solaar oil combustion signature samples is strongly recommended. As previously noted, the heavy duty diesel signature, as collected (Table 4-3), was further apportioned into its Fine and Coarse fraction components. These further breakdowns are not reflected in the pie chart diagrams. The iron and steel signatures for the converter and sintering operations were similar, with Fe, Cl, and K being the three most prevalent analytes. These categories also provided significant contributions of Pb. The Pb smelter signature is overwhelmed by the Pb component, but also includes analytes from the Mazut oil burner used in the process. The PM_{10} portion of the Pb smelter emission contained 64% Pb by weight. The lime kiln signature, which was similar to the cement plant, was collected to possibly explain the high levels of Cl found in many receptor samples. The vegetative burning signature is expected to be variable, depending on the actual mixture of vegetation and trash in the mixture. This signature represented a reasonable mixture of debris, but collection of signatures from additional vegetative/trash mixtures may be appropriate.

As expected, the four dust sample signatures were very similar, with the paved roadway dust signature appearing to be a mixture of the other dusts. In the majority of cases, the dust signatures were too similar to be used simultaneously in the model without producing collinearity errors. It was significant that the paved roadway dust contained 0.42% Pb, while the unpaved roadway sample contained 0.19%.

4.3 Receptor Modeling Results

The receptor modeling for this project was significantly more challenging and time consuming than expected because of the nature of the source signature samples. The heavily loaded filter samples posed substantial analytical problems, while the mixture of sources present in some samples required a preliminary subapportionment to separate the mixed signatures. In most cases the source signatures from the Cairo source samples were adequate for the apportionment, but library signatures were used when the concentration of a specific component was unusually large. This occurred most often in Cairo for the analyte Cl, which appeared excessive and unexplained in a number of receptor samples.

4.3.1 Source Apportionments

Mass - The model apportionments were segregated by particle size fraction, with the

Table 4-3. Cairo Source Signature Analytes by Category

Source Category	Signature Analytes	Comments
Agricultural Soil Dust	**Si, Ca, Al, Fe, K, Ti, S, La,** Cl, P, Mn, Zn, Sr, Pb, Cu	
Automobiles - Petrol	**OC, Pb, Br, EC,** Al, Ca, Zn, **Fe,** P, Cu, Cr, Mn, Ni	
Cement Production - Bypass Stack	**Cl, K, S, Ca,** OC, Rb, Br, Fe, Zn, Pb, Mn, Ti, Sr, Cu, V, Cr, Cd, Zr, Ni	
Cement Production - Wet Kiln	**Ca, K, Cl, S, Si, Fe, Al,** OC, Sr, Rb, Ti, Pb, Zn, Br, Mn, Cu, Cd, Zr	
Desert Dust	**Ca, Si, OC, Fe, Al, S, Cl, K,** Ti, Zn, P, Ba, Sr, Pb, Cu, Mn, Cr	
Heavy Duty Diesel (Bus)	**OC, EC, S, Fe,** Zn, Pb, **K, Ca, Cl,** Si, Sb, Br, **Al,** Cu, Mn, Ni, Cr, Sr	Mixed source category - see Figure 4-10
Heavy Oil (Mazut) Combustion	**EC, OC, S,** Si, Zn, Sn, Fe, V, Ni, Pb, Ca, Al, K, Cu, Sr,	
Iron and Steel (Sintering)	**Cl, K, Fe, OC, Zn,** Pb, Ca, Mn, Ti, Al, Rb, Ba, P, Cd, Cu, Se, Br, Sn, Mo, Sr, Zr	
Iron and Steel (Converter)	**Fe, Cl, K, Mn, Ca,** S, Zn, **Si, Pb,** P, Sr, Cu, Rb, Al	
Lead (Pb) Smelter	**Pb, Cl, Fe,** Zn, OC, Cu, Mn, EC, V, Ni	Mixed Source Category - includes Mazut oil
Light Oil (Solaar) Combustion	**S,** OC, EC, Si, Sn, Ca, Fe, K, Pb, Zn, Se, Br, Sr	Unknown signature error - OC & EC undersampled
Lime Kiln	**Cl, Ca, K, OC,** Fe, EC, P, Rb, Pb, Zn, Mn, Sr, Ti, Cd, Cu, Br, Cr, Ni	
Paved Roadway Dust	**Ca, Si, Fe, Al, S, EC, K, Cl,** Ti, Pb, Zn, P, Sr, Mn, Br, Cu, Cr, Zr, Ni	Mixed Source Category - see Figure 4-9 Pb = 0.42 % PM_{10}
Unpaved Roadway Dust	**Ca, Si, OC, Fe, Al, S, Cl, K,** Ti, Zn, P, Sr, Pb, Cu, Mn, Cr, Br, Ni, Zr	Pb = 0.19 % PM_{10}
Vegetative/Trash Burning	**OC,** Cl, S, Ca, K, Fe, Si, EC, Al, Br, Pb, Zn	

Notes: Analytes are listed in order of decreasing PM_{10} mass fraction.
Bold analytes exceed a 1.0 % contribution by mass; EC - elemental carbon; OC - organic carbon

Fine and Coarse fractions producing more robust apportionments for mass concentration than those for PM_{10}. Combustion sources tend to generate mostly Fine particles, while crustal wind-blown sources tend to produce mostly Coarse particles. Attempts to apportion the total PM_{10} fraction were typically unsuccessful because of the increase in complexity of the receptor samples. The composite PM_{10} fraction sample apportionment is only reported for the City Centre site. The Fine and Coarse apportionments are given for all sites. The Fine particle receptor samples generally produced better model fits than did the Coarse fraction. The larger Coarse particles are not as readily transported over long distances, and the correlation between the sources and receptors diminishes rapidly with distance. This is especially true for the largest re-entrained dust particles from soil or pavement surfaces. The elevation of the sampling sites above the ground also has some influence on the ability to represent the largest particles.

The apportionments are presented as percentages by source category in a graphical pie chart for a specific size fraction in Figures 4-5 through 4-16. The measured mass concentration (or composite mean of selected measurements) is given in the upper left corner, while the predicted percentage computed by the model is given in the lower right corner. The pie slices indicate the apportioned percentage and the computed uncertainty percentage. The apportionments for mass concentration are given in Figures 4-5 through 4-14.

Because of strong concerns about sources of lead exposure in Cairo, special attention was paid to the apportionment of airborne lead among the several possible contributing sources. Note that the focus of this study was on the apportionment of mass, not particular chemical analytes, so the number of distinct types of lead sources considered was limited. Nevertheless, the two presumed dominant emitters, automobiles using leaded gasoline and lead smelters, were included. The resulting apportionments are shown in Figures 4-15 and 4-16 for the City Centre.

Initial attempts to perform receptor modeling were confounded by the composite nature of some of the sources. This produced collinearity errors and poor fits. To resolve this problem, the two most confounded categories—paved roadway dust and heavy duty diesels—were individually subapportioned into their components. The Fine and Coarse fractions for the paved roadway dust signature apportionment are given in Figure 4-5, showing that the Fine fraction components are unpaved roadway dust (56%), desert dust (39%), Mazut oil combustion (4%), and minor contributions from automobiles and lead smelters. Coarse fraction paved roadway dust is composed of contributions from unpaved roadway dust (65%), desert dust (27%), lead smelters (7%), and automobiles (2%).

Similarly, the heavy duty diesel signature was apportioned in Figure 4-6, indicating that the Fine fraction is composed primarily of heavy duty diesel vehicle emissions (92%), but with contributions from unpaved roadway dust (5%), automobiles (1%), lead smelters (1%), and a minor contribution from an unknown Cl source. The Coarse fraction consists of heavy duty diesel emissions (47%), unpaved roadway dust (31%), desert dust (21%) and a minor contribution from automobiles. For clarity, the apportioned signatures for paved roadway dust and heavy duty diesels are not apportioned into their subcomponents in the subsequently presented pie charts.

The City Centre site had seven days of North winds (the direction of Shoubra El-Hkeima) from which to composite the data. As shown in Figure 4-7, the predicted mass concentration apportionments for these days were within ~5% of the measured values (103.7% and 94.6%) for the Fine and Coarse fractions. As expected, the sources contributing to the two particle sizes are dramatically different. The mixed signature paved roadway dust contributed the majority (92%) of the Coarse particle mass, while heavy duty diesels

contributed the most (38%) to the Fine fraction. Heavy (Mazut) oil combustion was the second largest single contributor (24%) to the Fine particles, followed by ambient sulfates and an unknown chloride (both at 12%). The ambient sulfate category (a library signature) represents a mixture of sulfates, which are heavily influenced by the amount of SO_2 in the Cairo atmosphere that converts to a particle SO_4 form. As mentioned previously, the Solaar oil signature was not considered accurate. An unknown Cl accounted for 12% of the Fine mass that could not be accounted for by the Cl in the available signatures and 8% of the Coarse mass. This anomalous Cl source was also present in the Coarse fraction, possibly because the precision of analyte data are not adequate to provide definitive apportionments when the source signatures tend to overlap. The less significant sources contributing to the Fine fraction at the City Centre site included automobiles (10%), paved roadway dust (4%), and lead smelters (3%). The magnitude of the +/- apportionment errors are important since it characterizes the quality of the fit. In most cases, the error is approximately one-third or less of the predicted fraction. Error terms of this magnitude or smaller were considered as reasonable fits for this study, based on the +/- 20% error in the source signatures measurements and +/- 10% error in the receptor signatures.

Figure 4-8 shows the PM_{10} apportionment for the City Centre, compositing the contributions from the Fine and Coarse fractions given in the previous figure. The largest single contributor to the mass is paved roadway dust (36%), followed by heavy duty diesels (27%). The relatively large contribution from Paved Roadway Dust is surprising, given the third flow sampling site elevation. Apparently, even the larger Coarse fraction particles are re-entrained in the street canyon at the Ramses street location. This would suggest that the combined Pb contributions from fresh auto exhaust and re-entrained dust to street level exposure concentrations may be substantial. The other defined contributors included are an unknown chloride source (10%), ambient sulfates (9%), Mazut oil combustion (8%), automobiles (5%), iron and steel - sintering (4%), and lead smelters (3%). Of these categories, ambient sulfates is considered the least reliable (7% +/- 6%). The presence of the iron and steel - sintering contribution to the PM_{10} fraction appears to be attributed to the overlap in the heavy metal signatures between the lead smelter and the iron and steel for analytes other than Pb. Combining the Coarse and Fine fractions for both the receptor and source samples computationally increases the relative errors and changes the quality of the fit. It also decreases the probability of definitive source identifications.

As shown in Figures 4-3 and 4-4, the analyte concentrations were significantly different on one of the seven composited North wind days—February 19, which was characterized as a "heavily polluted, smoggy day." To examine a worst case for the City Centre, this day was apportioned separately as shown in Figure 4-9. The predicted mass was 111% of the measured mass, indicating that one or more of the analytes was present in higher than expected quantities. The Coarse fraction apportionment was nearly identical to the composite shown in Figure 4-7, but the Fine fraction exhibits some slight differences. The contributions of heavy duty diesels and Mazut oil combustion are similar, with a slightly larger ambient sulfate contribution that is more uncertain. More significantly, the individual contributions of lead smelters (7%) and iron and steel - sintering (7%) were higher with less error, while the paved roadway contribution dropped significantly (only 2%).

Only one day of data with winds from the South were available at the City Centre. This reflected that the majority of contributions came from the City, with perhaps the distant influence of the Helwan industrial area. As shown in Figure 4-10, the Coarse fraction appears very similar to the other City Centre

apportionments, while the Fine fraction is substantially different. In this case, the influence of heavy duty diesels (55%) is very pronounced. A portion of this large contribution, as discussed previously, may be from Solaar oil combustion. The second largest contributor is paved roadway dust (29%), resulting primarily from the Pb content in the dust. The unknown chloride portion (11%) is approximately the same as the North wind composite, while the contributions of automobiles (3%) and lead smelters (1%) are smaller. Although the Helwan district is approximately 15 km south of the City Centre, it was expected that cement production would be a significant contribution to mass on a South wind day. Although a portion of the unknown chloride may have come from this source, cement production could not be identified definitively. One day of West winds was also available at the City Centre site but proved to be virtually identical in apportionment to the north wind composite shown in Figure 4-7.

The apportionment for the residential Maadi site represents a composite of only North wind situations as shown in Figure 4-11. During north winds, the City Centre area would become the primary source region, combined with the re-entrained dusts from the nearby open areas. The lower concentration levels shown in the figure for Maadi are partly attributed to the more distant proximity to sources and partly to the longer 24-hour averaging period. Night-time concentration levels tend to be lower, reducing the overall means. The Maadi Fine fraction apportionment shows the relatively large contributions of ambient sulfates (35%) and vegetive/trash burning (33%) to the total mass. Unpaved roadway dust (14%) and heavy oil combustion (13%) are also significant contributors. The iron and steel - sintering contributions (3% in the Fine and 7% in the Coarse) were unexpected for a North wind period, since the iron and steel manufacturing complex in Helwan is to the south. This may suggest that unidentified metallurgical sources are present just North of Maadi, or that transport from the distant Shoubra El-Kheima sources is occurring. The uncertainty error in the Coarse portion makes this identification questionable. Note that the overall prediction for the Coarse fraction was only 76% for Maadi.

A somewhat surprising finding for the Maadi site was that cement production did not contribute significantly to the Fine fraction and contributed only 2% to the Coarse fraction. The contribution of unpaved roadway dust was 14% in the Fine fraction and 38% in the Coarse fraction. Desert dust and lime production (both at 26%) were significant Coarse particle contributors, although a nearby lime production facility could not be identified. The large percentage (24%) of Coarse material that was not predicted, combined with the marginally large error for lime production, suggests that a combination of Cl sources is more probable. It was hypothesized that a mixture of settled cement dust and surface soil re-entrained into the air might produce a source signature very similar to the lime production. The sampling period in Maadi occurred during late Spring and encountered several days of elevated wind speeds. The re-suspension of mixed surface dusts in Cairo merits further investigation to assist in understanding the unknown chloride source.

The receptor samples collected in the industrial areas of Helwan and Shoubra El-Kheima are shown in Figures 4-12 and 4-13, respectively, for north wind periods only. The Helwan Fine particle apportionment shows a contribution similar to Maadi for vegetive/trash burning (33%) but a smaller ambient sulfate (17%) because of the higher total concentration level. The contribution of Mazut oil combustion is significant (28%) as expected for an industrial area, with the influence of the nearby iron and steel - converter source (8%) apparent. The desert dust contribution (13%) was unexpectedly high

for the Fine fraction and showed a very small error term. The Coarse fraction mass in Helwan was primarily attributed to unpaved roadway dust (66%) and desert dust (31%), with 3% from an unknown chloride source. Similar to the Maadi apportionment, the Coarse fraction mass prediction for Helwan was only 66%.

The Shoubra El-Kheima Fine fraction apportionment in Figure 4-13 is very similar to that for Helwan, except that the composite paved road dust replaces the more individual desert dust. The Coarse fraction source is primarily paved roadway dust (97%), with an improbable (based on the large error term) contribution from iron and steel - sintering and cement production. Since this site was not near a paved roadway, the composite mixture of unpaved roadway and desert dust is reasonable.

The background site receptor samples for north winds in northeast Cairo were composited and apportioned as shown in Figure 4-14. As expected, the Coarse fraction consisted of primarily desert dust (93 %), with 7% of unknown chloride; however 41% of the mass could not be predicted at the low concentration levels. The measured Fine fraction contained only 18 $\mu g/m^3$ and exhibited an apportionment similar to Maadi. Interestingly, lead smelters made a small contribution (3%), even though there were no identified smelters within 10 km. The indication of metropolitan area sources in the background site Fine fraction apportionment suggests that the site is influenced by these sources despite its remoteness.

Lead (Pb) - The receptor model was used to apportion the Pb concentrations at the City Centre site for the Fine, Coarse, and PM_{10} fractions as shown in Figures 4-15 and 4-16. The Fine apportionment showed that the majority of Pb was contributed from lead smelters (71%) and petrol-fueled automobiles (28%), with a minor contribution from paved roadway dust and an improbable contribution (large error) from Mazut oil combustion. The large contribution from lead smelters is surprising since most of the identified smelters are some distance north in Shoubra El-Kheima. It is possible that unidentified "smelter-like" metallurgical sources just north of the City Centre are contributing to the receptor Pb levels.

The Coarse fraction attributed 54% to automobiles and 45% to paved roadway dust, with a minor contribution from Mazut oil combustion. The Pb in the paved roadway dust was considered aged and had been deposited at a much earlier date. The automobile Pb particles are much more recently generated particles that have attached themselves at some point to larger particles, thus behaving as a coarse particle.

The PM_{10} Pb apportionment for Pb in Figure 4-16 again shows a substantial contribution from lead smelters (58%) and a contribution from automobiles (38%), but the error terms substantially reduce the value of this composite apportionment. The unexpectedly large Pb smelter contribution and relatively small petrol-fueled automobile contribution may have been caused by the focus of this apportionment study on mass concentrations, rather than Pb. No attempt was made to identify and rank the most probably Pb-emitting sources and collect additional signature samples. Although the 6th October elevated highway was approximately 1 block North of the City Centre site, a relatively large building between the site and the highway undoubtedly obstructed emissions transport. Paved roadway dust provided 4% (+/- 3%) of the Pb concentration. As with the mass concentrations, apportionment by specific size fraction more closely links the particle transport properties, as a function of particle size, with the source contributions.

4.3.2 Uncertainties

The accuracy of using a receptor model to apportion particles collected at a receptor site to individual source categories depends on the quality and representativeness of the input

receptor data and source signatures. The apportionments that used data on days when winds were from the north are not necessarily applicable to the days when winds were from the south. The City Centre apportionments for north and south winds were essentially identical for the Coarse fraction but were quite different for the Fine fraction. The input source signatures are presumed to be the major influencing source categories for the selected receptor site, but in some cases unidentified nearby sources may have influenced the outcome. The measured Cairo source signatures could not account for the unidentified excess chloride found in the receptor samples at a number of locations. Although the percentage contributions of the unknown chlorides are relatively small, their presence suggests that at least one source category may have been overlooked. The near 100% fitting percentages for the Fine fraction suggest that the majority of important source categories have been identified.

An inherent problem with the mathematical form of the receptor model is its inability to distinguish sources that have very similar (or collinear) signatures. The composite nature of the dust signatures requires that they not be present together in the same apportionment, except in special situations; therefore, these apportions demand a broader interpretation. Similarly, the combustion of oils (Mazut, Solaar, and heavy duty diesel), tend to have similar high proportions of EC, OC, and sulfur emissions. This places an excessive reliance on the accuracy of the individual analyses to provide distinctively different signatures. Repeating the sample collection to improve the signature quality is highly recommended.

The physical collection of the source signature air samples suitable for the analytical methods (XRF for metals and thermal decomposition for carbons) proved to be difficult. The initial inexperience of the sampling system operators, combined with extraordinarily high (mostly uncontrolled) stack concentrations in most of the Cairo sources, significantly affected the ultimate data quality. The most common problem was overloading of the filters, caused by operating the sampling system excessively (for example, sampling for 20 minutes instead of 5 minutes). The time of collection balances integration of a sample across a period that averages short-term source fluctuations with the requirements of the analyses. Extraordinarily high filter collections greatly exceeded the optimum sensitivity range and calibration of the XRF spectrometer at DRI, requiring system recalibration to attempt the analyses. In addition, it was apparent that significant quantities of particles had fallen off some of the filters during transport, undoubtedly biasing their results. These biases affected the consistency of the relationships between the Fine and Coarse particle fractions and between the carbon data and the metals data (collected on two different filter types). Since it was time consuming and expensive to resample sources (and often impossible to regain access), some assumptions were made to permit the data to be used. The most frequent assumption was that negative concentrations computed from differences were presumed to be zero (for example, from subtracting a Fine fraction from a smaller PM_{10} fraction).

An additional complication was an inability in some cases to sample the individual emission streams as representing only one source. As an example, the diesel bus signatures included emissions from the paved road surface dust and automobile exhaust Pb in the diesel mixture. Initial attempts to use the composite diesel bus signature resulted in collinearity problems with the separate paved road signature. The problem was resolved by using the model to apportion the composite sample into its component sources. This decomposition approach was also used to apportion paved roadway dust into its more basic constituents.

The implications of the various uncertainties described here on the resultant

apportionments are somewhat difficult to quantify. Based on the variabilities in the duplicate source signature sample sets for the same source, a conservative error of ±20% was assumed for the uncertainties in the sampling process. The precision data from the collocated receptor samplers suggested that the expected errors might be ± 10%. The model-computed errors for the apportionments (± values on pie charts) were based primarily on these inputs but are undoubtedly more variable given the other uncertainties that are difficult to quantify, especially the representativeness of the signature samples to represent the entire source category. In general it could be assumed that if the model computed error is less than approximately 30% of the apportioned percentage, the identified source category is a significant contributor.

The resultant apportionments for the Fine and Coarse fractions at all sites appear reasonable in most cases, even though the prediction percentages in the Coarse fraction were significantly poorer than those for the Fine fraction. This occurred in the Coarse fraction mainly because of the lack of carbon data from the signature sampling system. The overlaps in the dust signature categories, while unfortunate, did not appear to affect the quality of the crustal analyte apportionments. A subjective assessment based on visual observation of the potential sources near each receptor sites supports the conclusions that the listed sources are the significant contributors to the receptor site if the error term was approximately 30% or less, and the general orders of source influence on the mass concentration apportionments, are reasonable (for example, for the City Centre Fine fraction with north winds: heavy duty diesel > Mazut oil combustion > ambient sulfates > automobiles (petrol fueled). Because of the diversity of the sources contributing to the Fine and Coarse fractions, the quality of the composite PM_{10} apportionments was considered robust only at the City Centre site.

4.4 Transfer of Technology

4.4.1 Equipment

A secondary goal of this project was to transfer the sampling and analytical chemistry skills to the Egyptian scientists so they could conduct follow-on receptor modeling more expediently. As part of this project, the following equipment was procured for use by the Egyptian NRC:

- Two Graseby-Andersen PM_{10} dichotomous samplers
- One each of calibrated Coarse and Total channel dichotomous flowcheck orifices
- Two Graseby-Andersen PM_{10} high-volume samplers
- One calibrated high-volume sampler flowcheck orifice
- One University Research Glassware source signature sampling system
- One 486/33 personal computer and laser printer
- One Mettler AT261 analytical balance
- One Dionex Model 100 Ion Chromatograph
- One Perkin Elmer Model 3100 Atomic Absorption spectrometer with eight metal lamps and computer control
- Filter weighing supplies including petri dishes
- A supply of Teflon and quartz filters

This equipment will allow NRC staff to collect receptor and source signature samples; analyze them for mass, metals, sulfates, and nitrates; and conduct computer-based receptor modeling. The only capability not currently available is EC and OC analyses by thermal decomposition. Quartz filter samples will need to be returned to the United States for processing until a commercial analyzer is available.

4.4.2 Training

NRC staff were trained in how to replicate this study. They learned to set up, calibrate, and operate the PM_{10} dichotomous and high-volume samplers, as well as to operate the analytical balance to weigh the dichotomous samplers filters. Training on the application of the CMB 7 receptor model was conducted at a two-day training session held on-site at NRC. The training session was open to staff from other interested Egyptian government environmental agencies, including the Egyptian Environmental Affairs Agency. Copies of the CMB 7 software were distributed, along with file manipulation programs that permit new data to be added.

The analytical laboratory equipment (IC and AA Spectrometer) will include set-up and training on-site by the respective vendors. A limited split sample program to determine the comparability between these new methods and the XRF metals analyses used in this study is recommended.

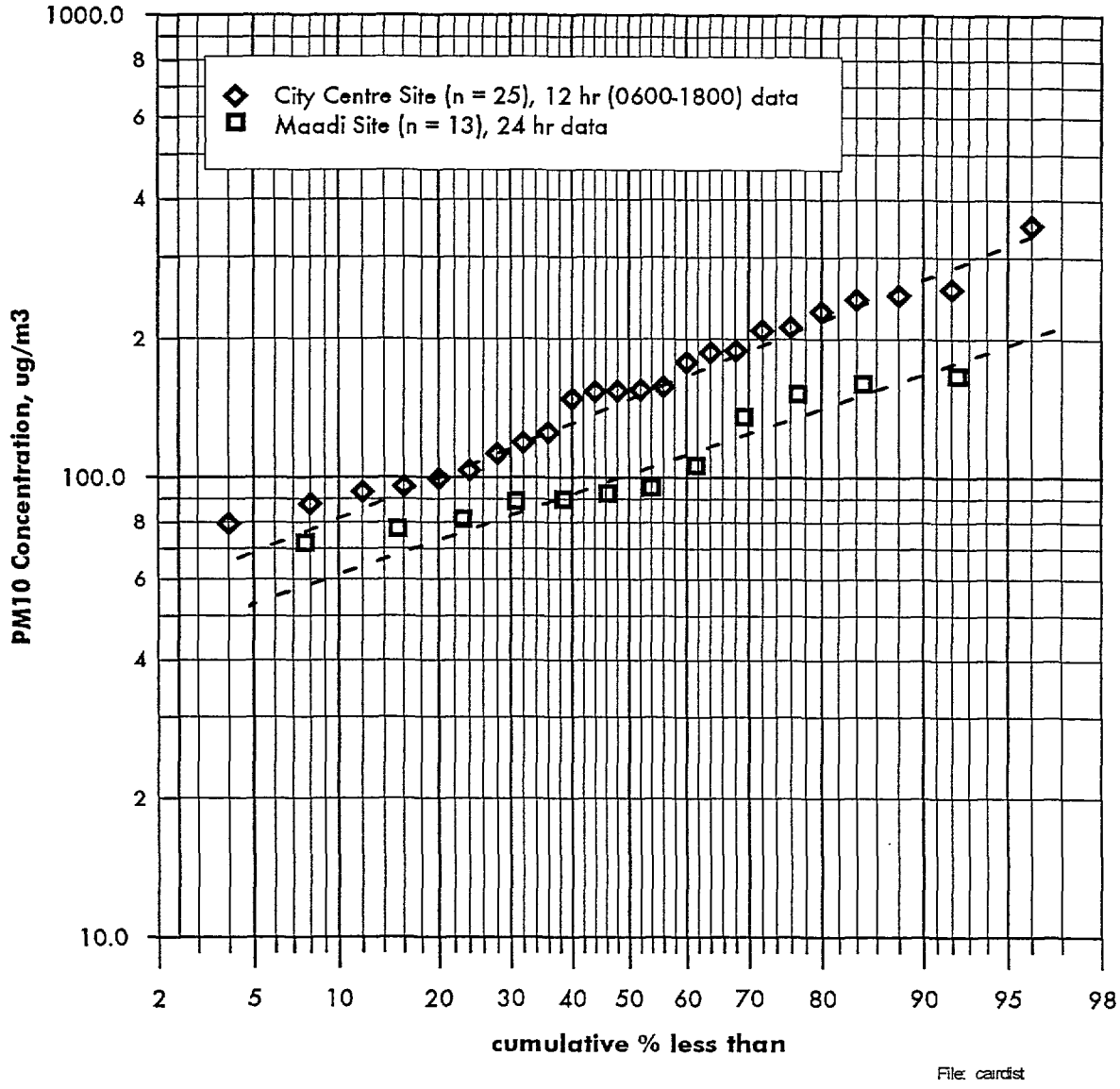


Figure 4-1. *Cairo Receptor Modeling Study PM10 Concentration Data Distributions*

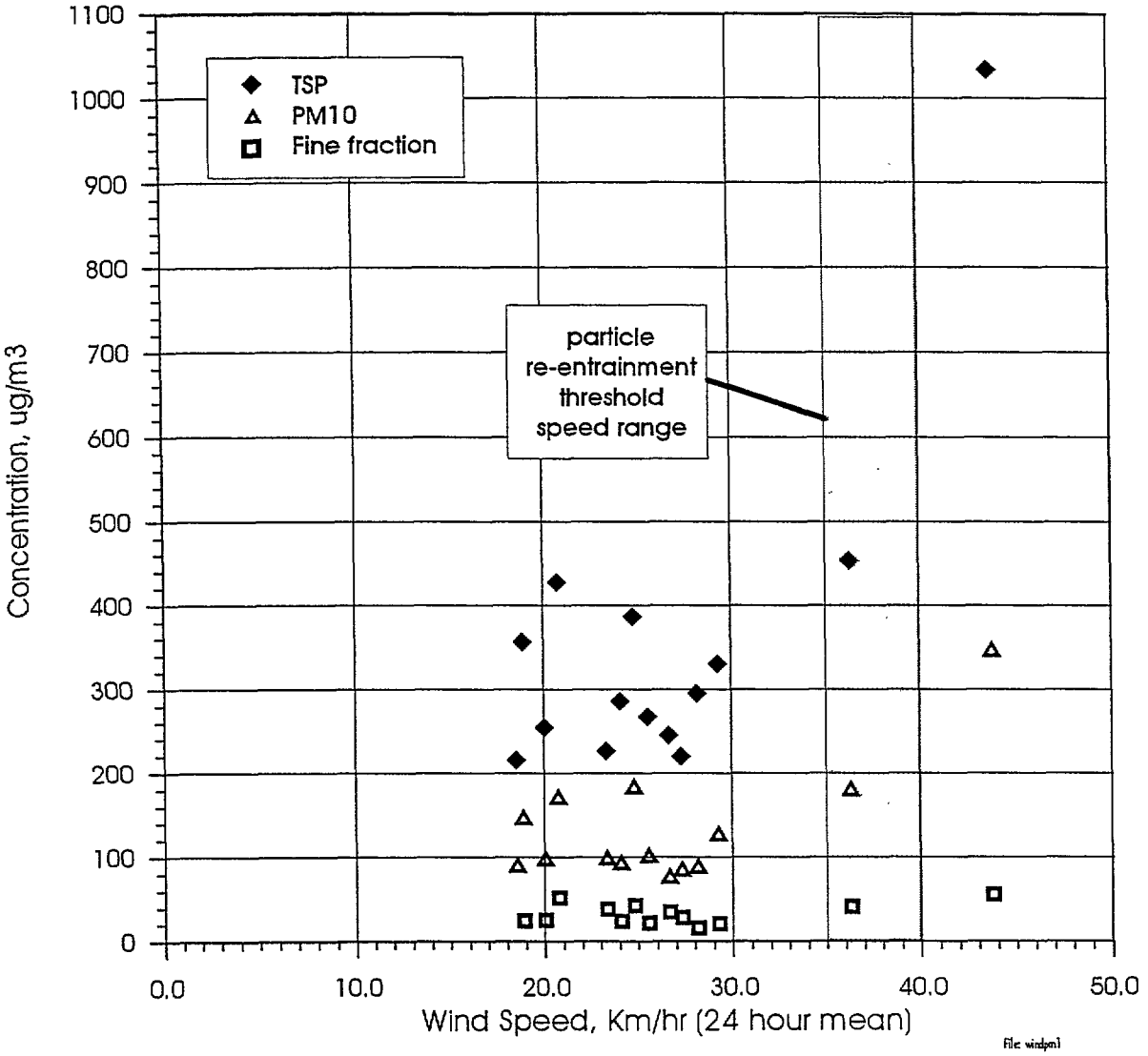


Figure 4-2. Wind Speed Versus Particle Concentration at Maadi

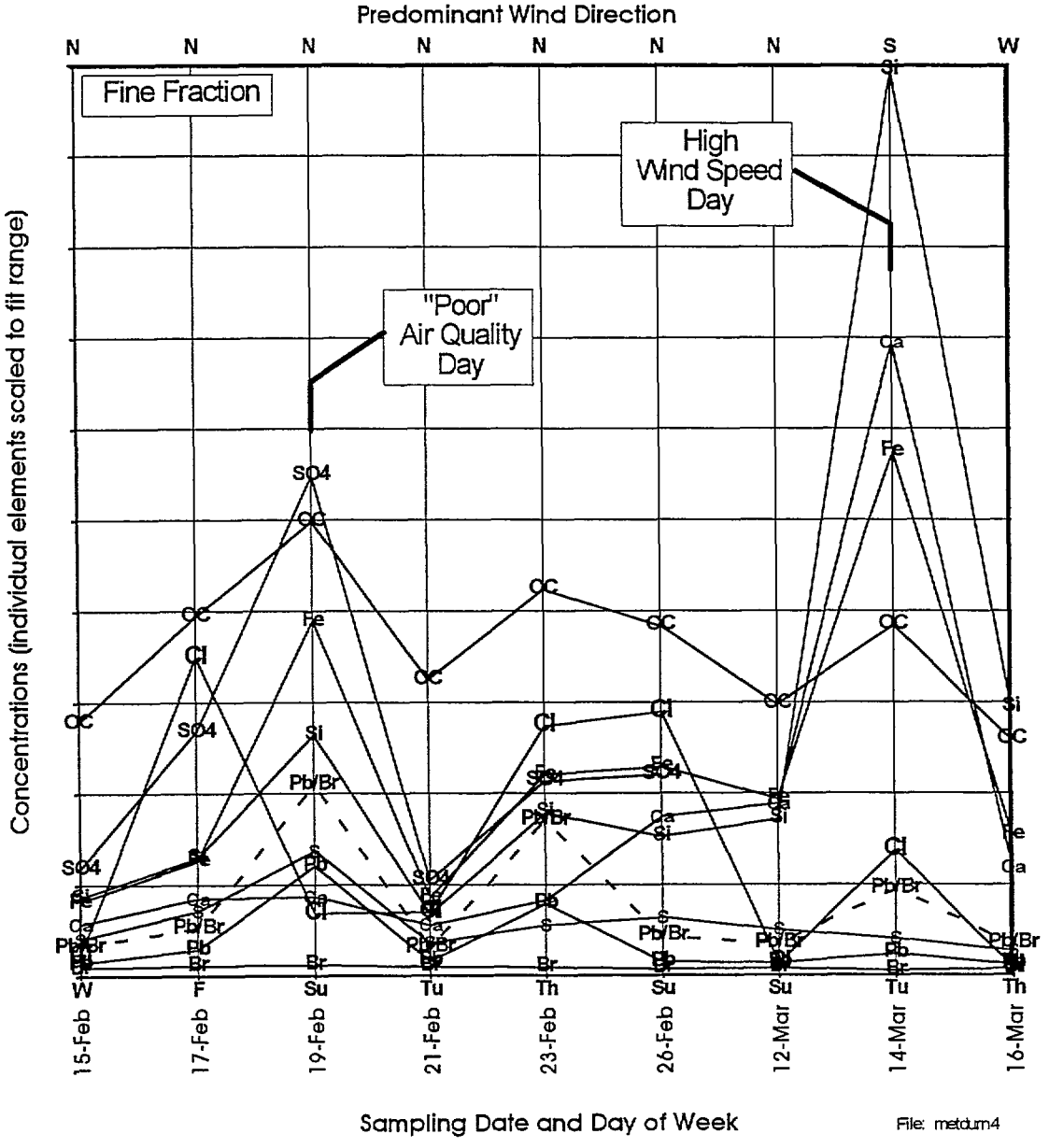


Figure 4-3. Daily Fluctuations in Fine Fraction Analytes for City Centre Site

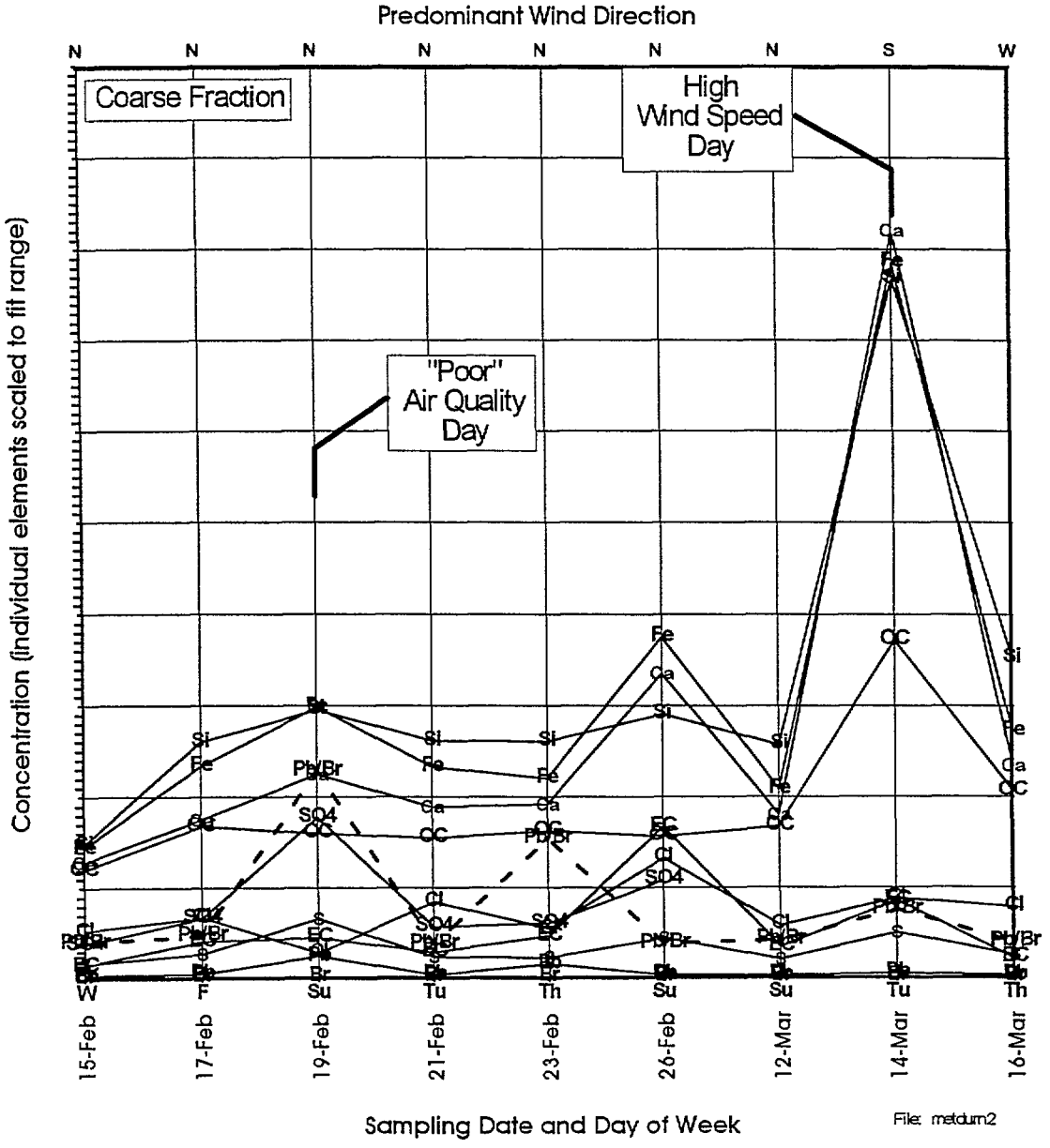
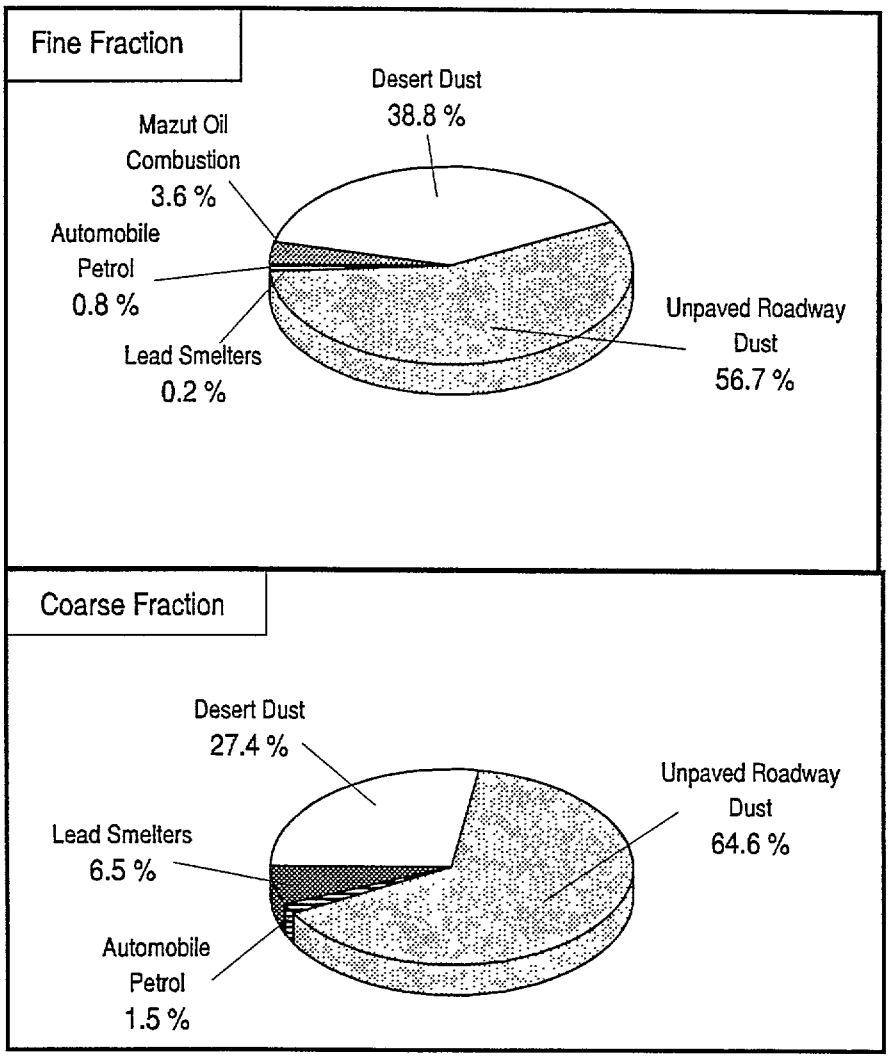


Figure 4-4. Daily Fluctuations in Coarse Fraction Analytes for City Centre Site

Composite Source Signature Apportionment

Paved Roadway Dust



Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-5. Composite Paved Roadway Dust Signature Apportioned by the Component Sources

File: sgms21

Composite Source Signature Apportionment

Heavy Duty Diesel

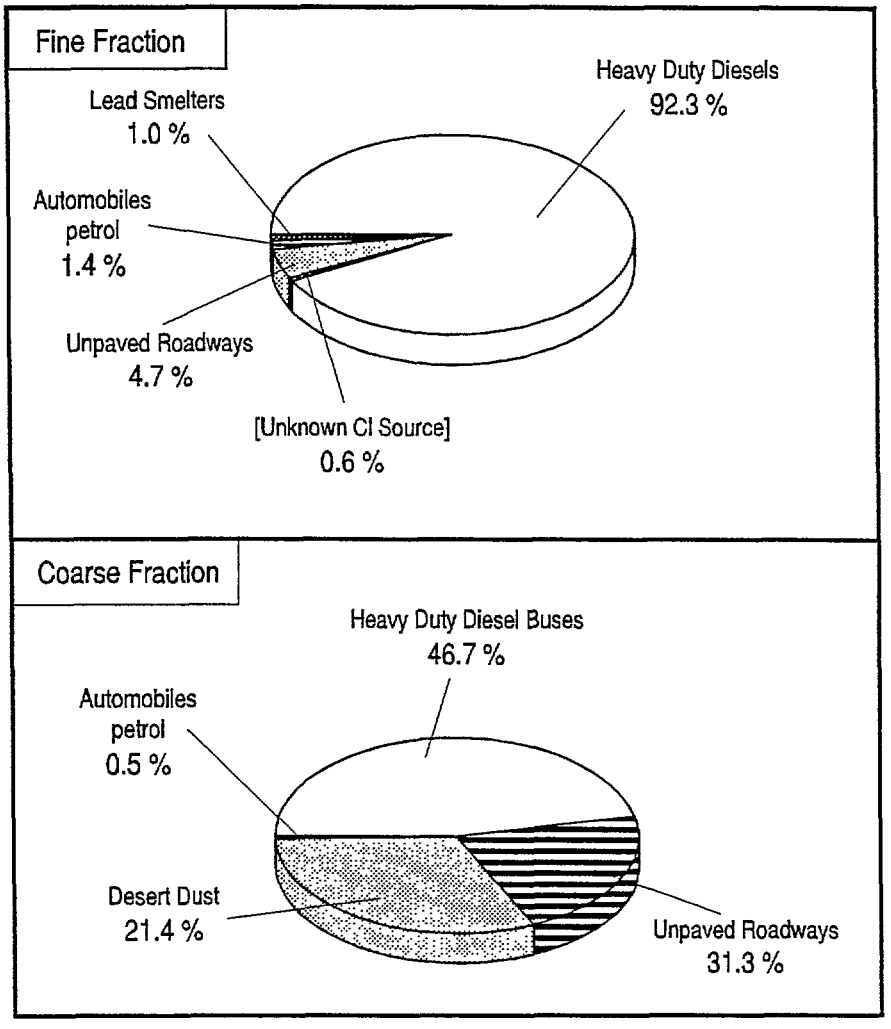
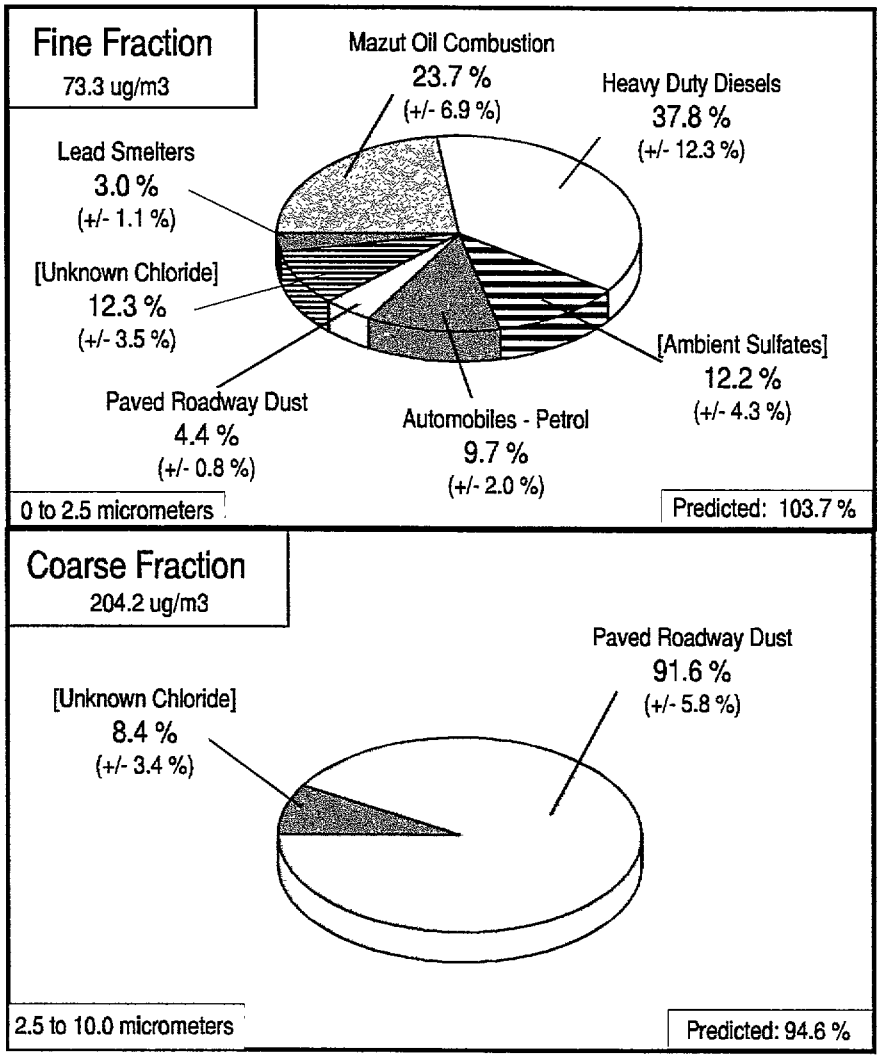


Figure 4-6. Composite Heavy Duty Diesel Bus Signature Apportioned by the Component Sources

file: sgms23

Particle Mass Concentration Apportionment

Composite of North Wind Days



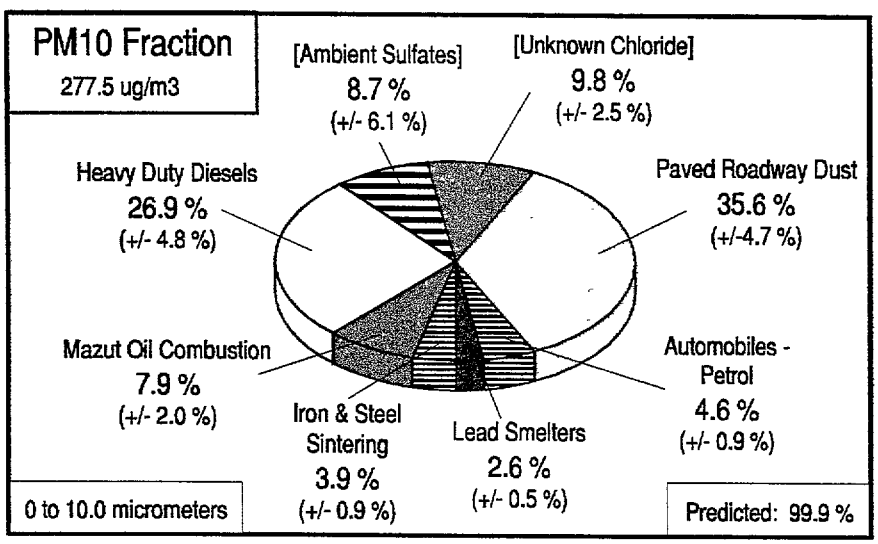
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-7. Cairo City Centre Particle Mass Apportionment

file: sgms3

Particle Mass Concentration Apportionment

Composite of North Wind Days



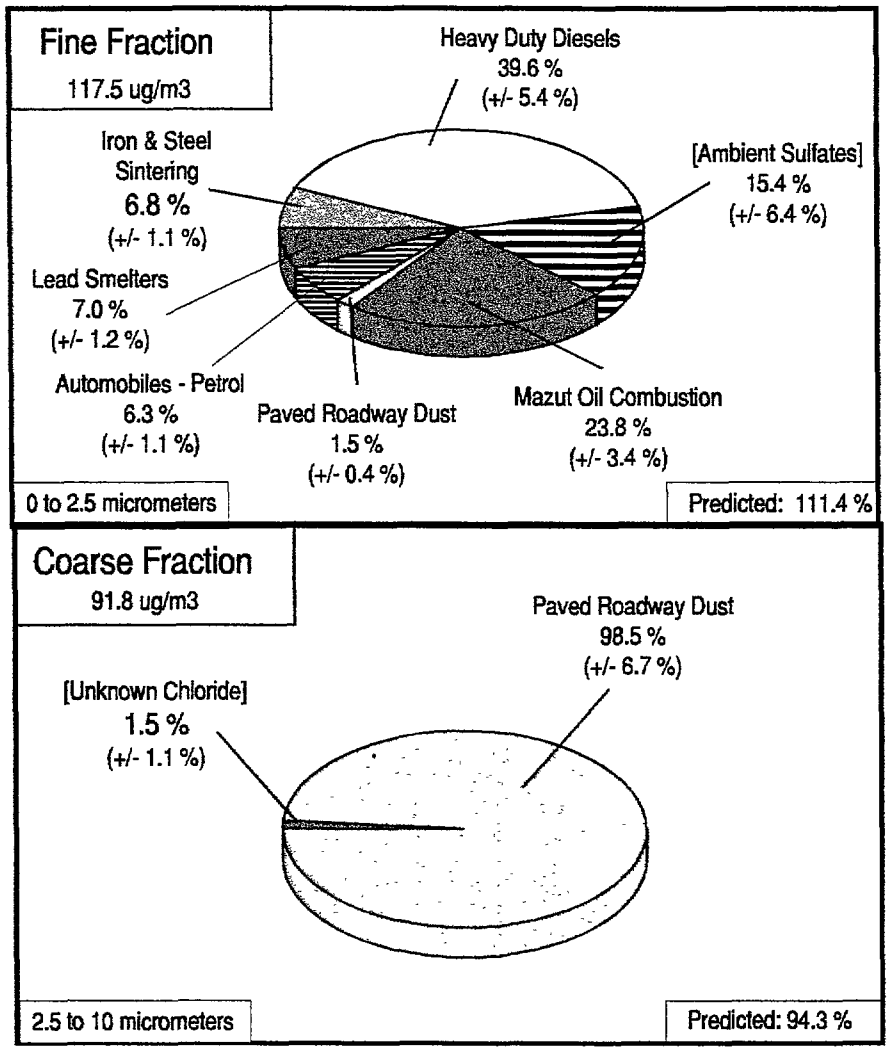
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-8. Cairo City Centre Particle Mass Apportionment

file: sgms1

Particle Mass Concentration Apportionment

Single Day - 19 February 95 - North Wind



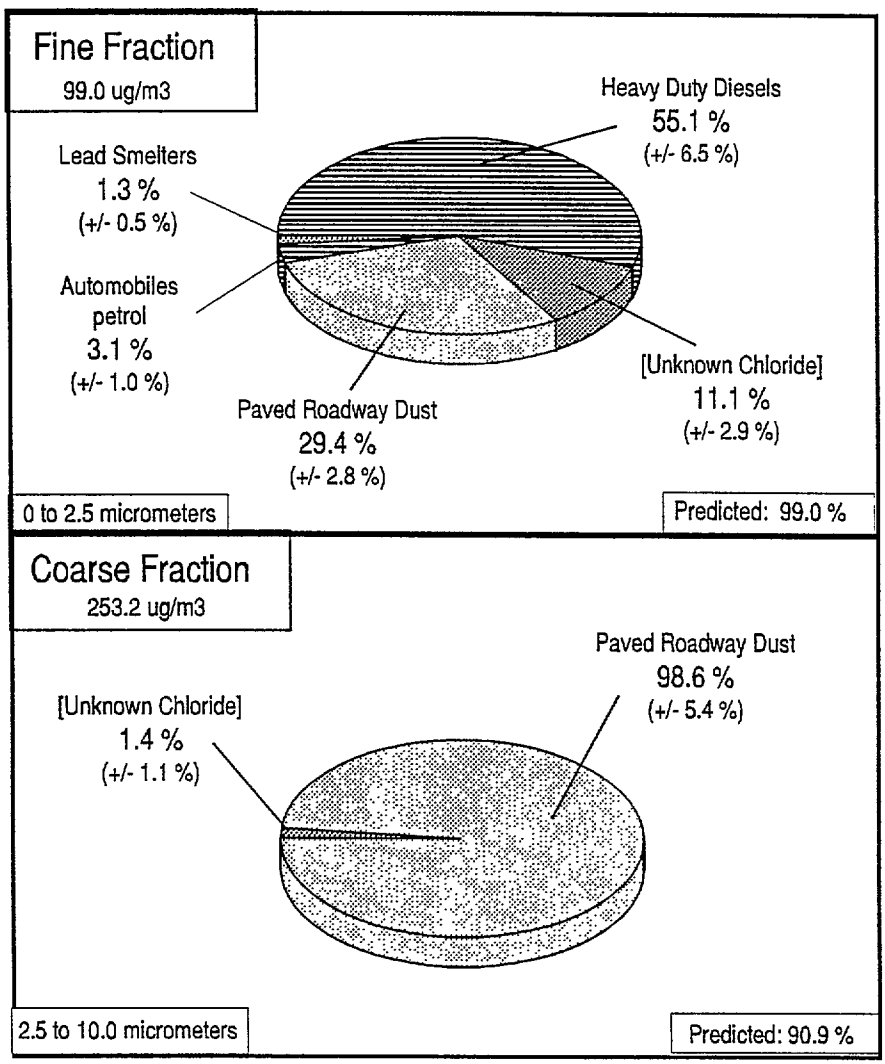
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-9. Cairo City Centre Particle Mass Apportionment

file: sgms20

Particle Mass Concentration Apportionment

Single day - 14 March 95 - South winds



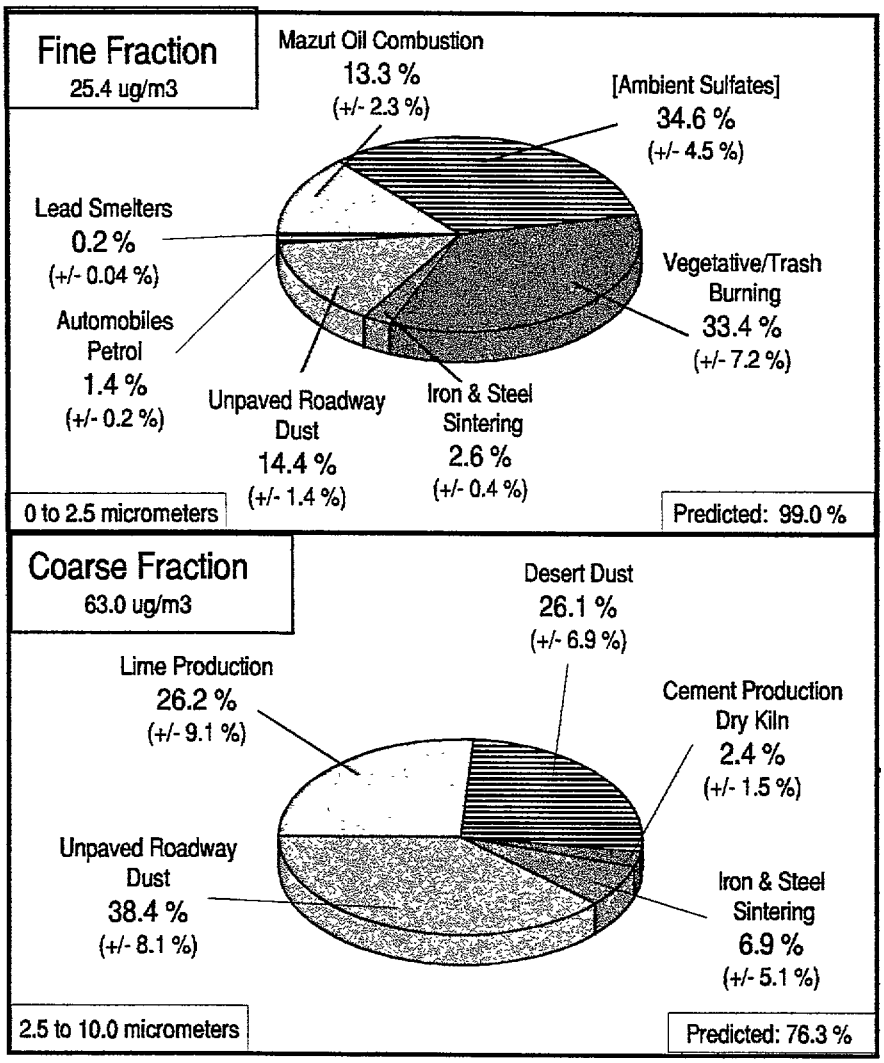
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-10. Cairo City Centre Particle Mass Apportionment

file: sgms13

Particle Mass Concentration Apportionment

Composite of North Wind Days



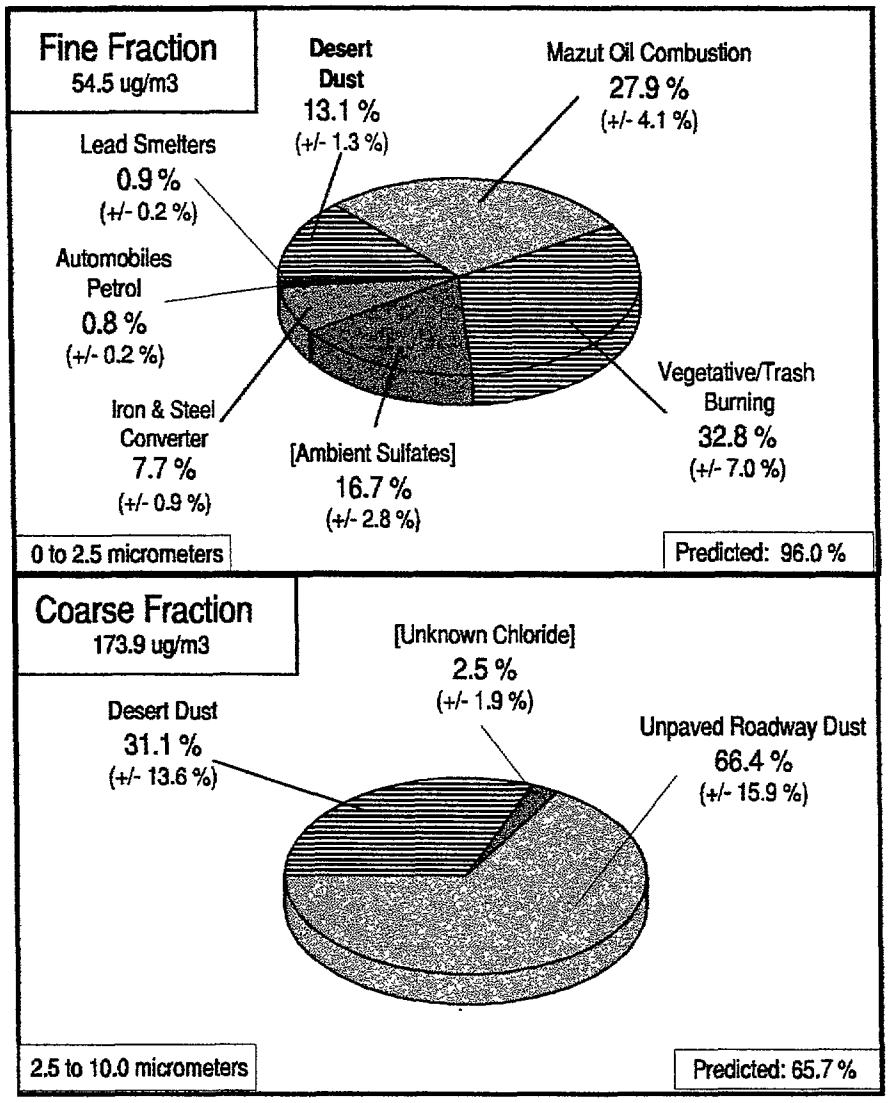
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-11. Maadi Particle Mass Apportionment

File: sgms14

Particle Mass Concentration Apportionment

Composite of North Wind Days



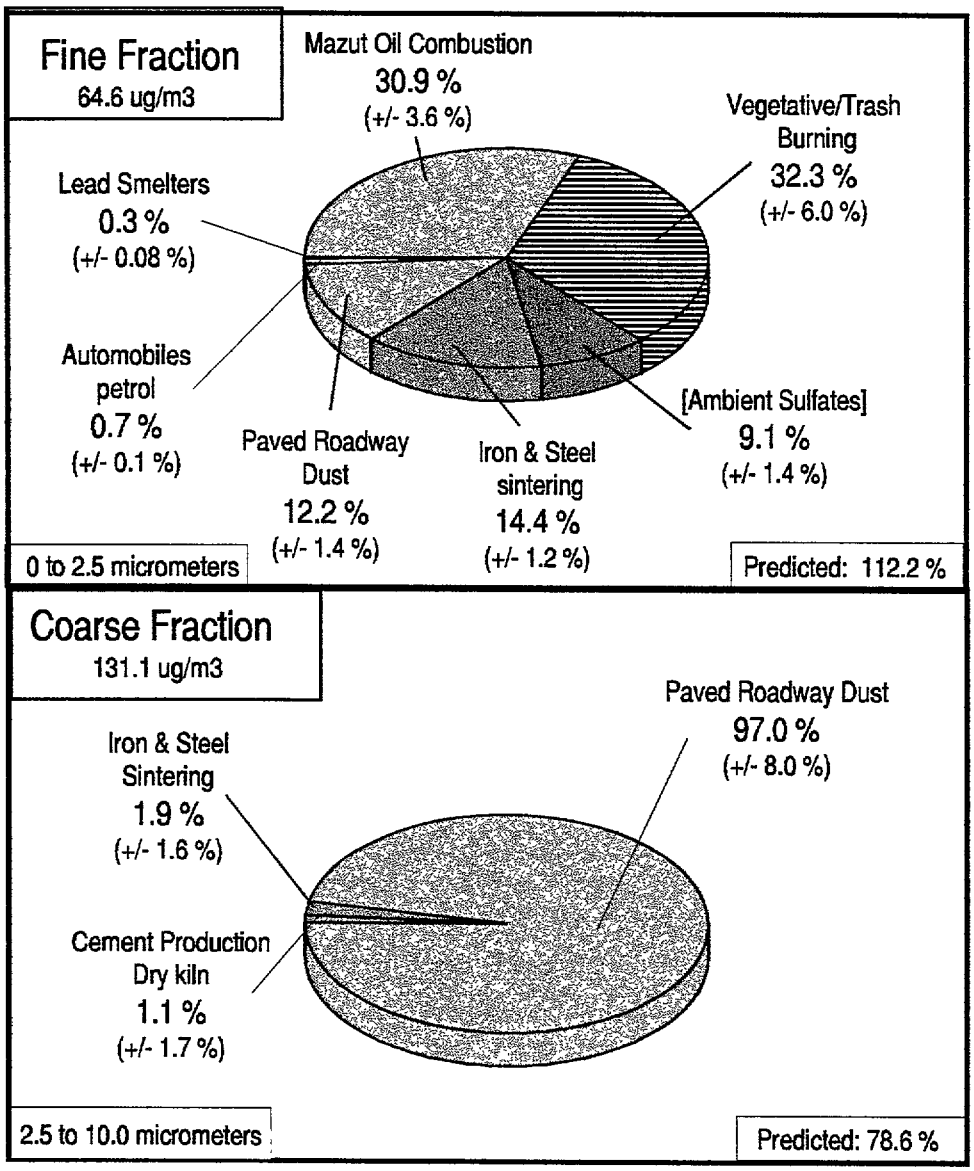
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-12. Helwan Particle Mass Apportionment

File: sgms16

Particle Mass Concentration Apportionment

Composite of North wind days



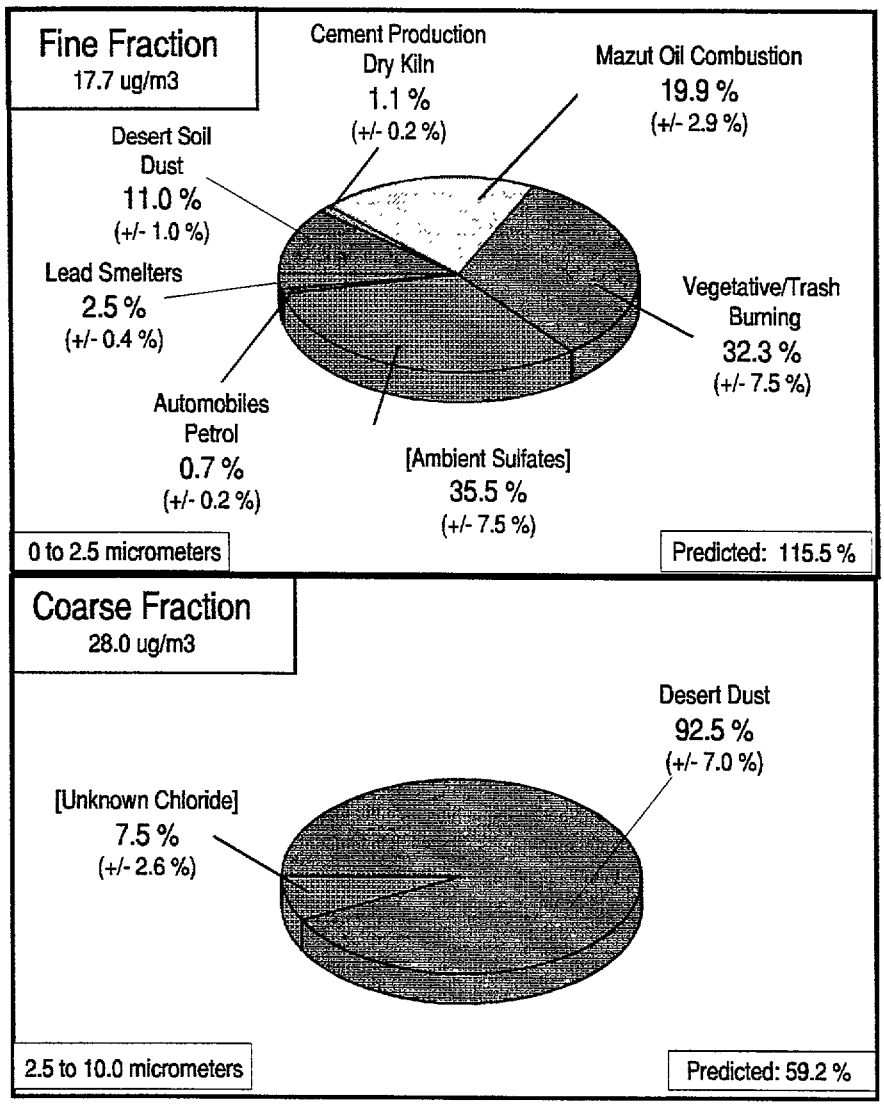
Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-13. Shoubra El-Kheima Particle Mass Apportionment

File: sgms15

Particle Mass Concentration Apportionment

Composite of North Wind Days



Note: Source categories in brackets [ ] are not from Cairo signatures

Figure 4-14. Background Site Particle Mass Apportionment

File: sgms18

Particle Lead (Pb) Concentration Apportionment

Composite of North Wind Days

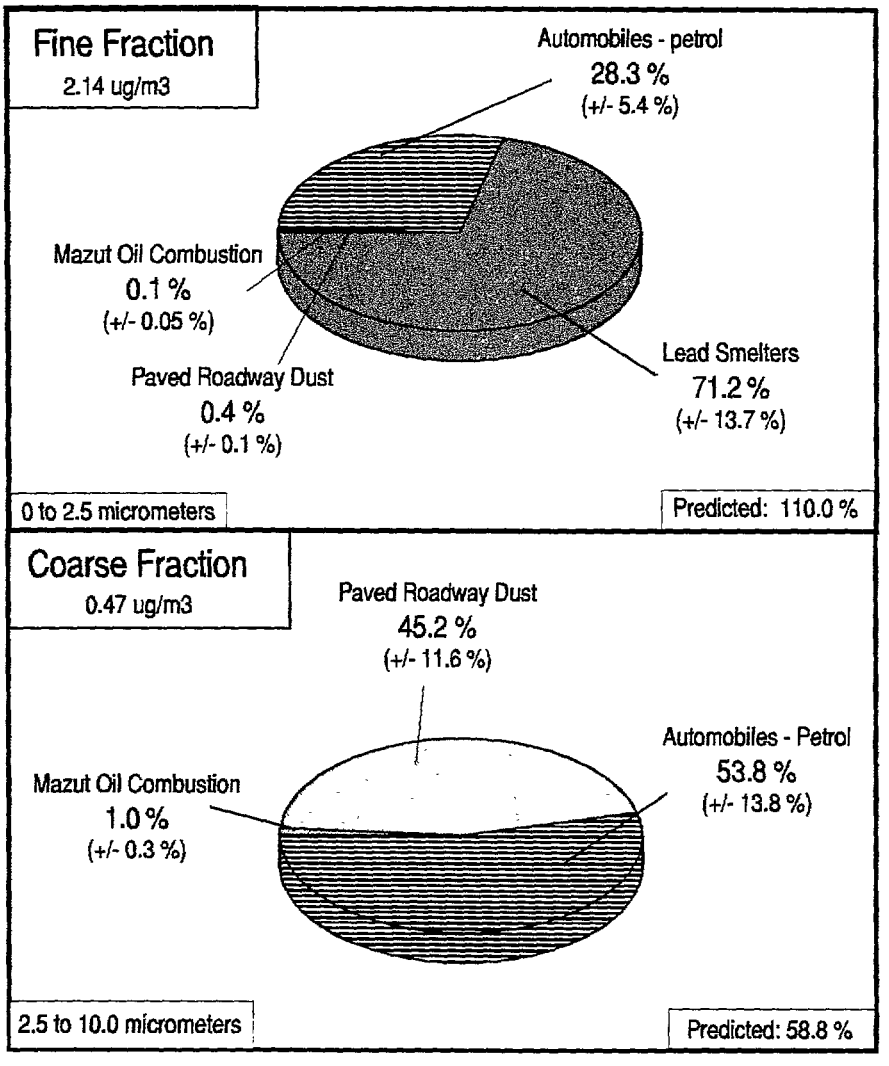


Figure 4-15. Cairo City Centre Particle Lead (Pb) Apportionment

file: sgms5

Particle Lead (Pb) Concentration Apportionment

Composite of North Wind Days

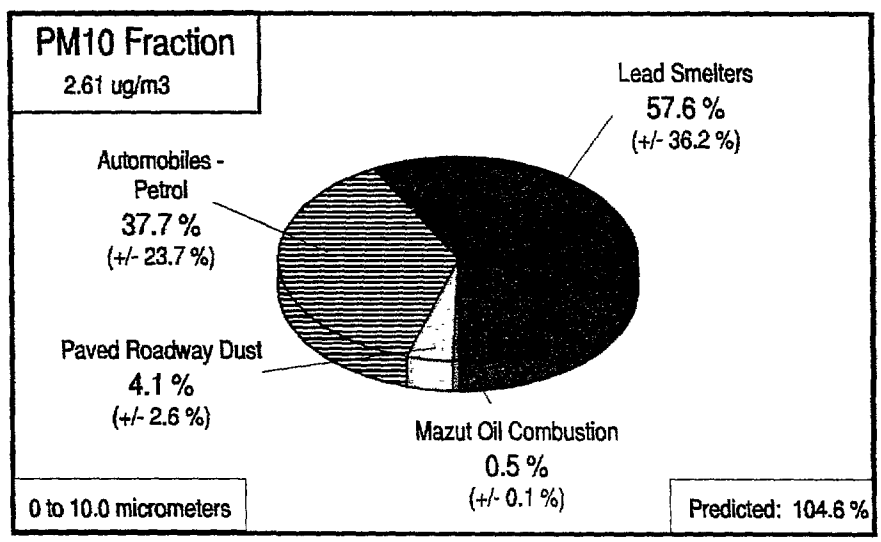


Figure 4-16. Cairo City Centre Particle Lead (Pb) PM10 Apportionment

file: sgms6

5 DISCUSSION

5.1 Receptor Concentration Data

Although the concentration data from the City Centre site represent a limited number of samples from five locations in a large metropolitan area, they still provide some interesting insights into the particulate problems. The concentration data strongly suggest that TSP is a poor indicator of the health risks in Cairo from air exposure since there is such a substantial fraction of mass that cannot be inhaled into the respiratory system. This does not preclude the possibility of larger Pb particles from settling on soil, vegetation, and food crops and being ingested. The application of high-volume samplers with PM_{10} inlets appeared to be an attractive sampler since its operation was somewhat familiar to the NRC staff. Unfortunately, this sampler could not accommodate the periodically high particle concentration levels found in Cairo. The PM_{10} dichotomous samplers used in this study successfully collected samples representing the Fine fraction particles that penetrate the lungs and the PM_{10} fraction that penetrates to the upper airways.

The PM_{10} mass concentration data at the City Centre site averaged more than 150 $\mu g/m^3$ (the U.S. standard level to protect health) over fifteen daytime 12-hour periods. The 24-hour average concentrations would be expected to be slightly lower, since they include the limited activity midnight to 0600 hr period. The Fine fraction, containing the particles most likely to penetrate to the deep lung, was approximately 50% of the PM_{10}. The PM_{10} levels at Maadi were slightly lower, averaging 126 $\mu g/m^3$ over 13 days. The Fine fraction at Maadi averaged only 25% of the PM_{10}. The Coarse fraction levels at the background site averaged 45–65 $\mu g/m^3$, suggesting that the contribution of re-entrained soil dust to the ambient PM_{10} concentration levels will always be at least this order of magnitude.

5.2 Source Signatures

The most notable findings from the Cairo source signatures were related to the high concentrations of Pb found in paved roadway dust (0.42% by weight) and the Pb smelter stack emissions (64% by weight). The prevalence of elemental (soot) and OC emissions from the various oil (light and heavy) combustion sources suggests that the levels of semivolatile organic compounds (for example, benzo-a-pyrene) may be of concern. Structural soiling as well as visibility degradation would also be prevalent.

5.3 Receptor Apportionments

The apportionments for the five Cairo receptor sites appear reasonable, given the uncertainties in the source signature samples. Although winds were primarily from the north for most of the sampling periods, the large cement plants in the Helwan area were specifically identified as only minor contributors to the mass concentrations at the receptor sites. Even on the single day when the predominant wind was from the south, the contributions of the cement plants were not significant. This apparent contradiction to the reality of the extremely visible daily cement plant stack emissions into Cairo air might be partly explained by the existing wind

directions during sampling (plume transport trajectories) and the elevated stack emissions levels. Since a limited number of samples were collected and only a subset selected for chemical analysis, it is conceivable that the plumes were not directed at the receptor locations for extended times during the modeled sampling periods. The unidentified chloride is speculated to be from re-entrained surface dust that is mixed with previously deposited cement dust. Many of the dust and industrial source signatures contained strong Cl components but not in the exact signature proportions needed to satisfy the model. A signature analysis of re-entrained local surface dusts near each receptor site may resolve this question.

Lead smelters (and other related metallurgical processes) contributed significantly to the City Centre mass and Pb concentrations, especially on heavily polluted days. On February 19, lead smelters and iron and steel production combined to contribute 14% of the Fine particle mass. Mobile sources (automobiles and heavy duty diesels) contributed 46% of the Fine mass, while stationary oil combustion contributed 24%. The Coarse fraction sample was almost completely attributed to paved roadway dust, but, similar to the unidentified chloride, the actual source may be a mixture of settled Pb from several sources and surface dust. Recognizing that paved roadway dust is primarily a mixture of surface soil dusts, much of Cairo's Coarse particulate air pollution problem appears to be from re-entrained dusts.

The contribution of oil combustion to the mass concentrations is very significant and could only be approximated by using a Mazut oil combustion signature. The Solaar oil combustion signature proved faulty, producing uncertainties in both the sulfur and carbon balances. The predicted sulfate levels at the receptor sites added 5–15 $\mu g/m^3$ to the receptor samples, with most originating from atmospheric SO_2 conversion reactions. This is consistent with the measured SO_4 levels reported for Cairo by Nasralla et al. (1992). A large percentage of the SO_2 in Cairo may originate from Solaar oil combustion.

A summary of the Fine and Coarse fraction mass apportionments for the North wind composite days for each site is given in Table 5-1. Table 5-2 summarizes the Fine and Coarse fraction Pb apportionment attributing more than two-thirds of the Fine Pb to lead smelter emissions and more than half of the Coarse Pb to automobiles.

5.4 Recommendations

This study's most obvious recommendations are to repeat or expand various aspects of the collection and analysis process to gather more precise and representative input data for the model. The most significant aspects of this process follow:

- Signature samples from selected sources should be repeated to provide samples more amenable (lightly loaded) to the subsequent analytical chemistry.
- Additional signature samples should be collected from selected sources to improve the representativeness for the entire Cairo area.
- Signature samples from selected sources should be repeated to minimize collinearity errors and provide samples that represent singular source categories as much as possible.
- A Coarse carbon channel should be added to the signature sampling system to collect the large particle carbon from some of the more uncontrolled Cairo sources.
- Procuring a thermal decomposition carbon analysis system for determining both elemental (soot) carbon and organic carbon.
- Additional receptor samples should be collected during south wind periods at the City Centre and Maadi sites to determine the influence of the Helwan sources.

- A portable meteorological station with a 10 meter tower should be installed at the receptor site during sample collection to better identify the variabilities in the local wind direction and speed and to provide data in a more timely manner to expedite sample selections for chemical analysis.
- Receptor sampling should be restricted to 12-hour periods from 6 a.m. – 6 p.m. to maximize the probability of consistent wind directions
- Comprehensive source inventories should be conducted within a 0.5–1 km radius of each receptor site to assist in interpretation of unusual data.

Table 5-1. Cairo Receptor Site Particle Mass Source Apportionments North Winds

Receptor Site	Fine Particles (<2.5 um) Category	%	Coarse Particles (2.5-10 um) Category	%
City Centre	Heavy Duty Diesels	38	Paved Roadway Dust	92
	Mazut Oil Combustion	24	Unknown Chloride Source	8
	Unknown Chloride Source	12		
	Ambient Sulfates	12		
	Automobiles/Petrol	10		
	Paved Roadway Dust	4		
	Lead Smelters	3		
Maadi	Ambient Sulfates	35	Unpaved Roadway Dust	38
	Vegetative/Trash Burning	33	Desert Dust	26
	Unpaved Roadway Dust	14	Lime Production*	26
	Iron & Steel/Sintering	3	Iron & Steel/Sintering	7
	Automobiles/Petrol	1	Cement Production/Dry Kiln	2
	Lead Smelters	<1		
Helwan	Vegetative/Trash Burning	33	Unpaved Roadway Dust	66
	Mazut Oil Combustion	28	Desert Dust	31
	Ambient Sulfates	17	Unknown Chloride Source	3
	Desert Dust	13		
	Iron & Steel/Converter	8		
	Automobiles/Petrol	<1		
	Lead Smelters	<1		
Shoubra El-Kheima	Vegetative/Trash Burning	32	Paved Roadway Dust	97
	Mazut Oil Combustion	31	Iron & Steel/Sintering	2**
	Iron & Steel/Sintering	14	Cement Production/Dry Kiln	1**
	Paved Roadway Dust	12		
	Ambient Sulfates	9		
	Automobiles/Petrol	<1		
	Lead Smelters	<1		
Background	Ambient Sulfates	36	Desert Dust	93
	Vegetative/Trash Burning	32	Unknown Chloride Source	8
	Mazut Oil Combustion	20		
	Desert Dust	11		
	Lead Smelters	3		
	Automobiles/Petrol	<1		

Notes: * speculated to be re-entrained Cement Production dust
** identification uncertain

Table 5-2. Cairo City Centre Lead (Pb) Source Apportionment North Winds

Receptor Site	Fine Particles (<2.5 um)		Coarse Particles (2.5-10 um)	
	Category	%	Category	%
City Centre				
	Lead Smelters	71	Automobiles/Petrol	54
	Automobiles/Petrol	28	Paved Roadway Dust	45
	Paved Roadway Dust	<1	Mazut Oil Combustion**	1
	Mazut Oil Combustion**	<1		

Notes: ** identification uncertain

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PN-ABY 838

ENVIRONMENTAL HEALTH PROJECT

ACTIVITY REPORT

No. 22

VOLUME II: APPENDICES
An Assessment and Source Apportionment of Airborne Particulate Matter in Cairo, Egypt

August, 1996

Charles E. Rodes
Mahmoud M. Nasralla
Philip A. Lawless

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D Detailed Analytical Data and 10-Year Meteorological Summaries
E Contact List of Key Personnel

APPENDIX A

Particulate Matter Characterization Considerations for the Cairo Modeling Study

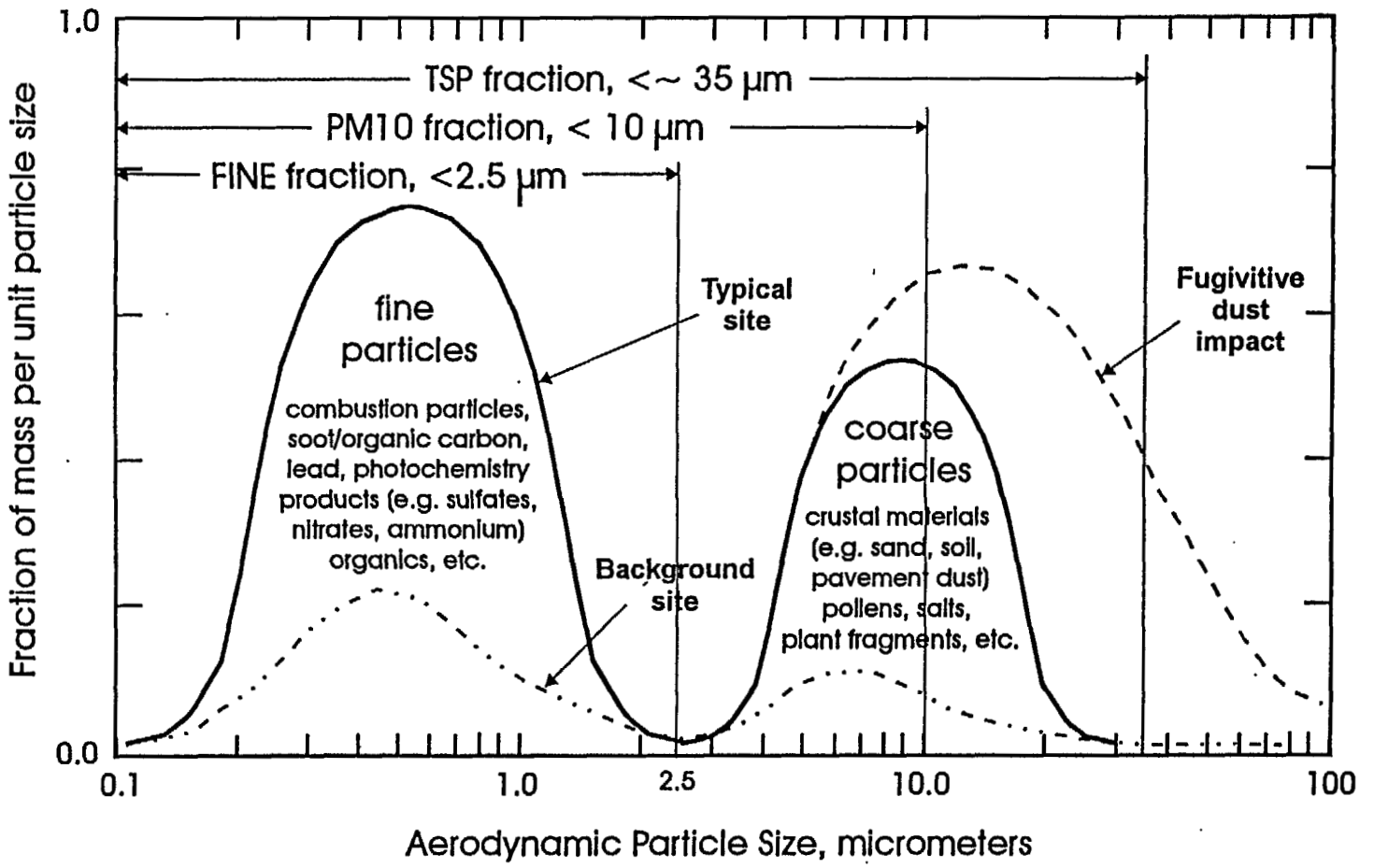
by Charles E. Rodes, PhD.
Research Triangle Institute
Research Triangle Park, NC USA

A modest understanding of the complex nature of particulate matter in the air and its relationships to health consequences is necessary to place this project into proper perspective. Unlike gases, particulate matter can be produced by sources in a number of particle sizes and forms that are not necessarily transported through the air, nor taken into the body in the same manner. Particulate matter suspended in the air tends to exist in a bi-modal distribution as shown in Figure 1, since the particle sizes tend to fall into general "fine" and "coarse" categories. Fine particles are produced primarily by combustion sources and atmospheric transformation reactions (smog). Coarse particles tend to be produced by mechanical processes such as re-entrainment of soil dust by the wind or automobiles. Very large re-entrained soil dust particles in the 50 to 200 micrometer (μm)[1] size range (e.g. desert sand) are not transported great distances or for extended times, since their settling velocities are rather large. Particles smaller than about 2 μm (e.g. diesel soot) can remain suspended for days and transport over large distances. As shown in Figure 1, "fugitive", mechanically agitated dust situations can substantially increase the mass of coarse (and total) particles. By contrast, background sites away from localized sources, can have very small fine and coarse fractions. The contribution of larger particles to the total mass of a samples can be substantial, since particle mass increases as the cube of the particle diameter. Several single particles greater than 20 micrometers can weigh more than all of the particles < 2.5 μm capable of reaching the lung. The toxicity of individual fine particles tend to substantially greater than that of coarse particles. This is generality is complicated, since fine particles can readily attach to larger particles (e.g. lead from the automobile tailpipe is generated in the 0.1 to 0.5 μm range, but readily attaches to 10 μm road dust particles re-entrained by the tires).

Although particles in the 30 to 50 μm size range can enter the nose and mouth, only particles smaller than 10 μm penetrate past the thorax, and only particles smaller than about 2.5 μm penetrate to the lungs. Since the toxicity of contaminants is partially determined by their point of deposition (and retention) in the body, an accurate assessment of health risks must consider the particulate matter by size fraction. Total body burden insults, such as those from lead and other heavy metals, require that all

[1] Particle diameters in this report are "aerodynamic" diameters, since respiratory separation by size occurs on this basis.

Figure 1. Typical Atmospheric Size Distributions of Particulate Matterby Sampling Fraction



particles entering the body be totaled (only the air exposure route is considered here). The Total Suspended Particulate (TSP) measurement historically reported in Cairo approximates this size fraction. The thoracic fraction (referred to as PM_{10}) was adopted as the U. S. particulate matter standard in 1987 to better identify carcinogenic species. A sub-fraction at 2.5 μm was recommended in the U. S. guidelines to be collected in parallel to more closely identify the lung-penetrable fraction, and assist in identifying source categories.

The data reported in this report will include the Fine (0 to 2.5 μm) fraction, the Coarse (2.5 to 10 μm) fraction, the PM_{10} (sum of Fine and Coarse) fraction, and the TSP (0 to ~35 μm) fraction. The latter fraction is included for comparison with historical data, and because the Cairo risk assessment[1] had only data from this fraction available as an input.

The atmospheric particulate matter concentrations (measured by local Egyptian agencies such as the National Research Center, or NRC) as Total Suspended Particulates (TSP) in Cairo were noted to be higher than in any other large city in the world. The TSP annual average concentration range reported in the risk assessment Technical Annexes[2] for Cairo was 349 to 857 $\mu g/m^3$, which can be compared to the U. S. standard of 75 $\mu g/m^3$. The chemical composition of the particulate matter was surmised to be as varied as the many sources in Cairo.

Appendix B

Cairo Receptor Modeling Study Work Plan

12/2/94

Environmental Health Project
Technical Work Plan
Conduct a Receptor Modeling Study of Airborne Particulate in Cairo, Egypt to Support the U. S. AID Mission

Charles E. Rodes, PhD
Center for Environmental Technology
Research Triangle Institute
Research Triangle Park, NC 27709

I. Background

The U.S. Agency for International Development (USAID) mission desires to identify the contributions of local man-made and natural sources to airborne, particle-phase toxics in and around Cairo, Egypt. As a key component of this identification process, RTI proposes to conduct a receptor modeling study for specific aerosol size fractions that would assist in fractionally apportioning the particles collected at selected receptor sites to specific source categories. An apportionment report would be prepared to provide input into a subsequent source control strategy development plan for Cairo. An important element of this plan is to provide cost-effective reduction of health risks attributable to aerosol source categories.

The apportionment study is driven by a previously prepared comparative risk assessment that noted that the average Cairo particulate levels (approximately 10 times WHO guidelines) may cause 4,000 to 16,000 excess deaths per year. The receptor modeling study would be an initial part of a new 8 year Cairo Air Project to begin in FY95 that will assess the risks, identify the most significant sources, determine cost-effective strategies to reduce the risks from these sources, incrementally fund industrial controls for some of the major sources, and develop appropriate indicators to assess the risk reductions from these interventions.

II. Objective

The objectives of the Cairo Receptor Modeling Study are to (1) support the Egyptian National Research Centre (NRC) in Cairo, Egypt in conducting a receptor modeling study, (2) conduct a model analysis and attribute Cairo airborne particulate, including coarse (2.5 to 10 μm) and fine (0 to 2.5 μm) particles to selected natural and anthropogenic sources, and (3) improve the NCR's capability to replicate the receptor modeling study in subsequent periods and at other locations.

III. Approach

The contracted support work as defined by USAID is to be divided into 5 tasks that are expected to be completed over a 5 month period:

Task 1 - Hardware/Software Procurement and Set-Up
Task 2 - Technical Assistance to the NRC for Sampling and Analysis
Task 3 - Technical Assistance to the NRC or Receptor Modeling
Task 4 - Reporting
Task 5 - Management

A basic component of the receptor modeling study will be the integration of a local Egyptian subcontractor, Environmental Quality International (EQI, secured under a separate agreement by the Environmental Health Project, or EHP, and the NRC), for 5 person-months (835 man-hours) of technical support services, including shipping and receiving, sampling set-up assistance, logistical and training assistance and initial sampling support. The U.S. contractor (Camp, Dresser and McKee, CDM) for EHP, through subcontractors (Research Triangle Institute, or RTI, and Radian) will be responsible for all air sampling activities thru the set-up and training of the operating personnel. Subsequent sample collection will be performed by an Egyptian subcontractor under joint direction with Dr. Nasralla of the NRC. RTI will procure the sampling hardware, an analytical balance to weigh filters on-site, provide Teflon, quartz and glass fiber filters (pre- and post-weighed if necessary), and arrange analysis subcontracts to analyze samples for a suite of metals by XRF, sulfates and nitrates by Ion Chromatography, and volatile organic and elemental carbon by thermal decomposition. RTI will assimilate the sampling and analysis data, and prepare an initial preliminary report, using limited data covering a 5 to 10 day period at a central site, and a subsequent, more extensive final report covering urban, industrial and rural locations. Radian Corporation will provide experts for assisting with the CMB computer model application and training the NRC on-site in its application.

CMB Framework

The output quality of a receptor model is dependent on a number of factors including: (1) the representativeness of the air sampling locations for the sources and regional scales being considered; (2) the availability of collected air samples in conjunction with "acceptable" meteorological conditions that demonstrate that the samples represent an air mass impacted by the source categories of interest; (3) the precision of the air samples (mass and analyte concentrations); (4) the availability and representativeness of source "signatures" for the desired source categories; (5) the availability of the samples collected by discreet aerosol size fractions and on specific sampling substrates (Teflon for mass, metals, sulfates and nitrates, Quartz for volatile and elemental carbon); (6) the availability of the necessary analyte measurement capabilities, including an extended list of metals, preferably by XRF, and carbon analyses by pyrolysis; and (7) the skill utilized in conducting the receptor modeling. The quality of the resultant CMB model is dependent on all of the steps being appropriately considered. Care must be taken that (a) the receptor samples represent substantial impacts from the selected source categories, and that (b) the signature samples are as representative and distinctive as possible for the selected source categories. Significant compromises in either of these aspects may substantially increase the variance components in the CMB model, and may produce a substantial percentage of mass for which a source cannot be determined. An unaccounted fraction of greater than about 40% would reduce the source apportionment quality to marginal at best. Acid gases will be removed by denuders during signature sampling, but the potential

contributions of these gases to aerosol phase sulfates and nitrates will not be quantified. The ambient receptor sampling will not use acid gas denuders (dichotomous samplers will be utilized, rather than VAPS samplers), and hence may contribute to the total Teflon filter collections (COARSE and FINE fractions) of sulfates and nitrates.

It is possible to conduct a very limited scale receptor modeling effort using only metals analyses from collected air samples and signatures "constructed" from available literature and local emissions factor data. This approach has been reported in the literature for a number of locations, but would be expected to provide model output data of undefined quality for this study. This would result primarily from an inability to determine the applicability of available source signatures from other locations (principally the U.S.) for the Cairo metropolitan area. A more robust effort would consist of parallel collection of representative source "signature" samples, while collecting the necessary receptor air samples. The list of metals currently interpreted by CMB analyses are readily attainable with the necessary analytical sensitivity by XRF analyses. The PM10 concentrations for urban Cairo are expected to be in the 100 to 300 $\mu g/m^3$ range, based on reported TSP levels. If the Egyptian labs wish to participate in a comparability study for these metals by atomic absorption from PM10 high volume sampler quartz filters, a limited split sample comparison will be made with selected filters (to be discussed with NRC)

CMB Model and Computer

A chemical mass balance (CMB) receptor model is an effective variance, least squares solution to a set of linear equations which express each measured chemical species concentration in the air sample as a linear sum of the contributions of each source to the chemical species. The current technology receptor model used by the U. S. Environmental Protection Agency (EPA) is designated "CMB, version 7", and is available (at no cost) with documentation. The model is PC-based, but not necessarily user-friendly. A copy of the model, the documentation and a suitable DOS 486/66 computer platform and printer will be obtained. A Radian engineer, Nikhil Shenoi, trained in receptor modeling, will assist Charles Rodes of RTI in conducting the computer set-up and training on the model application for this portion of the task on-site.

Signature Sampling

A signature sample would be collected for 10 source categories. The originally specified list provided by USAID included: soil and road dust, vegetable burning, auto exhaust (non-diesel), diesel exhaust, cement production, marine, residual oil, aluminum production, lead smelting. After consultation with Dr. Nasralla, a revised list of the 10 most pervasive sources includes: desert dust, agricultural dust, road dust, non-diesel auto exhaust, diesel auto exhaust, cement production, oil (solar light oil) combustion from bakery ovens, oil (mazut heavy oil) combustion from power plants, fertilizer production, and lead smelting. Signature sampling will be accomplished using a special EPA-designed sampling system (obtained from University Research Glassware, Carrboro, North Carolina, USA) that provides samples for mass, metals, semi-volatile organics (organics are not proposed for this effort), sulfates and nitrates, elemental carbon (C_e) and volatile organic carbon (C_v). The signature sampling locations would be selected jointly with the NRC, and should be representative of the source category and season of interest. Certain categories will be represented by collecting bulk dust samples and re-suspending the dust onto FINE and COARSE filters for subsequent analysis. These sources

include: desert dust, agricultural dust, and road dust. Dust samples will be collected at a number of locations in the metropolitan area for either separate analysis or compositing prior to analysis. Sampling for cement production, oil combustion, fertilizer production and lead smelting would be conducted randomly over approximately a 2 day periods at each location for 30 to 60 minutes/sample, when the sources were operating normally. Up to 4 samples will be collected, and possibly composited sequentially for each source, depending on the expected variability of the source emissions. Total non-diesel and diesel automotive sources would be represented while the sampler operated at either a confined location (e.g. tunnel, underpass) or a nearby downwind location representing autos, trucks and buses. Separate samples would be collected adjacent to a covered bus depot to represent diesel automotive source contributions. Hopefully, the total automotive and diesel sources could be subtracted to obtain relatively discreet signatures with minimal auto-correlation. Signature sampling requires a significant amount of skill, given the research nature of the all glass sampling system, and will require an expert trained in source sampling. Currently, Ramesh Kapolanu of Radian will be trained at RTI to provide the expertise to set-up the signature sampler in Egypt and train the NRC personal on its operation.

Air Sampling

The primary receptor air sampling would consist of two collocated dichotomous samplers obtained from Graseby Andersen (Atlanta, Georgia, USA) providing 0 - 2.5 μm FINE fractions and 2.5 - 10.0 μm COARSE fractions. One dichotomous sampler would be operated with 37 mm Teflon filters (both size fractions) for mass, water soluble sulfates and nitrates by Ion Chromatograph (IC) and metals by X-Ray Fluorescence (XRF), and the other would use 37 mm Quartz filters (both size fractions) for carbon as C_v and C_e. Filters and shipping cassettes would be provided. Secondary air sampling (a 10 - 20 % subset of samples for comparability) would consist of the existing TSP hi-vol (provided by the NRC) and a PM10 hi-vol obtained from Graseby Andersen (Atlanta, Georgia, USA), both using glass fiber filters for mass concentrations. Samples will be collected at each site for 24 hour periods (midnight to midnight) on an every other day operating schedule, with sampler operation controlled by a clock timer.

After initial set-up at an urban, center-city location (see attached figure), the duplicate PM_{10} high volume samplers and dichotomous samplers would be operated collocated for three 24 hour sample periods to obtain precision estimates. The selection of all sampling locations (receptor and signature) will be determined jointly with Dr. Nasralla of the NRC. Two receptor sampling periods would then be conducted. Period 1 will consist of collection of 2 to 4 sets of collocated sampler sets for precision, 5 to 10 sets of air samples (10 to 20 calendar days) at 1 site, from which 5 sets of samples will be analyzed, followed by 5 days of sampling at a regional background site. Period 2 will consist of collection of 15 sets of air samples (30 calendar days/site) at the same site as period 1, plus an additional site, from which 10 sets of samples will be analyzed. Between Periods 1 and 2, the PM_{10} dichotomous samplers (only) would be moved to a regional "background" location to obtain samples representing the upwind Cairo airshed. The two receptor sampling sites will be selected jointly with NRC to represent a center-city urban location and a residential location proximal to an industrial area. A set of filters/receptor site sampling day would consist of 1 each TSP hi-vol filter, PM10 hi-vol glass fiber filter, FINE fraction Teflon filters, FINE fraction Quartz filters, COARSE fraction Teflon filters, and

COARSE fraction Quartz filter. Sampling will also be conducted at a background site, that would consist of 1 TSP hi-vol filter and 1 PM10 hi-vol glass fiber filter. The background site Teflon filters would be analyzed for mass, metals, sulfates, nitrates and carbon concentrations, unless the wind direction proved to be highly variable (such that they may not be true background samples). In the latter case only mass concentrations would be determined, and the need for additional background sampling after Period 2 would be assessed.

A significant concern for the air samplers is selecting aerosol inlets that can sample under high loading conditions for extended periods, with minimum bias from internal dust soiling and minimum maintenance by the operators. A routine cleaning (and re-oiling for the PM_{10} high volume sampler inlets) procedure will be required, resulting from the elevated aerosol concentration levels in Cairo. TSP concentration levels have often been reported in the 500 to 1000 $\mu g/m^3$ range.

The air sampling locations should represent the exposed populations in an urban, center-city and an industrial setting, plus a regional background (predominantly upwind of the airshed) location. The initial set-up would be implemented with assistance from EQI and conducted at an urban, center-city location with an existing TSP sampler that can be operated with glass fiber filters. A second PM10 hi-vol would be added, along with the two dichotomous samplers. The samplers would be subsequently moved to the industrial site by NRC personnel. The sampling sites should be 2 to 5 meters above the ground, have sufficient space (approx. 9 m^2) for the TSP and PM_{10} high volume samplers and the 2 dichotomous samplers simultaneously, adequate power (approx. 8 amps at 220 VAC for each sampler) for simultaneous sampler operation, and be relatively free from nearby obstruction. The background site would have only a TSP and the two PM10 dichotomous samplers.

Meteorological Data

Analysis of the air samples beyond mass for the receptor modeling will be guided by the local meteorological data. It is anticipated that hourly wind speed and direction data collected at the standard 10 meter elevation will routinely be available from a local station in the Cairo metropolitan area. These data must be collected and entered into the study data base to conduct cluster analyses of the mass concentration data as a function of wind direction. Wind direction variability will also be computed. The cluster analyses will be conducted as a precursor step to the CMB modeling, and is used to select a subset of days/sampling location for which the filters will be analyzed. Favorable meteorology for receptor sampling in this study is broadly defined as (a) adequate wind speeds (>2 km/hr) to move the air mass from the source to the receptor locations, and (b) wind directions during the 24 hour sampling period "in-sector" (±45 degrees) for at least 50% of the time. The services of a local meteorologist would be highly desirable to help select the appropriate sites, determine if the necessary favorable conditions had been met, and project the ground level locations downwind of the selected point sources at which to locate the signature sampling system.

Filters, Sampling and Shipping Cassettes

The 20.3 by 25.4 cm TSP and PM10 hi-vol glass fiber filters and the 37 mm Teflon filters for the dichotomous sampler will be obtained from Gelman Sciences (Ann Arbor, Michigan, USA) and provided, including field and laboratory blanks. The 37 mm Quartz filters for the dichotomous sampler and 47 mm Quartz filters for signature sampler will be obtained

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from Sunset Laboratories (Beaverton, Oregon, USA). The Quartz filters are pre-fired to minimize background levels. Filter shipping cassettes will be also be obtained from Gelman. Cassettes to hold the Teflon and Quartz filters during sampling would be obtained from the sampler manufacturer (Graseby-Andersen).

Sample Analysis

The filters from the selected days based on meteorology of air sampling/receptor site, plus background site filters will be analyzed, in addition to the signature samples. It has tentatively been determined that mass determinations ($\mu g/m^3$) for the TSP and PM10 hi-vol glass fiber filters, the dichotomous sampler Teflon and Quartz filters (FINE and COARSE), and the Teflon and Quartz filters from the signature sampler can be done by the subcontractor, EQI, if an analytical balance is procured and provided. The humidity equilibration of these filters will be a slight problem, but in the short time available, a suitable procedure has not yet been identified. The filters alternatively will be pre- and post-weighed by RTI in the US, but at the potential loss of particulate during shipment of the exposed filters.

Sulfates and nitrates analyses from the Teflon filters for the dichotomous and signature sampler Teflon filters (FINE and COARSE) will be done by the Research Triangle Institute, Research Triangle Park, NC. Metal analyses on the Teflon filters will be done (tentatively) by Desert Research Institute in Reno, NV (USA). The list of metals by XRF includes Al, Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, Sr, Sn, Ba, and Pb. Volatile organic and elemental carbon analyses (C_v and C_e) on a 1.5 x 1.5 cm square punched from the remaining halves of the dichotomous sampler Quartz filters (FINE and COARSE), and remaining halves of the Quartz filters from the signature sampler will be done under a subcontract to Sunset Laboratories in Beaverton, Oregon, USA. After gravimetric mass determination the Quartz filters will be sent to Sunset for punching prior to return shipment to NRC for (possible) metals analyses on a subset of samples by AA. Similarly, the Teflon filters will be sent to Desert Research Institute laboratory after gravimetric analysis. Since the XRF and carbon analyses may be done in batches to reduce costs, and the analytical time may be 5 to 15 days, it would be expected that the receptor analysis could not be conducted until approximately 20-30 days after the completion of sample collection. This time allowance also accounts for gravimetric analyses in Egypt and international air freight shipments to and from the U. S.

Quality Assurance (QA) and Sampling Support

In order to collect data of consistent and known quality, a QA program for sampling, analysis and reporting will be developed and implemented to meet the QA objectives for the receptor modeling. The preliminary QA objectives are (1) >90 percent data capture, and (2) ±15 % precision for the mass and analyte concentrations for collocated sampling fractions (PM_{10}, Fine and Coarse). For sampling, this program will consist of an initial QA plan, defining equipment specifications, determining that the delivered equipment meets these specifications, developing a consistent data format among participants for sampling and analysis results, providing apparatus to routinely calibrate the sampling flowrates, defining a collocated sampling schedule (air samplers only) to determine sampling precision, providing a sample and data custody scheme to assure integrity, and (most importantly) providing local operator training in set-up and operation that is consistent for the duration of the project. For analysis, the QA will consist of defining the rate of repeat analyses for precision estimation, providing blind samples

to the participating laboratories and defining a split sample program among laboratories for comparability.

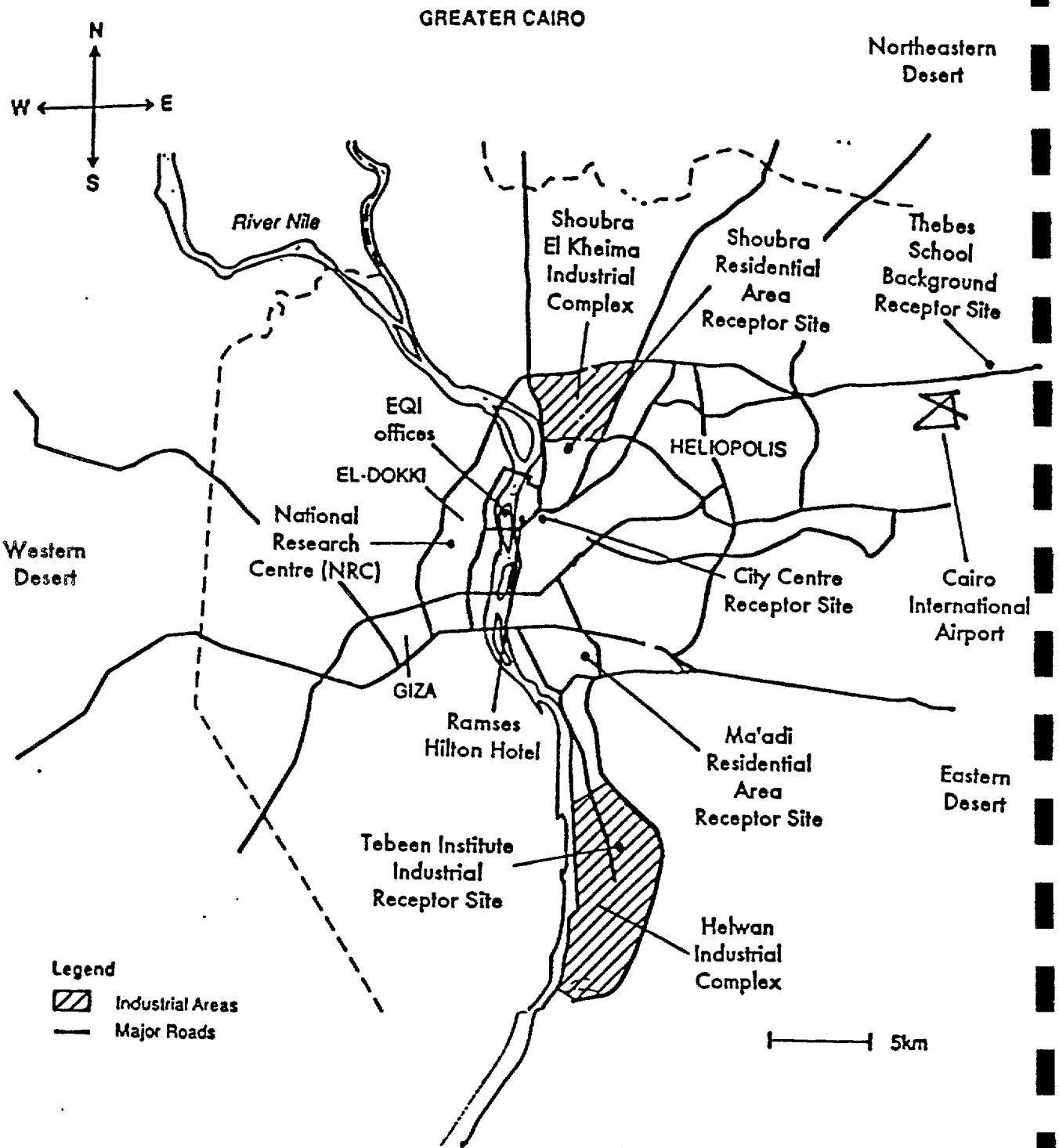
Sampling data will be returned to RTI in the Research Triangle Park, North Carolina on a routine (preferably bi-weekly) basis and reviewed for consistency and to identify possible sampling problems. Additional filters, maintenance items and other sampling supplies will be procured and sent to Cairo, if necessary. Routine (monthly) telephone discussions will be held with the on-site support contractor and NRC personnel to assess the sampling progress.

Scheduling

A detailed schedule identifying significant milestones, participants and outputs is attached.

Reporting

A preliminary report will be prepared by early April, 1995, describing the source apportionment modeled from the samples collected during Period 1. A final report will be prepared by the end of July, 1995, describing the sampling results, concentration data base, results of the CMB model application for Period 2, and interpretation in light of potential source control strategies for population exposure reduction. All reports will be submitted first to the Environmental Health Project for internal reviews, prior to being finalized and submitted to the U. S. AID mission and the NRC. The final report will be of publishable quality in a peer-reviewed technical journal, co-authored with Dr. Nasralla and other contributors.


GREATER CAIRO
N
W
E
S
Northeastern Desert
River Nile
Shoubra El Kheima Industrial Complex
Shoubra Residential Area Receptor Site
Thebes School Background Receptor Site
EQI offices
EL-DOKKI
HELIOPOLIS
National Research Centre (NRC)
Western Desert
City Centre Receptor Site
Cairo International Airport
GIZA
Ramses Hilton Hotel
Ma'adi Residential Area Receptor Site
Eastern Desert
Tebeen Institute Industrial Receptor Site
Helwan Industrial Complex
Legend
Industrial Areas
Major Roads
5km

CAIRO PROJECT SCHEDULE - accelerated version

Charles E. Rodes, RTI, 11/4/94

Task	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	
Start date	x									
Finalize written plans	x									
Prepare specifications for equipment	x									
Initiate receptor and signature ampler procurements	x									
Initiate supply (filters, etc) procurements	x									
Initiate computer procurement	x									
Initiate analysis subcontracts (XRF and carbon analyses)	x									
Cairo project team meeting, Washington DC	x									
Receive supplies (filters, etc.)	x									
Receive PM10 Hi-vols and Dichotomous sampers	x									
Check, calibrate and crate receptor samplers	x									
Air freight ship receptor samplers to contractor in Cairo	x									
Prepare SOP's, copy references, prepare training materials for receptor samplers	x									
Initial visit to Cairo		xxxx								
Set up receptor samplers, site 1		xx								
Train technicians on receptor sampler operations		x								
Duplicate receptor precision sampling at one site		xx								
Preliminary receptor sampling, period #1		xxx	xx(xxx)							

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Task	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Collect local meteorology data for sampling period #1			xxx							
Ship sampling period #1 filters to US for analyses			xx							
XRF sample analyses (Teflon filters)			x	xx						
Carbon sample analyses (Quartz filters)			x	xx						
Analyze data, complete preliminary source apportionment, select key sources for signatures				xxx						
Prepare and submit report on initial Cairo source apportionment				x	xx					
Second visit to Cairo			xxx	xx						
Train technicians on signature sampler operation			xx							
Set up and operate signature sampler at 1 site			x	x						
Set up computer system w/CMB7, provide initial training				x						
Plan signature sampling schedule with Egyptian contractor				xx						
Conduct signature sampling for up to 10 sources				xxxxxx	xxxxxx					
Conduct receptor sampling period #2				xxxxxx	xxxxxx					
Move receptor samplers to site 2					x					
External audit QA visit to Cairo to check samplers, calibrations and procedures					xxx					

Task	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Collect local meteorology data for sampling period #2					xxx					
Ship sampling period #2 filters to US for analyses					x					
XRF sample analyses (Teflon filters)						xxxx				
Carbon sample analyses (Quartz filters)						xxxx				
Sulfate and nitrate analyses (Quartz filters)						xxxx				
Analytical data assimilated and validated						xx				
Analyze data, complete extended source apportionment						x	xxx			
Receptor modeling visit to Cairo to enter data, run CMB model and train Egyptians							xxxxx			
Prepare and submit final report including extended Cairo source apportionment								xxx		
Final visit to Cairo to present report, results, recommendations								xxx		

APPENDIX C

Sources of Receptor and Signature Samplers

Receptor Sampler

Identification: SA241M Dichotomous Sampler
with a 10 μm inlet and a 2.5 μm stage cutpoint

Source:

Graseby Andersen, Inc.
4801 Fulton Industrial Blvd.
Atlanta, GA 30336
ph. 800-241-6898
FAX 404-691-6315

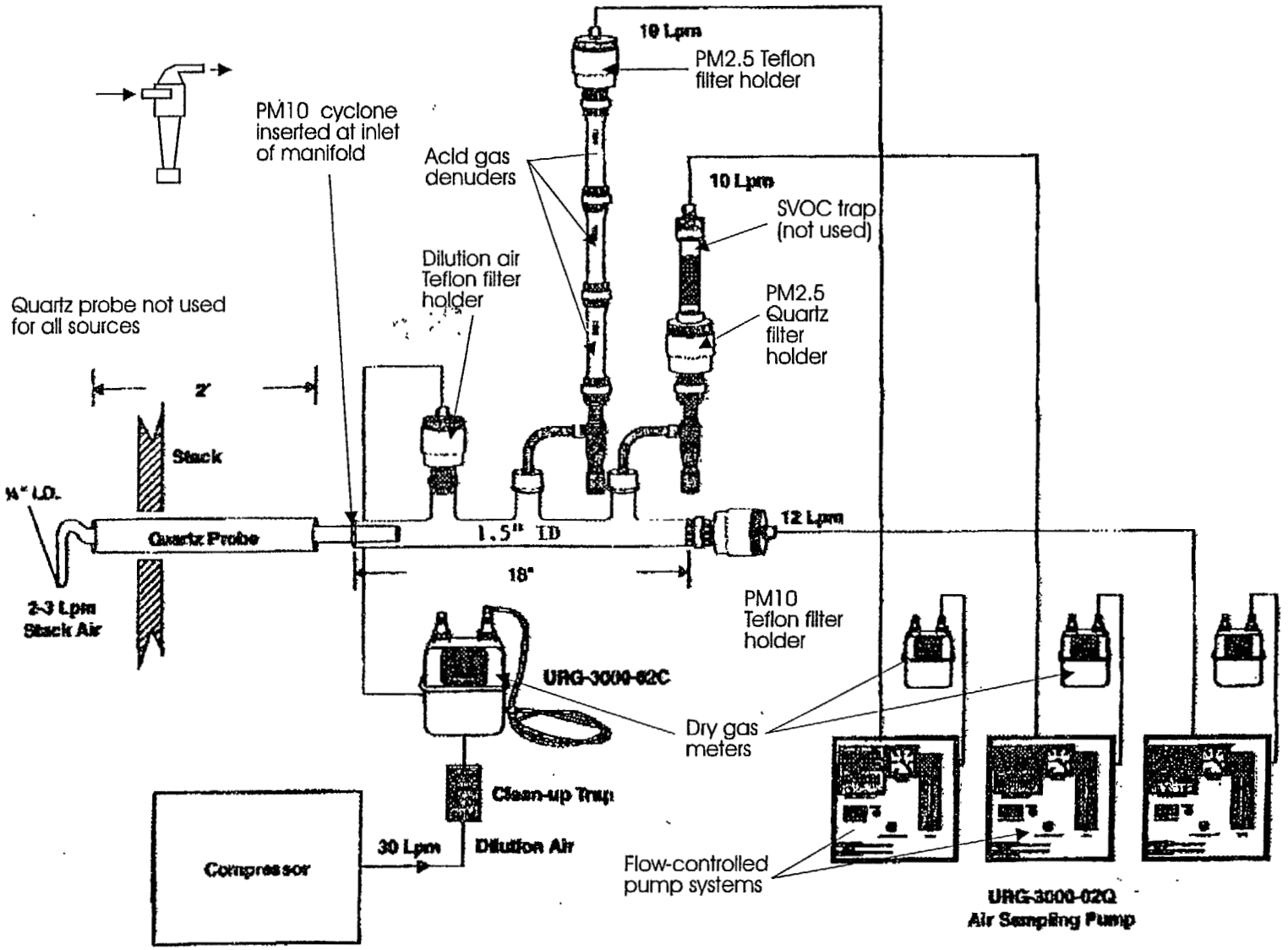
Source Signature Sampler

Identification: Dilution-Equilibration Source Signature Sampler

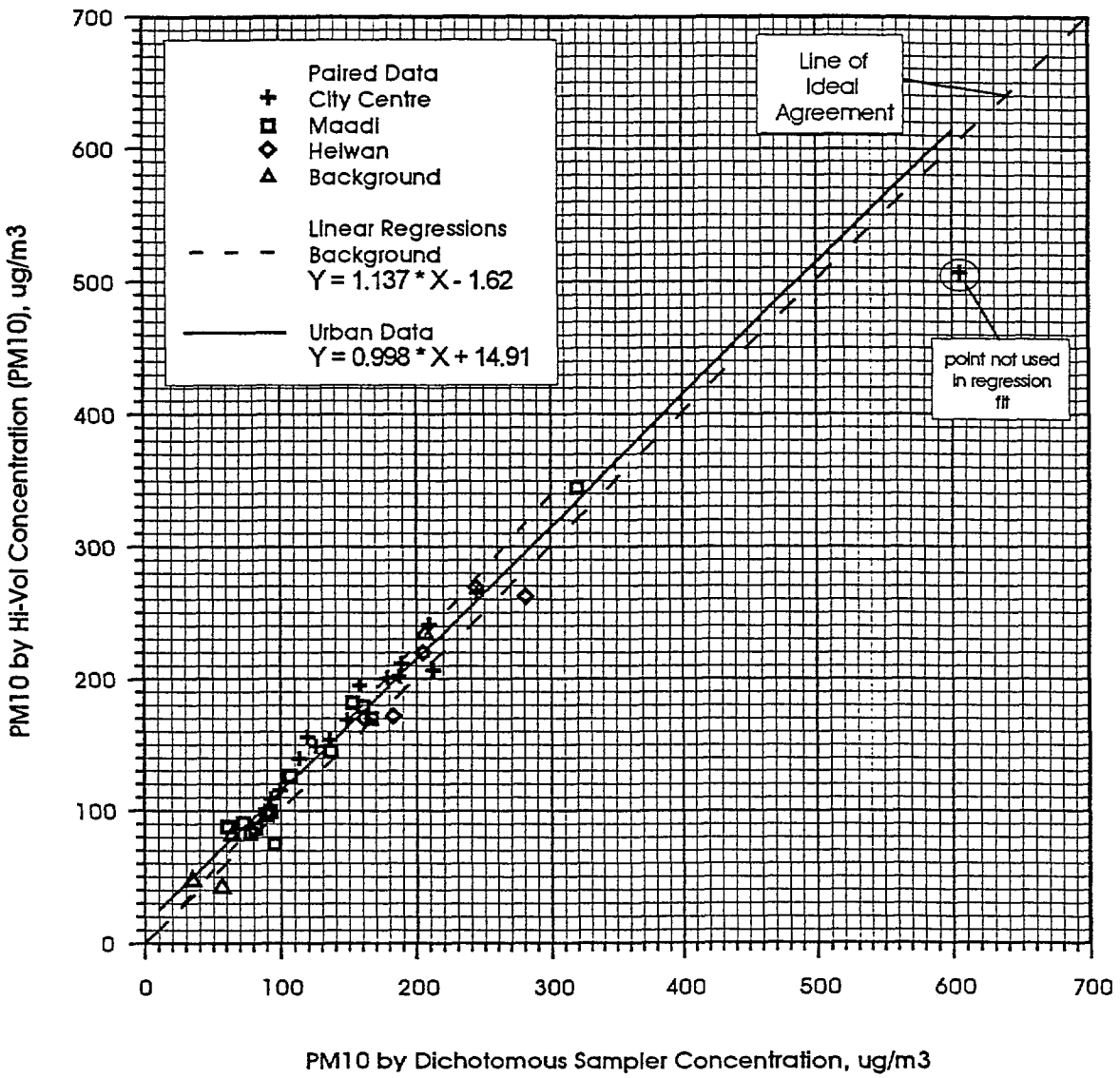
Source:

University Research Glassware (URG)
P. O. Box 368
Carrboro, NC 27510
ph. 919-942-2753
FAX 919-942-3522

Source Signature Sampling System (URG design) Used in Cairo Study



Relationships Between PM10 Measurements by Dichotomous and PM10 Hi-Vol by Receptor Sampling Site in Cairo



Appendix D

Detailed Analystical Data and 10 Year Meterological Summaries

<u>Contents</u>

Dichotomous Samplers Filter Data Log Sheets
[identifies filter numbers and types]

Source Signature Sampler Data Log Sheets
[identifies filter numbers and types]

X-Ray Fluorescence Metals Analysis Data by Filter Number

Source Signatures by Analytes

10 Year Meteorology Summary

Original XRF Laboratory Results

Cairo Receptor Modeling Study Mass Concentration Data

Dichotomous Sampler : Fine fraction: 0 to 2.5 micrometers
Coarse fraction: 2.5 to 10 micrometers
PM10 fraction: 0 to 10 micrometers

18-Mar-96

1995 data				Fine	Coarse	PM10	Ratio	Ratio	Ratio
Start Date	End Date	Site	stat.	Conc. ug/m3	Conc. ug/m3	Conc. ug/m3	COARSE / FINE	FINE / PM10	COARSE / PM10
27-Jan	23-Mar	C	#	25	25	25	25	25	25
		C	mean	73.9	103.5	177.5	1.553	0.418	0.582
		C	std. dev.	35.8	55.2	80.2	0.567	0.088	0.088
		C	max	149.8	340.4	439.4	3.437	0.601	0.775
		C	min	41.2	67.0	99.7	0.948	0.370	0.487
27-Mar	30-Mar	B	#	4	4	4	4	4	3
		B	mean	24.91	65.74	90.65	2.492	0.305	0.695
		B	std. dev.	17.35	61.80	78.39	0.984	0.090	0.090
		B	max	49.80	156.90	206.70	3.480	0.416	0.777
		B	min	11.83	22.88	34.71	1.403	0.223	0.584
12-Apr	7-May	M	#	13	13	13	13	13	13
		M	mean	32.6	93.6	126.2	2.926	0.276	0.724
		M	std. dev.	12.4	57.8	66.8	1.153	0.081	0.081
		M	max	55.5	264.3	319.7	4.765	0.432	0.827
		M	min	15.9	48.2	72.2	1.316	0.173	0.568
31-May	6-Jun	H	#	5	5	5	5	5	5
		H	mean	51.08	163.91	215.00	3.236	0.237	0.763
		H	std. dev.	12.39	36.48	47.83	0.302	0.018	0.018
		H	max	62.50	218.50	281.00	3.496	0.267	0.778
		H	min	49.40	124.11	205.23	2.752	0.222	0.733
1-Aug	7-Aug	S	#	6	6	6	6	6	6
		S	mean	59.85	129.65	189.50	2.214	0.322	0.678
		S	std. dev.	6.19	27.12	23.50	0.650	0.063	0.063
		S	max	69.10	161.19	221.28	3.218	0.406	0.763
		S	min	49.59	99.93	159.47	1.462	0.237	0.594
19-Aug	30-Aug	C	#	6	6	6	6	6	6
		C	mean	54.4	68.1	122.4	1.735	0.387	0.613
		C	std. dev.	9.7	7.4	14.9	0.723	0.099	0.099
		C	max	66.2	81.3	147.5	3.064	0.551	0.754
		C	min	42.6	59.2	108.2	0.815	0.246	0.449
6-Sep	26-Sep	B	#	7	7	7	6	6	6
		B	mean	27.9	45.8	73.7	1.279	0.442	0.558
		B	std. dev.	6.4	14.5	15.2	0.222	0.041	0.041
		B	max	36.5	65.9	87.4	1.610	0.477	0.617
		B	min	17.6	26.1	50.8	1.096	0.383	0.523

Site ID's: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima,
B - Background (Thebes School)

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat9.xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3	Comments
1	27-Jan-95	C	C	T	82760	31001	0.105480	0.106850	0.001370	10.83	1.17		110.7		
	27-Jan-95	C	F	T	82760	31002	0.101640	0.103050	0.001410	10.83	1.17	146.0		256.7	
2	27-Jan-95	C	C	T	82760	31004	0.107090	0.108440	0.001350	11.75	1.20		99.6		collocated duplicate
	27-Jan-95	C	F	T	82760	31003	0.102470	0.104050	0.001580	11.75	1.20	149.8		249.4	
3	31-Jan-95	C	C	T	82760	31006	0.113990	0.115320	0.001330	11.59	1.16		102.0		
	31-Jan-95	C	F	T	82760	31007	0.113270	0.113970	0.001330	11.59	1.16	127.5		229.5	
4	31-Jan-95	C	C	T	82760	31008	0.115840	0.116890	0.001050	11.52	1.15		84.1		collocated duplicate
	31-Jan-95	C	F	T	82760	31009	0.107360	0.108090	0.000730	11.52	1.15	70.4		154.5	
5	2-Feb-95	C	C	T	82760	31010	0.117090	0.118220	0.001130	11.70	1.17		90.0		
	2-Feb-95	C	F	T	82760	31011	0.109660	0.110350	0.000690	11.70	1.17	65.5		155.6	
6	2-Feb-95	C	C	T	82760	31013	0.109470	0.110560	0.001090	11.74	1.17		86.1		collocated duplicate
	2-Feb-95	C	F	T	82760	31012	0.107900	0.108620	0.000720	11.74	1.17	68.1		154.2	
7	6-Feb-95	C	C	T	82760	31014	0.108650	0.109370	0.000720	11.28	1.16		61.1		
	6-Feb-95	C	F	T	82760	31015	0.107610	0.107880	0.000270	11.28	1.16	26.7		87.8	
8	6-Feb-95	C	C	T	82760	31016	0.107640	0.108250	0.000610	12.07	1.17		47.4		collocated duplicate
	6-Feb-95	C	F	T	82760	31019	0.107190	0.107540	0.000350	12.07	1.17	32.1		79.5	
9	8-Feb-95	C	C	T	82760	31018	0.109440	0.110140	0.000700	11.90	1.21		54.6		
	8-Feb-95	C	F	T	82760	31026	0.109450	0.109890	0.000440	11.90	1.21	41.2		95.8	
10	8-Feb-95	C	C	T	82760	31027	0.114630	0.115470	0.000840	11.75	1.17		67.9		collocated duplicate
	8-Feb-95	C	F	T	82760	31028	0.109400	0.109780	0.000380	11.75	1.17	35.9		103.8	

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda10.xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	15-Feb-95	C	C	Q	na	2			na	11.84	1.19		na	
	15-Feb-95	C	F	Q	na	1			na	11.84	1.19	na		na
2	15-Feb-95	C	C	T	82760	31029	0.109310	0.109960	0.000650	11.60	1.16		51.9	
	15-Feb-95	C	F	T	82760	31030	0.109630	0.110060	0.000430	11.60	1.16	41.2		93.1
3	17-Feb-95	C	C	Q	na	4			na				na	
	17-Feb-95	C	F	Q	na	3			na			na		na
4	17-Feb-95	C	C	T	82760	31032	0.110750	0.111800	0.001050	11.53	1.16		80.3	
	17-Feb-95	C	F	T	82760	31031	0.108290	0.109400	0.001110	11.53	1.16	107.0		187.3
5	19-Feb-95	C	C	Q	na	6			na				na	
	19-Feb-95	C	F	Q	na	5			na			na		na
6	19-Feb-95	C	C	T	82760	31033	0.105700	0.106920	0.001220	11.80	1.16		91.8	
	19-Feb-95	C	F	T	82760	31034	0.107510	0.108760	0.001250	11.80	1.16	117.5		209.3
7	21-Feb-95	C	C	Q	na	8			na				na	
	21-Feb-95	C	F	Q	na	7			na			na		na
8	21-Feb-95	C	C	T		31036	0.108470	0.109450	0.000980	11.72	1.17		79.0	
	21-Feb-95	C	F	T		31035	0.108770	0.109260	0.000490	11.72	1.17	46.4		125.4
9	23-Feb-95	C	C	Q	na	10			na				na	
	23-Feb-95	C	F	Q	na	9			na			na		na
10	23-Feb-95	C	C	T		31038	0.106460	0.107510	0.001050	11.87	1.19		78.4	
	23-Feb-95	C	F	T		31037	0.109890	0.110960	0.001070	11.87	1.19	100.2		178.6

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Khelma, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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File: dichda11.xls
C. Rodes, RTI, 9/12/95

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	26-Feb-95	C	C	Q	na	12			na	11.87	1.18		na	
	26-Feb-95	C	F	Q	na	11			na	11.87	1.18	na		na
2	26-Feb-95	C	C	T	82760	31040	0.105890	0.107210	0.001320	11.53	1.18		106.0	
	26-Feb-95	C	F	T	82760	31039	0.105520	0.106380	0.000860	11.53	1.18	83.1		189.1
3			C											
			F											
4			C											
			F											
5			C											
			F											
6			C											
			F											
7			C											
			F											
8			C											
			F											
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat7.xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	28-Feb-95	C	C	Q	na	14			na	?	1.15		na	
	28-Feb-95	C	F	Q	na	13			na	?	1.15	na		na
2	28-Feb-95	C	C	T	82760	31042	0.108170	0.110190	0.002020	11.80	1.17		163.2	
	28-Feb-95	C	F	T	82760	31041	0.113040	0.113900	0.000860	11.80	1.17	80.9		244.1
3	2-Mar-95	C	C	Q	na	16			na	10.93	1.78		na	
	2-Mar-95	C	F	Q	na	15			na	10.93	1.78	na		na
4	2-Mar-95	C	C	T	82760	31046	0.109770	0.110610	0.000840	11.94	1.24		67.0	
	2-Mar-95	C	F	T	82760	31045	0.111120	0.111470	0.000350	11.94	1.24	32.7		99.7
5	9-Mar-95	C	C	Q	na	18			na	11.80	1.18		na	
	9-Mar-95	C	F	Q	na	17			na	11.80	1.18	na		na
6	9-Mar-95	C	C	T	438210	31071	0.118360	0.120090	0.001730	11.94	1.18		137.5	
	9-Mar-95	C	F	T	438210	31070	0.110270	0.111080	0.000810	11.94	1.18	75.3		212.7
7	12-Mar-95	C	C	Q	na	20			na	?	1.20		na	
	12-Mar-95	C	F	Q	na	19			na	?	1.20	na		na
8	12-Mar-95	C	C	T	438210	31073	0.114530	0.115560	0.001030	11.63	1.14		83.5	
	12-Mar-95	C	F	T	438210	31072	0.114970	0.115510	0.000540	11.63	1.14	51.5		135.0
9	14-Mar-95	C	C	Q	na	22			na	11.59	1.16		na	
	14-Mar-95	C	F	Q	na	21			na	11.59	1.16	na		na
10	14-Mar-95	C	C	T	438210	31075	0.105480	0.108500	0.003020	11.47	1.17		253.2	
	14-Mar-95	C	F	T	438210	31074	0.105520	0.106540	0.001020	11.47	1.17	99.0		352.2

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat8.xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	16-Mar-95	C	C	Q	na	24			na	11.68	1.18		na	
	16-Mar-95	C	F	Q	na	23			na	11.68	1.18	na		na
2	16-Mar-95	C	C	T	436210	31077	0.102590	0.104000	0.001410	12.38	1.22		110.1	
	16-Mar-95	C	F	T	436210	31076	0.101680	0.102110	0.000430	12.38	1.22	38.5		148.6
3	19-Mar-95	C	C	Q	na	26			na	11.70	1.18		na	
	19-Mar-95	C	F	Q	na	25			na	11.70	1.18	na		na
4	19-Mar-95	C	C	T	436210	31079	0.104800	0.105790	0.000990	11.74	1.17		80.5	
	19-Mar-95	C	F	T	436210	31078	0.106170	0.106580	0.000410	11.74	1.17	38.8		119.3
5	21-Mar-95	C	C	Q	na	28			na	?	1.19		na	
	21-Mar-95	C	F	Q	na	27			na	?	1.19	na		na
6	21-Mar-95	C	C	T	436210	31081	0.107060	0.108050	0.000990	11.67	1.17		76.7	
	21-Mar-95	C	F	T	436210	31080	0.101100	0.101950	0.000850	11.67	1.17	81.0		157.7
7	23-Mar-95	C	C	Q	na	30			na	11.50	1.59		na	
	23-Mar-95	C	F	Q	na	29			na	11.50	1.59	na		na
8	23-Mar-95	C	C	T	436210	31083	0.112720	0.113600	0.000880	12.11	1.19		68.3	
	23-Mar-95	C	F	T	436210	31082	0.114430	0.114920	0.000490	12.11	1.19	44.9		113.1
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Khelma, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

File: dichdat .xls
C. Rodes, RTI, 9/12/95

Dichotomous Sampler Filter Data Log Sheet

(complete data not yet available)

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	27-Mar-95	B	C	Q	na	32			na	15.06	1.55		na	
	27-Mar-95	B	F	Q	na	31			na	15.06	1.55	na		na
2	27-Mar-95	B	C	T		31085	0.105820	0.106390	0.000570	16.03	1.64		33.1	
	27-Mar-95	B	F	T		31084	0.104250	0.104590	0.000340	16.03	1.64	23.6		56.8
3	28-Feb-95	B	C	Q	na	34			na	17.75	1.78		na	
	28-Feb-95	B	F	Q	na	33			na	17.75	1.78	na		na
4	28-Feb-95	B	C	T		31087	0.101430	0.101860	0.000430	17.86	1.80		22.9	
	28-Feb-95	B	F	T		31086	0.102430	0.102620	0.000190	17.86	1.80	11.8		34.7
5	29-Mar-95	B	C	T		30189	0.106370	0.109560	0.003190	19.69	2.02		156.9	
	29-Mar-95	B	F	T		30188	0.102350	0.103230	0.000880	19.69	2.02	49.8		206.7
6	30-Mar-95	B	C	T		31091	0.103180	0.104530	0.001350	26.24	2.59		50.0	
	30-Mar-95	B	F	T		31090	0.106850	0.107190	0.000340	26.24	2.59	14.4		64.4
7			C											
			F											
8			C											
			F											
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat3.xls

C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3	Comments
1	12-Apr-95	M	C	Q	na	46			na	21.61	2.23		na		
	12-Apr-95	M	F	Q	na	45			na	21.61	2.23	na		na	
2	12-Apr-95	M	C	T	409107	31093	0.111290	0.114020	0.002730	22.58	2.33		115.6		
	12-Apr-95	M	F	T	409107	31092	0.113200	0.114240	0.001040	22.58	2.33	51.4		167.0	
3	13-Apr-95	M	C	Q	na	48			na	24.70	2.41		na		
	13-Apr-95	M	F	Q	na	47			na	24.70	2.41	na		na	
4	13-Apr-95	M	C	T	409107	31095	0.111460	0.118190	0.006730	24.96	2.42		264.3		Thebes dust storm
	13-Apr-95	M	F	T	409107	31094	0.111980	0.113230	0.001250	24.96	2.42	55.5		319.7	Thebes dust storm
5	15-Apr-95	M	C	Q	na	50			na	24.00	2.40		na		
	15-Apr-95	M	F	Q	na	49			na	24.00	2.40	na		na	
6	15-Apr-95	M	C	T	409107	31097	0.110980	0.113060	0.002080	23.63	2.43		85.9		
	15-Apr-95	M	F	T	409107	31096	0.113240	0.113680	0.000440	23.63	2.43	20.8		106.6	
7	17-Apr-95	M	C	Q	na	52			na	24.50	2.38		na		
	17-Apr-95	M	F	Q	na	51			na	24.50	2.38	na		na	
8	17-Apr-95	M	C	T	409107	31099	0.113960	0.117080	0.003120	25.22	2.41		119.8		
	17-Apr-95	M	F	T	409107	31098	0.110140	0.111070	0.000930	25.22	2.41	40.8		160.6	
9	19-Apr-95	M	C	Q	na	56			na	24.89	2.40		na		
	19-Apr-95	M	F	Q	na	55			na	24.89	2.40	na		na	
10	19-Apr-95	M	C	T	409107	31101	0.113870	0.114850	0.000980	21.82	2.34		43.0		VOID
	19-Apr-95	M	F	T	409107	31100	0.113320	0.113660	0.000340	21.82	2.34	17.5		60.5	VOID

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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File: dichdat4.xls

C. Rodes, RTI, 9/12/95

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	20-Apr-95	M	C	Q	na	56			na	24.89	2.40		na	
	20-Apr-95	M	F	Q	na	55			na	24.89	2.40	na		na
2	20-Apr-95	M	C	T	409107	31103	0.110860	0.112200	0.001340	24.70	2.34		50.6	
	20-Apr-95	M	F	T	409107	31102	0.114440	0.115300	0.000860	24.70	2.34	38.5		89.1
3	22-Apr-95	M	C	Q	na	58			na	20.57	21.54		na	
	22-Apr-95	M	F	Q	na	57			na	20.57	21.54	na		na
4	22-Apr-95	M	C	T	409107	31105	0.112130	0.113510	0.001380	21.50	2.27		60.5	
	22-Apr-95	M	F	T	409107	31104	0.113210	0.113880	0.000670	21.50	2.27	34.8		95.3
5	23-Apr-95	M	C	Q	na	60			na	24.13	2.36		na	
	23-Apr-95	M	F	Q	na	59			na	24.13	2.36	na		na
6	23-Apr-95	M	C	T	409107	31107	0.108100	0.109310	0.001210	23.20	2.30		49.4	
	23-Apr-95	M	F	T	409107	31106	0.107830	0.108420	0.000590	23.20	2.30	28.2		77.6
7	28-Apr-95	M	C	Q	na	62			na	22.14	2.23		na	
	28-Apr-95	M	F	Q	na	61			na	22.14	2.23	na		na
8	28-Apr-95	M	C	T	409107	31109	0.103930	0.105590	0.001660	22.67	2.32		71.0	
	28-Apr-95	M	F	T	409107	31108	0.110690	0.111130	0.000440	22.67	2.32	21.6		92.6
9	29-Apr-95	M	C	Q	na	64			na	24.77	2.45		na	
	29-Apr-95	M	F	Q	na	63			na	24.77	2.45	na		na
10	29-Apr-95	M	C	T	409107	31111	0.106480	0.108030	0.001550	23.10	2.33		65.5	
	29-Apr-95	M	F	T	409107	31110	0.111460	0.111790	0.000330	23.10	2.33	15.9		81.4

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Khelma, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

File: dichdat5.xls
C. Rodes, RTI, 9/12/95

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	1-May-95	M	C	Q	na	66			na	23.05	2.39		na	
	1-May-95	M	F	Q	na	65			na	23.05	2.39	na		na
2	1-May-95	M	C	T	409107	31113	0.108250	0.110900	0.002650	23.11	2.42		110.2	
	1-May-95	M	F	T	409107	31112	0.106660	0.107540	0.000880	23.11	2.42	42.5		152.7
3	4-May-95	M	C	Q	na	68			na	24.12	2.38		na	
	4-May-95	M	F	Q	na	67			na	24.12	2.38	na		na
4	4-May-95	M	C	T	409107	31115	0.104830	0.106450	0.001620	24.02	2.42		64.9	
	4-May-95	M	F	T	409107	31114	0.105970	0.106510	0.000540	24.02	2.42	25.0		89.9
5	6-May-95	M	C	Q	na	70			na	21.72	2.22		na	
	6-May-95	M	F	Q	na	69			na	21.72	2.22	na		na
6	6-May-95	M	C	T	409107	31117	0.118900	0.121340	0.002440	21.38	2.23		111.6	
	6-May-95	M	F	T	409107	31116	0.109520	0.109990	0.000470	21.38	2.23	24.5		136.1
7	7-May-95	M	C	Q	na	72			na	23.86	2.36		na	
	7-May-95	M	F	Q	na	71			na	23.86	2.36	na		na
8	7-May-95	M	C	T	409107	31119	0.108740	0.109960	0.001220	24.10	2.44		48.2	
	7-May-95	M	F	T	409107	31118	0.119050	0.119570	0.000520	24.10	2.44	24.0		72.2
9	31-May-95	H	C	Q	na	74			na	22.90	2.27		na	
	31-May-95	H	F	Q	na	73			na	22.90	2.27	na		na
10	31-May-95	H	C	T	409107	31121	0.118060	0.121420	0.003360	22.95	2.32		142.2	
	31-May-95	H	F	T	409107	31120	0.095130	0.095980	0.000850	22.95	2.32	41.2		183.4

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat6.xls

C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	1-Jun-95	H	C	Q	na	76			na	23.90	2.27		na	
	1-Jun-95	H	F	Q	na	75			na	23.90	2.27	na		na
2	1-Jun-95	H	C	T	409107	31123	0.099590	0.102640	0.003050	23.85	2.41		124.1	
	1-Jun-95	H	F	T	409107	31122	0.091940	0.092740	0.000800	23.85	2.41	37.3		161.4
3	3-Jun-95	H	C	Q	na	78			na	24.20	2.79		na	
	3-Jun-95	H	F	Q	na	77			na	24.20	2.79	na		na
4	3-Jun-95	H	C	T	409107	31125	0.094380	0.098930	0.004550	24.56	2.41		178.9	
	3-Jun-95	H	F	T	409107	31124	0.095130	0.096570	0.001440	24.56	2.41	65.0		243.9
5	4-Jun-95	H	C	Q	na	80			na	22.71	2.32		na	
	4-Jun-95	H	F	Q	na	79			na	22.71	2.32	na		na
6	4-Jun-95	H	C	T	409107	31127	0.094440	0.098010	0.003570	22.17	2.33		155.8	
	4-Jun-95	H	F	T	409107	31126	0.096170	0.097150	0.000980	22.17	2.33	49.4		205.2
7	6-Jun-95	H	C	Q	na	82			na	22.60	2.25		na	
	6-Jun-95	H	F	Q	na	81			na	22.60	2.25	na		na
8	6-Jun-95	H	C	T	409107	31129	0.103400	0.108910	0.005510	24.52	2.44		218.5	
	6-Jun-95	H	F	T	409107	31128	0.100230	0.101610	0.001380	24.52	2.44	62.5		281.0
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda13 .xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	1-Aug-95	S	C	Q	na	84			na	22.65	2.29		na	
	1-Aug-95	S	F	Q	na	83			na	22.65	2.29	na		na
2	1-Aug-95	S	C	T	79579	31131	0.115730	0.119290	0.003560	21.24	2.27		161.2	
	1-Aug-95	S	F	T	79579	31130	0.112310	0.113450	0.001140	21.24	2.27	60.1		221.3
3	2-Aug-95	S	C	Q	na	86			na	21.91	2.20		na	
	2-Aug-95	S	F	Q	na	85			na	21.91	2.20	na		na
4	2-Aug-95	S	C	T	79579	31133	0.110950	0.113780	0.002830	22.15	2.21		121.8	
	2-Aug-95	S	F	T	79579	31132	0.105450	0.106650	0.001200	22.15	2.21	60.2		181.9
5	3-Aug-95	S	C	Q	na	88			na	24.03	2.36		na	
	3-Aug-95	S	F	Q	na	87			na	24.03	2.36	na		na
6	3-Aug-95	S	C	T	79579	31135	0.104090	0.106710	0.002620	24.77	2.43		99.9	
	3-Aug-95	S	F	T	79579	31134	0.102080	0.103410	0.001330	24.77	2.43	59.6		159.5
7	5-Aug-95	S	C	Q	na	90			na	22.45	2.27		na	
	5-Aug-95	S	F	Q	na	89			na	22.45	2.27	na		na
8	5-Aug-95	S	C	T	79579	31137	0.105270	0.107710	0.002440	22.57	2.31		101.0	
	5-Aug-95	S	F	T	79579	31136	0.102490	0.103890	0.001400	22.57	2.31	69.1		170.1
9	6-Aug-95	S	C	Q	na	92			na	16.04	1.62		na	
	6-Aug-95	S	F	Q	na	91			na	16.04	1.62	na		na
10	6-Aug-95	S	C	T	79579	31139	0.107230	0.109890	0.002660	16.16	1.64		159.6	
	6-Aug-95	S	F	T	79579	31138	0.111560	0.112280	0.000720	16.16	1.64	49.6		209.2

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda14 .xls
C. Rodes, RTI, 9/12/95

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	7-Aug-95	S	C	Q	na	94			na	22.62	2.28		na	
	7-Aug-95	S	F	Q	na	93			na	22.62	2.28	na		na
2	7-Aug-95	S	C	T	79579	31141	0.110290	0.113390	0.003100	22.05	2.24		134.4	
	7-Aug-95	S	F	T	79579	34410	0.110000	0.111200	0.001200	22.05	2.24	60.6		195.0
3			C											
			F											
4			C											
			F											
5			C											
			F											
6			C											
			F											
7			C											
			F											
8			C											
			F											
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda17 .xls
C. Rodes, RTI, 3/18/96

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	19-Aug-95	C	C	Q	na	133			na	23.61	2.40		na	
	19-Aug-95	C	F	Q	na	132			na	23.61	2.40	na		na
2	19-Aug-95	C	C	T	79579	31152	0.090660	0.092750	0.002090	23.73	2.43		81.3	
	19-Aug-95	C	F	T		31151	0.116080	0.117490	0.001410	23.73	2.43	66.2		147.5
3	20-Aug-95	C	C	Q	na	106			na	24.56	2.48		na	
	20-Aug-95	C	F	Q	na	105			na	24.56	2.48	na		na
4	20-Aug-95	C	C	T	79579	31154	0.093340	0.095170	0.001830	25.12	2.56		68.5	
	20-Aug-95	C	F	T		31153	0.093240	0.094200	0.000960	25.12	2.56	42.6		111.1
5	22-Aug-95	C	C	Q	na	108			na	21.36	2.09		na	
	22-Aug-95	C	F	Q	na	107			na	21.36	2.09	na		na
6	22-Aug-95	C	C	T	79579	31156	0.089970	0.091550	0.001580	21.05	2.06		69.1	
	22-Aug-95	C	F	T		31155	0.115720	0.116870	0.001150	21.05	2.06	60.6		129.7
7	23-Aug-95	C	C	Q	na	110			na	22.87	2.29		na	
	23-Aug-95	C	F	Q	na	109			na	22.87	2.29	na		na
8	23-Aug-95	C	C	T	79579	31158	0.114960	0.116530	0.001570	22.64	2.32		64.9	
	23-Aug-95	C	F	T		31157	0.090950	0.091830	0.000880	22.64	2.32	43.3		108.2
9	24-Aug-95	C	C	Q	na	112			na	26.00	2.52		na	
	24-Aug-95	C	F	Q	na	111			na	26.00	2.52	na		na
10	22-Aug-95	C	C	T	79579	31160	0.117390	0.119080	0.001690	26.28	2.53		59.2	
	22-Aug-95	C	F	T		31159	0.119320	0.120600	0.001280	26.26	2.53	53.9		113.1

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Khelma, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda18 .xls
C. Rodes, RTI, 3/18/96

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	30-Aug-95	C	C	Q	na	114			na	21.99	2.22		na	
	30-Aug-95		F	Q	na	113			na	21.99	2.22	na		na
2	30-Aug-95	C	C	T	79579	31162	0.116870	0.118430	0.001560	21.82	2.22		65.4	
	30-Aug-95		F	T		31161	0.110880	0.112050	0.001170	21.82	2.22	59.7		125.1
3			C											
			F											
4			C											
			F											
5			C											
			F											
6			C											
			F											
7			C											
			F											
8			C											
			F											
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, T - Tebeene, S - Shoubra El-Khelma, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichdat15 .xls
C. Rodes, RTI, 3/18/96

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	6-Sep-95	B	C	Q	na	118			na	24.30	2.43		na	
	6-Sep-95		F	Q	na	117			na	24.30	2.43	na		na
2	6-Sep-95	B	C	T	79579	31166	0.083990	0.085610	0.001620	23.80	2.41		65.9	
	6-Sep-95		F	T		31165	0.084480	0.084940	0.000460	23.80	2.41	21.5		87.4
3	9-Sep-95	B	C	Q	na	120			na	24.37	2.41		na	
	9-Sep-95		F	Q	na	119			na	24.37	2.41	na		na
4	9-Sep-95	B	C	T	79579	31168	0.077760	0.078600	0.000840	24.03	2.46		33.2	
	9-Sep-95		F	T		31167	0.098730	0.099110	0.000380	24.03	2.46	17.6		50.8
5	14-Sep-95	B	C	Q	na	123			na	23.50	2.35		na	
	14-Sep-95		F	Q	na	122			na	23.50	2.35	na		na
6	14-Sep-95	B	C	T	79579	31172	0.100420	0.101080	0.000660	22.54	2.24		26.1	
	14-Sep-95		F	T		31171	0.103650	0.104300	0.000650	22.54	2.24	32.0		58.1
7	17-Sep-95	B	C	Q	na	125			na	24.66	2.44		na	
	17-Sep-95		F	Q	na	124			na	24.66	2.44	na		na
8	17-Sep-95	B	C	T	79579	31174	0.115420	0.116570	0.001150	24.93	2.47		42.5	
	17-Sep-95		F	T		31173	0.117720	0.118540	0.000820	24.93	2.47	36.5		79.0
9	19-Sep-95	B	C	Q	na	127			na	25.17	2.49		na	
	19-Sep-95		F	Q	na	128			na	25.17	2.49	na		na
10	19-Sep-95	B	C	T	79579	31176	0.097900	0.099360	0.001460	24.28	2.44		57.1	
	19-Sep-95		F	T		31175	0.117260	0.117910	0.000650	24.28	2.44	29.8		86.9

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

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Cairo Receptor Modeling Study

Dichotomous Sampler Filter Data Log Sheet

File: dichda16 .xls
C. Rodes, RTI, 3/18/96

#	Sampling Date mo/da/yr	Sampling Site	Fraction C or F	Type T, Q or B	Filter Lot Number	Filter Number	Pre-weight, grams w1	Post-weight, grams w2	Aerosol weight grams w2 - w1 MC or MF	TOTAL Volume, m3 QT x t VT	COARSE Volume, m3 QC x t VC	FINE Conc. ug/m3	COARSE Conc. ug/m3	PM10 Conc. ug/m3
1	24-Sep-95	B	C	Q	na	129			na	25.35	2.52		na	
	24-Sep-95	B	F	Q	na	128			na	25.35	2.52	na		na
2	24-Sep-95	B	C	T	79579	31178	0.100710	0.102220	0.001510	25.24	2.47		56.9	
	24-Sep-95	B	F	T		31177	0.097650	0.098330	0.000680	25.24	2.47	29.9		86.8
3	26-Sep-95	B	C	Q	na	131			na	24.80	2.46		na	
	26-Sep-95	B	F	Q	na	130			na	24.80	2.46	na		na
4	26-Sep-95	B	C	T	79579	31180	0.094380	0.095380	0.001000	23.98	2.45		38.9	
	26-Sep-95	B	F	T		31179	0.099010	0.099610	0.000600	23.98	2.45	27.9		66.7
5			C											
			F											
6			C											
			F											
7			C											
			F											
8			C											
			F											
9			C											
			F											
10			C											
			F											

Fractions: C - COARSE, F - FINE

Types: T - Teflon, Q - Quartz, TB - Teflon Blank, QB - Quartz Blank

Site: C - City Centre, M - Maadi, H - Helwan, S - Shoubra El-Kheima, B - Thebes background

Calculations:

FINE (ug/m3) = (MF x 1,000,000) / (VT - VC)

COARSE (ug/m3) = (MC x 1,000,000 - FINE x VC) / VT

PM10 (ug/m3) = FINE + COARSE

Cairo Source Signature Samples														
Source Type:		Automotive - petrol										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	27-Nov	Teflon	Fine	142	0.123230	0.125680	0.002450	9.7	10	0.097	0.052	25.1	30.1	200.0
		Teflon	PM10	141	0.125950	0.128980	0.003030	7.9	12	0.095	0.052	32.1	37.1	247.3
		Quartz	Fine	D	na	na	na	15.8	10	0.158	0.052	na	na	240.0
									total:	0.350				
2	27-Nov	Teflon	Fine	143	0.127760	0.131580	0.003820	10.0	10	0.100	0.048	38.1	47.1	311.8
		Teflon	PM10	144	0.122270	0.126630	0.004360	8.2	12	0.098	0.048	44.1	54.1	355.9
		Quartz	Fine	F	na	na	na	7.0	10	0.070	0.048	na	na	374.2
									total:	0.268				
3	27-Nov	Teflon	Fine	145	0.128910	0.129300	0.000390	12.5	10	0.125	0.260	3.1	5.1	31.8
		Teflon	PM10	155	0.124800	0.125660	0.000860	23.3	12	0.280	0.260	3.1	5.1	70.2
		Quartz	Fine	G	na	na	na	23.0	10	0.230	0.260	na	na	38.2
File: cairsg13									total:	0.635				

Cairo Source Signature Samples														
Source Type:		Cement Plant Bypass Stack - Dry												
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	19-Jun	Teflon	Fine	13	0.125710	0.208690	0.082980	na	na	0.440	0.903	189.1	632.1	6774.1
		Teflon	PM10	14	0.120400	0.257090	0.136690	na	na	0.434	0.903	315.1	1056.1	11158.1
		Quartz	Fine	4	na	na	na	na	na	0.413	0.903	na	na	na
									total:	1.287				
2	19-Jun	Teflon	Fine	15	0.123860	0.143480	0.019620	na	na	0.165	0.346	119.1	445.1	1602.1
		Teflon	PM10	16	0.124780	0.161750	0.036970	na	na	0.157	0.346	235.1	882.1	3018.1
		Quartz	Fine	5	na	na	na	na	na	0.150	0.346	na	na	na
									total:	0.472				
3	20-Jun	Teflon	Fine	17	0.126480	0.135070	0.008590	na	na	0.177	0.306	49.1	167.1	701.1
		Teflon	PM10	18	0.126760	0.139070	0.012310	na	na	0.122	0.306	101.1	348.1	1005.1
		Quartz	Fine	7	na	na	na	na	na	0.132	0.306	na	na	na
File: cairsig3									total:	0.431				

Cairo Source Signature Samples														
Source Type:		Cement Plant Wet Kiln												
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	17-Jun	Teflon	Fine	6	0.124060	0.134330	0.010270	na	na	0.859	1.800	12.1	44.1	838.1
		Teflon	Total	7	0.125990	0.136700	0.010710	na	na	0.751	1.800	14.1	52.1	874.1
		Quartz	Fine	1	na	na	na	na	na	0.862	1.800	na	na	na
									total:	2.472				
2	17-Jun	Teflon	Fine	9	0.124360	0.132280	0.007920	na	na	0.607	1.019	13.1	31.1	647.1
		Teflon	Total	8	0.133220	0.142580	0.009360	na	na	0.529	1.019	18.1	42.1	764.1
		Quartz	Fine	2	na	na	na	na	na	0.633	1.019	na	na	na
									total:	1.769				
3	17-Jun	Teflon	Fine	12	0.126690	0.136050	0.009360	na	na	0.450	0.553	21.1	37.1	764.1
		Teflon	Total	10	0.125150	0.138240	0.013090	na	na	0.339	0.553	39.1	69.1	1069.1
		Quartz	Fine	3	na	na	na	na	na	0.466	0.553	na	na	na
File: cairsig5									total:	1.255				

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Cairo Source Signature Samples

Source Type: Heavy Duty Diesel Exhaust

Sample	Collect Date	Filter Type	Size Fraction	Filter #	Pre-weight g	Post-weight g	Collection g	Sample time, min	Channel Flow rate, lpm	Channel Volume, m3	Dilution Volume, m3	Dilution Manifold Conc. mg/m3	Source Conc. mg/m3	Filter Loading, ug/cm2
1	5-Oct	Teflon	Fine	105	0.121600	0.128600	0.007000	na	na	1.825	0.000	3.836	3.836	571.4
		Teflon	PM10	104	0.123170	0.123700	0.000530	na	na	1.747	0.000	0.303	0.303	43.3
		Quartz	Fine	202	na	na	na	na	na	1.590	0.000	na	na	na
									total:	5.162				
2	5-Oct	Teflon	Fine	108	0.118120	0.119500	0.001380	na	na	1.009	0.130	1.368	1.434	112.7
		Teflon	PM10	109	0.122820	0.123210	0.000390	na	na	0.750	0.130	0.520	0.545	31.8
		Quartz	Fine	203	na	na	na	na	na	1.041	0.130	na	na	na
									total:	2.800				
3	5-Oct	Teflon	Fine	135	0.125410	0.125880	0.000470	na	na	2.130	0.280	0.221	0.231	38.4
		Teflon	PM10	134	0.143640	0.144300	0.000660	na	na	2.050	0.280	0.322	0.337	53.9
		Quartz	Fine	14	na	na	na	na	na	2.230	0.280	na	na	na
									total:	6.410				

File: cairsig9

Cairo Source Signature Samples														
Source Type:		Heavy Oil (Mazut) combustion										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	25-Oct	Teflon	Fine	128	0.130510	0.137230	0.006720	na	na	0.097	0.063	69.1	88.1	549.1
		Teflon	PM10	129	0.125520	0.133400	0.007880	na	na	0.098	0.063	80.1	102.1	643.1
		Quartz	Fine	10	na	na	na	na	na	0.102	0.063	na	na	na
									total:	0.297				
2	25-Oct	Teflon	Fine	130	0.127070	0.141950	0.014880	na	na	0.160	0.140	93.1	132.1	1215.1
		Teflon	PM10	131	0.137570	0.154810	0.017240	na	na	0.150	0.140	115.1	163.1	1407.1
		Quartz	Fine	11	na	na	na	na	na	0.164	0.140	na	na	na
									total:	0.474				
3	25-Oct	Teflon	Fine	132	0.127730	0.130530	0.002800	na	na	0.063	0.120	44.1	166.1	229.1
		Teflon	PM10	133	0.143050	0.146440	0.003390	na	na	0.061	0.120	56.1	207.1	277.1
		Quartz	Fine	12	na	na	na	na	na	0.040	0.120	na	na	na
File: cairsig7									total:	0.164				

Cairo Source Signature Samples														
Source Type:		Iron and Steel - Converter Stack												
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	9-Jul	Teflon	Fine	42	0.137320	0.138440	0.001120	na	na	0.116	0.193	10.1	23.1	91.1
		Teflon	PM10	35	0.139490	0.140760	0.001270	na	na	0.104	0.193	12.1	29.1	104.1
		Quartz	Fine	14	na	na	na	na	na	0.114	0.193	na	na	na
									total:	0.334				
2	9-Jul	Teflon	Fine	39	0.129170	0.129850	0.000680	na	na	0.116	0.154	6.1	11.1	56.1
		Teflon	PM10	38	0.135310	0.136370	0.001060	na	na	0.100	0.154	11.1	20.1	87.1
		Quartz	Fine	15	na	na	na	na	na	0.109	0.154	na	na	na
									total:	0.325				
3	9-Jul	Teflon	Fine	41	0.137460	0.138620	0.001160	na	na	0.165	0.221	7.1	14.1	95.1
		Teflon	PM10	40	0.153810	0.158180	0.004370	na	na	0.151	0.221	29.1	57.1	357.1
		Quartz	Fine	16	na	na	na	na	na	0.132	0.221	na	na	na
File: cairsig6									total:	0.448				

Cairo Source Signature Samples														
Source Type:		Light oil - Solaar										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	23-Oct	Teflon	Fine	111	0.124130	0.131150	0.007020	39.0	10	0.390	0.555	18.1	39.1	573.1
		Teflon	PM10	110	0.120880	0.126160	0.005280	21.7	12	0.260	0.555	20.1	44.1	431.0
		Quartz	Fine	3	na	na	na	37.4	10	0.374	0.555	na	na	687.7
									total:	1.024				
2	23-Oct	Teflon	Fine	114	0.120960	0.125400	0.004440	31.1	10	0.311	0.606	14.1	37.1	362.4
		Teflon	PM10	113	0.122910	0.126880	0.003970	26.9	12	0.323	0.606	12.1	31.1	324.1
		Quartz	Fine	4	na	na	na	36.1	10	0.361	0.606	na	na	434.9
									total:	0.995				
3	23-Oct	Teflon	Fine	116	0.115420	0.119660	0.004240	29.5	10	0.295	0.438	14.1	32.1	346.1
		Teflon	PM10	115	0.119290	0.122980	0.003690	19.2	12	0.230	0.438	16.1	35.1	301.2
		Quartz	Fine	5	na	na	na	27.5	10	0.275	0.438	na	na	415.3
File: cairsg14									total:	0.800				

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Cairo Source Signature Samples														
Source Type		Lime Kiln										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	26-Jul	Teflon	Fine	44	0.129510	0.134240	0.004730	na	na	0.081	0.145	58.1	218.1	386.1
		Teflon	PM10	43	0.130070	0.140240	0.010170	na	na	0.053	0.145	192.1	717.1	830.1
		Quartz	Fine	101	na	na	na	na	na	0.064	0.145	na	na	na
									total:	0.198				
2	26-Jul	Teflon	Fine	46	0.138230	0.141450	0.003220	na	na	0.044	0.076	73.1	228.1	263.1
		Teflon	PM10	47	0.138980	0.146830	0.007850	na	na	0.030	0.076	262.1	814.1	641.1
		Quartz	Fine	102	na	na	na	na	na	0.038	0.076	na	na	na
									total:	0.112				
3	26-Jul	Teflon	Fine	49	0.153560	0.157090	0.003530	na	na	0.055	0.096	64.1	204.1	288.1
		Teflon	PM10	48	0.132430	0.142990	0.010560	na	na	0.038	0.096	278.1	884.1	862.1
		Quartz	Fine	17	na	na	na	na	na	0.047	0.096	na	na	na
File: cairsg4									total:	0.140				

Cairo Source Signature Samples														
Source Type:		Secondary Lead Smelting 1										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	21-Jun	Teflon	Fine	19	0.123180	0.229700	0.106520	na	na	0.207	0.514	515.1	2326.1	8696.1
		Teflon	PM10	20	0.135790	0.251290	0.115500	na	na	0.214	0.514	540.1	2440.1	9429.1
		Quartz	Fine	8	na	na	na	na	na	0.239	0.514	na	na	na
									total:	0.660				
2	21-Jun	Teflon	Fine	23	0.145060	0.204730	0.059670	na	na	0.159	0.338	375.1	1398.1	4871.1
		Teflon	PM10	22	0.136510	0.196600	0.060090	na	na	0.148	0.338	406.1	1513.1	4905.1
		Quartz	Fine	9	na	na	na	na	na	0.155	0.338	na	na	na
									total:	0.462				
3	21-Jun	Teflon	Fine	24	0.124610	0.172150	0.047540	na	na	0.110	0.226	432.1	1494.1	3881.1
		Teflon	PM10	25	0.129060	0.176650	0.047590	na	na	0.101	0.226	471.1	1629.1	3885.1
		Quartz	Fine	10	na	na	na	na	na	0.107	0.226	na	na	na
File: cairsg1									total:	0.318				

Cairo Source Signature Samples														
Source Type:		Secondary Lead Smelting 2										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	na	Teflon	Fine	149	0.117840	0.179200	0.061360	na	na	0.035	0.057	1753.1	4326.1	5009.0
		Teflon	PM10	146	0.124600	0.187880	0.063280	na	na	0.029	0.057	2182.1	5384.1	5165.7
		Quartz	Fine	N	na	na	na	na	na	0.031	0.057	na	na	na
									total:	0.095				
2		Teflon	Fine					na	na					
		Teflon	PM10					na	na					
		Quartz	Fine		na	na	na	na	na					
									total:	0.000				
3		Teflon	Fine					na	na					
		Teflon	_PM10					na	na					
		Quartz	Fine		na	na	na	na	na					
File: cairslg10									total:	0.000				

Cairo Source Signature Samples														
Source Type:		Sintering Plant - Steel Mill												
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	9-Jul	Teflon	Fine	29	0.143950	0.150040	0.006090	na	na	0.266	0.209	23.1	40.1	497.1
		Teflon	PM10	30	0.139210	0.143820	0.004610	na	na	0.095	0.209	49.1	85.1	376.1
		Quartz	Fine	11	na	na	na	na	na	0.129	0.209	na	na	na
									total:	0.490				
2	9-Jul	Teflon	Fine	32	0.141010	0.146730	0.005720	na	na	0.370	0.313	15.1	29.1	467.1
		Teflon	PM10	31	0.149420	0.151730	0.002310	na	na	0.112	0.313	21.1	38.1	189.1
		Quartz	Fine	12	na	na	na	na	na	0.193	0.313	na	na	na
									total:	0.675				
3	9-Jul	Teflon	Fine	34	0.134480	0.140780	0.006300	na	na	0.177	0.102	36.1	52.1	514.1
		Teflon	PM10	33	0.140470	0.142650	0.002180	na	na	0.071	0.102	31.1	45.1	178.1
		Quartz	Fine	13	na	na	na	na	na	0.071	0.102	na	na	na
File: cairsg2									total:	0.319				

Cairo Source Signature Samples														
Source Type:		Vegative/Trash burning										Dilution		
									Channel	Channel	Dilution	Manifold	Source	Filter
	Collect	Filter	Size	Filter	Pre-weight	Post-weight	Collection	Sample	Flow rate,	Volume,	Volume,	Conc.	Conc.	Loading,
Sample	Date	Type	Fraction	#	g	g	g	time, min	lpm	m3	m3	mg/m3	mg/m3	ug/cm2
1	25-Nov	Teflon	Fine	139	0.126960	0.130360	0.003400	na	na	0.050	0.136	68.1	200.1	278.1
		Teflon	PM10	138	0.123270	0.126360	0.003090	na	na	0.031	0.136	100.1	293.1	252.1
		Quartz	Fine	A	na	na	na	na	na	0.125	0.136	na	na	na
									total:	0.206				
2	25-Nov	Teflon	Fine	150	0.124760	0.127880	0.003120	na	na	0.081	0.130	39.1	81.1	255.1
		Teflon	PM10	151	0.130920	0.135650	0.004730	na	na	0.071	0.130	67.1	139.1	386.1
		Quartz	Fine	B	na	na	na	na	na	0.097	0.130	na	na	na
									total:	0.249				
3	25-Nov	Teflon	Fine	152	0.125645	0.129550	0.003905	na	na	0.090	0.120	43.1	81.1	319.1
		Teflon	PM10	153	0.125970	0.130930	0.004960	na	na	0.081	0.120	61.1	114.1	405.1
		Quartz	Fine	C	na	na	na	na	na	0.089	0.120	na	na	na
File: cairsg11									total:	0.260				

Table 1

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: B Date: 02/28/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Mass	XRF
Fine:	31086	16.0			
Coarse:	31087	17.8			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	11.8306	±	1.3787	22.8838	±	1.7931	34.7144	±	2.2619
Al	0.0966	±	0.0080	0.8454	±	0.2523	0.9420	±	0.2524
Si	0.3439	±	0.0182	2.8409	±	0.9006	3.1848	±	0.9008
P	0.0000	±	0.0112	0.0000	±	0.0126	0.0000	±	0.0169
S	1.6118	±	0.0810	0.2406	±	0.1894	1.8524	±	0.2060
Cl	0.0086	±	0.0307	0.4093	±	0.1192	0.4179	±	0.1231
K	0.1561	±	0.0083	0.1794	±	0.0387	0.3355	±	0.0396
Ca	0.1890	±	0.0098	2.2114	±	0.3722	2.4004	±	0.3723
Ti	0.0086	±	0.0153	0.0523	±	0.0056	0.0609	±	0.0163
V	0.0013	±	0.0066	0.0026	±	0.0063	0.0039	±	0.0091
Cr	0.0009	±	0.0024	0.0009	±	0.0023	0.0018	±	0.0033
Mn	0.0032	±	0.0006	0.0086	±	0.0008	0.0118	±	0.0010
Fe	0.1148	±	0.0059	0.5548	±	0.0289	0.6696	±	0.0295
Co	0.0000	±	0.0023	0.0005	±	0.0088	0.0005	±	0.0091
Ni	0.0018	±	0.0005	0.0011	±	0.0004	0.0029	±	0.0006
Cu	0.0090	±	0.0007	0.0068	±	0.0008	0.0158	±	0.0011
Zn	0.0173	±	0.0010	0.0058	±	0.0013	0.0231	±	0.0016
Ga	0.0000	±	0.0021	0.0000	±	0.0013	0.0000	±	0.0025
As	0.0011	±	0.0226	0.0000	±	0.0067	0.0011	±	0.0236
Se	0.0003	±	0.0010	0.0000	±	0.0007	0.0003	±	0.0012
Br	0.0089	±	0.0007	0.0023	±	0.0007	0.0112	±	0.0010
Rb	0.0000	±	0.0008	0.0002	±	0.0006	0.0002	±	0.0010
Sr	0.0011	±	0.0002	0.0092	±	0.0005	0.0103	±	0.0005
Y	0.0004	±	0.0015	0.0000	±	0.0008	0.0004	±	0.0017
Zr	0.0007	±	0.0009	0.0019	±	0.0003	0.0026	±	0.0009
Mo	0.0007	±	0.0016	0.0005	±	0.0015	0.0012	±	0.0022
Pd	0.0000	±	0.0062	0.0015	±	0.0057	0.0015	±	0.0084
Ag	0.0000	±	0.0069	0.0000	±	0.0063	0.0000	±	0.0093
Cd	0.0000	±	0.0070	0.0000	±	0.0064	0.0000	±	0.0095
In	0.0014	±	0.0080	0.0000	±	0.0075	0.0014	±	0.0110
Sn	0.0027	±	0.0101	0.0002	±	0.0091	0.0029	±	0.0136
Sb	0.0007	±	0.0119	0.0063	±	0.0105	0.0070	±	0.0159
Ba	0.0000	±	0.0437	0.0000	±	0.0391	0.0000	±	0.0586
La	0.0000	±	0.0579	0.0000	±	0.0518	0.0000	±	0.0777
Au	0.0001	±	0.0023	0.0005	±	0.0020	0.0006	±	0.0030
Hg	0.0006	±	0.0018	0.0002	±	0.0015	0.0008	±	0.0023
Tl	0.0002	±	0.0045	0.0000	±	0.0019	0.0002	±	0.0049
Pb	0.1460	±	0.0075	0.0241	±	0.0100	0.1701	±	0.0125
U	0.0004	±	0.0015	0.0000	±	0.0013	0.0004	±	0.0020
Sum	2.7282	±	0.1218	7.4073	±	1.0348	10.1355	±	1.0419

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Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: B Date: 03/27/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Flags Mass	Flags XRF
Fine:	31084	14.3			n3
Coarse:	31085	16.0			i3

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	23.6275	±	1.8241	33.1410	±	2.6187	56.7685	±	3.1914
Al	0.0684	±	0.0078	0.9744	±	0.2905	1.0428	±	0.2906
Si	0.3030	±	0.0166	3.3893	±	1.0737	3.6923	±	1.0738
P	0.0000	±	0.0129	0.0000	±	0.0165	0.0000	±	0.0209
S	1.8880	±	0.0957	0.2849	±	0.2224	2.1729	±	0.2421
Cl	0.0556	±	0.0126	1.0080	±	0.2928	1.0636	±	0.2931
K	0.1349	±	0.0074	0.2551	±	0.0527	0.3900	±	0.0532
Ca	0.3199	±	0.0164	2.8951	±	0.4875	3.2150	±	0.4878
Ti	0.0158	±	0.0166	0.0689	±	0.0068	0.0847	±	0.0179
V	0.0004	±	0.0072	0.0022	±	0.0074	0.0026	±	0.0103
Cr	0.0018	±	0.0026	0.0028	±	0.0009	0.0046	±	0.0028
Mn	0.0039	±	0.0007	0.0114	±	0.0010	0.0153	±	0.0012
Fe	0.1416	±	0.0072	0.7573	±	0.0392	0.8989	±	0.0399
Co	0.0000	±	0.0027	0.0032	±	0.0119	0.0032	±	0.0122
Ni	0.0018	±	0.0005	0.0015	±	0.0005	0.0033	±	0.0007
Cu	0.0080	±	0.0006	0.0080	±	0.0008	0.0160	±	0.0010
Zn	0.0265	±	0.0015	0.0151	±	0.0020	0.0416	±	0.0025
Ga	0.0000	±	0.0058	0.0000	±	0.0030	0.0000	±	0.0065
As	0.0000	±	0.0783	0.0000	±	0.0373	0.0000	±	0.0867
Se	0.0000	±	0.0023	0.0000	±	0.0013	0.0000	±	0.0026
Br	0.0089	±	0.0014	0.0045	±	0.0009	0.0134	±	0.0017
Rb	0.0000	±	0.0010	0.0003	±	0.0008	0.0003	±	0.0013
Sr	0.0002	±	0.0009	0.0129	±	0.0007	0.0131	±	0.0011
Y	0.0000	±	0.0043	0.0000	±	0.0022	0.0000	±	0.0048
Zr	0.0008	±	0.0011	0.0037	±	0.0005	0.0045	±	0.0012
Mo	0.0003	±	0.0017	0.0007	±	0.0017	0.0010	±	0.0024
Pd	0.0000	±	0.0069	0.0006	±	0.0067	0.0006	±	0.0096
Ag	0.0000	±	0.0077	0.0000	±	0.0076	0.0000	±	0.0108
Cd	0.0000	±	0.0074	0.0000	±	0.0078	0.0000	±	0.0108
In	0.0012	±	0.0089	0.0000	±	0.0088	0.0012	±	0.0125
Sn	0.0041	±	0.0110	0.0018	±	0.0110	0.0059	±	0.0156
Sb	0.0143	±	0.0044	0.0038	±	0.0124	0.0181	±	0.0132
Ba	0.0000	±	0.0479	0.0209	±	0.0461	0.0209	±	0.0665
La	0.0000	±	0.0624	0.0000	±	0.0597	0.0000	±	0.0864
Au	0.0005	±	0.0028	0.0000	±	0.0025	0.0005	±	0.0038
Hg	0.0000	±	0.0027	0.0001	±	0.0020	0.0001	±	0.0034
Tl	0.0000	±	0.0141	0.0000	±	0.0069	0.0000	±	0.0157
Pb	0.5102	±	0.0257	0.1843	±	0.0357	0.6945	±	0.0440
U	0.0000	±	0.0017	0.0007	±	0.0016	0.0007	±	0.0023
Sum	3.5101	±	0.1555	9.9115	±	1.2743	13.4216	±	1.2838

XRF: Metallic particles.

Table 1 (continued)

[redacted]rch Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

B Date: 03/29/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	30188	17.6	I		
Coarse:	30189	19.6			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

Fine	Coarse	PM_{10}
49.8019 ± 2.7353	156.9020 ± 8.5936	206.7039 ± 9.0184
0.6406 ± 0.0341	4.1090 ± 1.2254	4.7496 ± 1.2259
1.9232 ± 0.0969	13.1062 ± 4.1568	15.0294 ± 4.1579
0.0000 ± 0.0140	0.0000 ± 0.0290	0.0000 ± 0.0322
1.2679 ± 0.0639	0.9423 ± 0.3536	2.2102 ± 0.3593
2.7161 ± 0.1370	4.4580 ± 1.3201	7.1741 ± 1.3272
1.1340 ± 0.0573	1.3468 ± 0.2890	2.4808 ± 0.2946
2.1266 ± 0.1067	18.8639 ± 3.1761	20.9905 ± 3.1779
0.0649 ± 0.0061	0.3623 ± 0.0198	0.4272 ± 0.0207
0.0063 ± 0.0099	0.0156 ± 0.0172	0.0219 ± 0.0198
0.0028 ± 0.0037	0.0106 ± 0.0024	0.0134 ± 0.0044
0.0285 ± 0.0017	0.0879 ± 0.0054	0.1164 ± 0.0057
0.8384 ± 0.0420	4.5004 ± 0.2321	5.3388 ± 0.2359
0.0017 ± 0.0129	0.0043 ± 0.0695	0.0060 ± 0.0707
0.0055 ± 0.0005	0.0074 ± 0.0009	0.0129 ± 0.0010
0.0117 ± 0.0007	0.0124 ± 0.0011	0.0241 ± 0.0013
0.1365 ± 0.0069	0.0519 ± 0.0096	0.1884 ± 0.0118
0.0002 ± 0.0023	0.0000 ± 0.0016	0.0002 ± 0.0028
0.0037 ± 0.0269	0.0000 ± 0.0095	0.0037 ± 0.0285
0.0016 ± 0.0004	0.0000 ± 0.0009	0.0016 ± 0.0010
0.0325 ± 0.0018	0.0140 ± 0.0024	0.0465 ± 0.0030
0.0053 ± 0.0006	0.0060 ± 0.0006	0.0113 ± 0.0008
0.0129 ± 0.0007	0.0964 ± 0.0049	0.1093 ± 0.0049
0.0000 ± 0.0017	0.0041 ± 0.0005	0.0041 ± 0.0018
0.0031 ± 0.0004	0.0158 ± 0.0015	0.0189 ± 0.0016
0.0004 ± 0.0014	0.0000 ± 0.0019	0.0004 ± 0.0024
0.0000 ± 0.0062	0.0000 ± 0.0081	0.0000 ± 0.0102
0.0000 ± 0.0069	0.0000 ± 0.0089	0.0000 ± 0.0113
0.0000 ± 0.0069	0.0042 ± 0.0090	0.0042 ± 0.0113
0.0000 ± 0.0080	0.0042 ± 0.0101	0.0042 ± 0.0129
0.0093 ± 0.0100	0.0031 ± 0.0120	0.0124 ± 0.0156
0.0035 ± 0.0114	0.0000 ± 0.0135	0.0035 ± 0.0177
0.0127 ± 0.0393	0.0571 ± 0.0159	0.0698 ± 0.0424
0.0283 ± 0.0517	0.0166 ± 0.0583	0.0449 ± 0.0779
0.0007 ± 0.0052	0.0000 ± 0.0034	0.0007 ± 0.0062
0.0007 ± 0.0018	0.0000 ± 0.0020	0.0007 ± 0.0027
0.0016 ± 0.0051	0.0016 ± 0.0026	0.0032 ± 0.0057
0.1734 ± 0.0089	0.0388 ± 0.0119	0.2122 ± 0.0149
0.0007 ± 0.0017	0.0011 ± 0.0021	0.0018 ± 0.0027
11.1953 ± 0.2365	48.1420 ± 5.5574	59.3373 ± 5.5624

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: C Date: 03/12/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31072	10.3	F		f2
Coarse:	31073	11.4			n9

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	99.0291	±	5.3186	340.3780	±	18.3648	439.4071	±	19.1195
Al	0.1235	±	0.0170	1.6908	±	0.5041	1.8143	±	0.5044
Si	0.4284	±	0.0237	6.4257	±	2.0348	6.8541	±	2.0349
P	0.0000	±	0.0197	0.0184	±	0.0327	0.0184	±	0.0382
S	2.5067	±	0.1272	1.0378	±	0.4471	3.5445	±	0.4648
Cl	0.6516	±	0.0381	2.9213	±	0.8502	3.5729	±	0.8511
K	0.3757	±	0.0197	0.5538	±	0.1172	0.9295	±	0.1188
Ca	0.9428	±	0.0477	9.0403	±	1.5219	9.9831	±	1.5226
Ti	0.0308	±	0.0096	0.1556	±	0.0117	0.1864	±	0.0151
V	0.0157	±	0.0042	0.0107	±	0.0043	0.0264	±	0.0060
Cr	0.0005	±	0.0040	0.0068	±	0.0016	0.0073	±	0.0043
Mn	0.0193	±	0.0015	0.0363	±	0.0027	0.0556	±	0.0031
Fe	0.4837	±	0.0244	2.0833	±	0.1093	2.5670	±	0.1120
Co	0.0002	±	0.0078	0.0013	±	0.0325	0.0015	±	0.0334
Ni	0.0107	±	0.0010	0.0051	±	0.0011	0.0158	±	0.0015
Cu	0.0159	±	0.0011	0.0252	±	0.0018	0.0411	±	0.0021
Zn	0.1929	±	0.0098	0.0876	±	0.0138	0.2805	±	0.0169
Ga	0.0000	±	0.0077	0.0000	±	0.0034	0.0000	±	0.0084
As	0.0130	±	0.1032	0.0017	±	0.0375	0.0147	±	0.1098
Se	0.0000	±	0.0033	0.0000	±	0.0016	0.0000	±	0.0037
Br	0.3861	±	0.0195	0.0773	±	0.0263	0.4634	±	0.0327
Rb	0.0000	±	0.0134	0.0004	±	0.0045	0.0004	±	0.0141
Sr	0.0055	±	0.0006	0.0474	±	0.0025	0.0529	±	0.0026
Y	0.0004	±	0.0061	0.0008	±	0.0025	0.0012	±	0.0066
Zr	0.0016	±	0.0017	0.0073	±	0.0009	0.0089	±	0.0019
Mo	0.0000	±	0.0028	0.0022	±	0.0027	0.0022	±	0.0039
Pd	0.0000	±	0.0103	0.0000	±	0.0104	0.0000	±	0.0146
Ag	0.0000	±	0.0115	0.0011	±	0.0114	0.0011	±	0.0162
Cd	0.0000	±	0.0114	0.0020	±	0.0115	0.0020	±	0.0162
In	0.0000	±	0.0135	0.0010	±	0.0133	0.0010	±	0.0190
Sn	0.0066	±	0.0168	0.0000	±	0.0165	0.0066	±	0.0235
Sb	0.0094	±	0.0197	0.0100	±	0.0192	0.0194	±	0.0275
Ba	0.1082	±	0.0255	0.0522	±	0.0688	0.1604	±	0.0734
La	0.0000	±	0.0953	0.0000	±	0.0879	0.0000	±	0.1296
Au	0.0000	±	0.0079	0.0000	±	0.0053	0.0000	±	0.0095
Hg	0.0004	±	0.0041	0.0006	±	0.0030	0.0010	±	0.0051
Tl	0.0000	±	0.0186	0.0000	±	0.0073	0.0000	±	0.0200
Pb	0.6687	±	0.0337	0.1633	±	0.0459	0.8320	±	0.0569
U	0.0000	±	0.0067	0.0000	±	0.0032	0.0000	±	0.0074
Sum	6.9983	±	0.2152	24.4673	±	2.7712	31.4656	±	2.7795

Field: Holes.

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: C Date: 03/14/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31074	10.3			g2
Coarse:	31075	11.4			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	99.0291	±	5.3186	253.1941	±	14.4184	352.2232	±	15.3681
Al	0.7710	±	0.0438	5.7527	±	1.7143	6.5237	±	1.7149
Si	2.4833	±	0.1256	19.1919	±	6.0841	21.6752	±	6.0854
P	0.0000	±	0.0267	0.0155	±	0.0508	0.0155	±	0.0574
S	2.0207	±	0.1067	2.5139	±	0.8991	4.5346	±	0.9054
Cl	6.8787	±	0.3458	4.4302	±	1.4487	11.3089	±	1.4894
K	1.8307	±	0.0926	2.0620	±	0.4512	3.8927	±	0.4606
Ca	3.4739	±	0.1744	41.0337	±	6.9041	44.5076	±	6.9063
Ti	0.0856	±	0.0097	0.5764	±	0.0317	0.6620	±	0.0332
V	0.0190	±	0.0041	0.0301	±	0.0087	0.0491	±	0.0096
Cr	0.0054	±	0.0015	0.0315	±	0.0040	0.0369	±	0.0043
Mn	0.0519	±	0.0030	0.1650	±	0.0099	0.2169	±	0.0103
Fe	1.4360	±	0.0720	7.8598	±	0.4049	9.2958	±	0.4113
Co	0.0013	±	0.0220	0.0102	±	0.1213	0.0115	±	0.1233
Ni	0.0096	±	0.0009	0.0190	±	0.0017	0.0286	±	0.0019
Cu	0.0895	±	0.0046	0.0544	±	0.0067	0.1439	±	0.0081
Zn	0.6510	±	0.0326	0.1947	±	0.0450	0.8457	±	0.0556
Ga	0.0000	±	0.0130	0.0000	±	0.0052	0.0000	±	0.0140
As	0.0133	±	0.1802	0.0000	±	0.0626	0.0133	±	0.1908
Se	0.0027	±	0.0052	0.0000	±	0.0023	0.0027	±	0.0057
Br	0.2473	±	0.0128	0.0702	±	0.0171	0.3175	±	0.0214
Rb	0.0085	±	0.0089	0.0081	±	0.0017	0.0166	±	0.0091
Sr	0.0184	±	0.0011	0.2065	±	0.0105	0.2249	±	0.0106
Y	0.0006	±	0.0099	0.0046	±	0.0016	0.0052	±	0.0100
Zr	0.0040	±	0.0007	0.0231	±	0.0030	0.0271	±	0.0031
Mo	0.0011	±	0.0029	0.0000	±	0.0033	0.0011	±	0.0044
Pd	0.0000	±	0.0117	0.0000	±	0.0145	0.0000	±	0.0186
Ag	0.0023	±	0.0130	0.0018	±	0.0158	0.0041	±	0.0205
Cd	0.0000	±	0.0130	0.0096	±	0.0160	0.0096	±	0.0206
In	0.0000	±	0.0150	0.0000	±	0.0179	0.0000	±	0.0234
Sn	0.0498	±	0.0069	0.0028	±	0.0215	0.0526	±	0.0226
Sb	0.0619	±	0.0080	0.0000	±	0.0242	0.0619	±	0.0255
Ba	0.0435	±	0.0734	0.1678	±	0.0292	0.2113	±	0.0790
La	0.0148	±	0.0948	0.0000	±	0.1009	0.0148	±	0.1384
Au	0.0000	±	0.0229	0.0000	±	0.0104	0.0000	±	0.0252
Hg	0.0000	±	0.0057	0.0000	±	0.0040	0.0000	±	0.0070
Tl	0.0000	±	0.0321	0.0020	±	0.0117	0.0020	±	0.0342
Pb	1.1735	±	0.0590	0.2660	±	0.0803	1.4395	±	0.0996
U	0.0000	±	0.0051	0.0013	±	0.0039	0.0013	±	0.0064
Sum	21.4493	±	0.4985	84.7048	±	9.5363	106.1541	±	9.5493

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: C Date: 03/16/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Mass	XRF
Fine:	31076	11.1			
Coarse:	31077	12.3			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	38.5305	±	2.6312	110.0964	±	6.3014	148.6269	±	6.8287
Al	0.2923	±	0.0209	2.2830	±	0.6811	2.5753	±	0.6814
Si	0.7338	±	0.0381	8.8218	±	2.7941	9.5556	±	2.7944
P	0.0049	±	0.0149	0.0278	±	0.0350	0.0327	±	0.0380
S	1.3358	±	0.0691	1.2890	±	0.4697	2.6248	±	0.4748
Cl	0.4227	±	0.0244	3.9361	±	1.1430	4.3588	±	1.1433
K	0.2786	±	0.0147	0.8609	±	0.1754	1.1395	±	0.1760
Ca	0.5930	±	0.0301	11.7237	±	1.9715	12.3167	±	1.9717
Ti	0.0197	±	0.0225	0.2118	±	0.0136	0.2315	±	0.0263
V	0.0046	±	0.0098	0.0101	±	0.0129	0.0147	±	0.0162
Cr	0.0004	±	0.0035	0.0084	±	0.0017	0.0088	±	0.0039
Mn	0.0123	±	0.0012	0.0438	±	0.0029	0.0561	±	0.0031
Fe	0.3848	±	0.0194	2.7225	±	0.1387	3.1073	±	0.1401
Co	0.0000	±	0.0063	0.0031	±	0.0419	0.0031	±	0.0424
Ni	0.0036	±	0.0007	0.0051	±	0.0008	0.0087	±	0.0011
Cu	0.0188	±	0.0012	0.0325	±	0.0022	0.0513	±	0.0025
Zn	0.1683	±	0.0085	0.0931	±	0.0123	0.2614	±	0.0150
Ga	0.0000	±	0.0067	0.0000	±	0.0031	0.0000	±	0.0074
As	0.0000	±	0.0898	0.0000	±	0.0337	0.0000	±	0.0959
Se	0.0000	±	0.0028	0.0000	±	0.0015	0.0000	±	0.0032
Br	0.3406	±	0.0172	0.0764	±	0.0233	0.4170	±	0.0290
Rb	0.0000	±	0.0118	0.0013	±	0.0042	0.0013	±	0.0125
Sr	0.0047	±	0.0005	0.0582	±	0.0030	0.0629	±	0.0030
Y	0.0000	±	0.0053	0.0015	±	0.0023	0.0015	±	0.0058
Zr	0.0006	±	0.0014	0.0079	±	0.0010	0.0085	±	0.0017
Mo	0.0000	±	0.0024	0.0027	±	0.0008	0.0027	±	0.0025
Pd	0.0000	±	0.0095	0.0000	±	0.0100	0.0000	±	0.0138
Ag	0.0000	±	0.0105	0.0000	±	0.0112	0.0000	±	0.0154
Cd	0.0004	±	0.0105	0.0000	±	0.0113	0.0004	±	0.0154
In	0.0000	±	0.0120	0.0002	±	0.0130	0.0002	±	0.0177
Sn	0.0036	±	0.0150	0.0035	±	0.0154	0.0071	±	0.0215
Sb	0.0060	±	0.0175	0.0164	±	0.0176	0.0224	±	0.0248
Ba	0.0242	±	0.0646	0.0803	±	0.0223	0.1045	±	0.0683
La	0.0000	±	0.0854	0.0000	±	0.0810	0.0000	±	0.1177
Au	0.0000	±	0.0071	0.0000	±	0.0052	0.0000	±	0.0088
Hg	0.0000	±	0.0035	0.0015	±	0.0027	0.0015	±	0.0044
Tl	0.0000	±	0.0162	0.0000	±	0.0066	0.0000	±	0.0175
Pb	0.5815	±	0.0294	0.1515	±	0.0401	0.7330	±	0.0497
U	0.0000	±	0.0058	0.0010	±	0.0029	0.0010	±	0.0065
Sum	5.2352	±	0.1788	32.4751	±	3.7081	37.7103	±	3.7124

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: M Date: 04/13/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31094	22.5	U		
Coarse:	31095	24.9	U		g2,i

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	55.4570	±	2.9114	264.2546	±	13.7571	319.7116	±	14.0618
Al	1.3114	±	0.0670	4.1802	±	1.2605	5.4916	±	1.2623
Si	4.1279	±	0.2069	13.2168	±	4.2231	17.3447	±	4.2282
P	0.0000	±	0.0128	0.0000	±	0.0263	0.0000	±	0.0292
S	1.2855	±	0.0656	1.2749	±	0.4633	2.5604	±	0.4679
Cl	0.8157	±	0.0431	2.4205	±	0.7084	3.2362	±	0.7097
K	0.6468	±	0.0337	1.4219	±	0.2939	2.0687	±	0.2958
Ca	3.5007	±	0.1753	23.1208	±	3.8977	26.6215	±	3.9016
Ti	0.1421	±	0.0083	0.4714	±	0.0262	0.6135	±	0.0275
V	0.0123	±	0.0026	0.0227	±	0.0063	0.0350	±	0.0068
Cr	0.0061	±	0.0011	0.0212	±	0.0028	0.0273	±	0.0030
Mn	0.0497	±	0.0028	0.0902	±	0.0063	0.1399	±	0.0069
Fe	1.8748	±	0.0938	5.6442	±	0.3094	7.5190	±	0.3233
Co	0.0028	±	0.0285	0.0131	±	0.0882	0.0159	±	0.0927
Ni	0.0050	±	0.0005	0.0139	±	0.0011	0.0189	±	0.0012
Cu	0.0160	±	0.0009	0.0197	±	0.0015	0.0357	±	0.0017
Zn	0.6355	±	0.0318	0.1790	±	0.0439	0.8145	±	0.0542
Ga	0.0000	±	0.0049	0.0001	±	0.0018	0.0001	±	0.0052
As	0.0045	±	0.0654	0.0000	±	0.0170	0.0045	±	0.0676
Se	0.0005	±	0.0019	0.0000	±	0.0009	0.0005	±	0.0021
Br	0.0320	±	0.0020	0.0119	±	0.0023	0.0439	±	0.0030
Rb	0.0023	±	0.0005	0.0057	±	0.0005	0.0080	±	0.0007
Sr	0.0224	±	0.0012	0.1357	±	0.0070	0.1581	±	0.0071
Y	0.0008	±	0.0036	0.0036	±	0.0006	0.0044	±	0.0036
Zr	0.0059	±	0.0005	0.0201	±	0.0021	0.0260	±	0.0022
Mo	0.0005	±	0.0013	0.0000	±	0.0012	0.0005	±	0.0018
Pd	0.0000	±	0.0057	0.0000	±	0.0074	0.0000	±	0.0093
Ag	0.0000	±	0.0063	0.0064	±	0.0080	0.0064	±	0.0102
Cd	0.0022	±	0.0065	0.0100	±	0.0029	0.0122	±	0.0071
In	0.0013	±	0.0073	0.0000	±	0.0089	0.0013	±	0.0115
Sn	0.0167	±	0.0032	0.0043	±	0.0106	0.0210	±	0.0111
Sb	0.0062	±	0.0103	0.0026	±	0.0118	0.0088	±	0.0157
Ba	0.0219	±	0.0343	0.0817	±	0.0140	0.1036	±	0.0370
La	0.0029	±	0.0442	0.0140	±	0.0493	0.0169	±	0.0662
Au	0.0000	±	0.0215	0.0000	±	0.0083	0.0000	±	0.0230
Hg	0.0000	±	0.0029	0.0000	±	0.0020	0.0000	±	0.0035
Tl	0.0000	±	0.0117	0.0022	±	0.0035	0.0022	±	0.0122
Pb	0.4262	±	0.0214	0.0591	±	0.0290	0.4853	±	0.0360
U	0.0000	±	0.0015	0.0021	±	0.0007	0.0021	±	0.0017
Sum	14.9786	±	0.3240	52.4700	±	5.9607	67.4486	±	5.9695

Field: Thebes dust storm.

Field: Thebes dust storm.

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: M Date: 04/22/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31104	19.2			n3
Coarse:	31105	21.5			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	34.8414	±	2.0289	60.5074	±	3.9404	95.3488	±	4.4321
Al	0.0776	±	0.0079	1.5444	±	0.4595	1.6220	±	0.4596
Si	0.2863	±	0.0156	4.9428	±	1.5650	5.2291	±	1.5651
P	0.0000	±	0.0138	0.0321	±	0.0151	0.0321	±	0.0205
S	3.1558	±	0.1580	0.6196	±	0.3956	3.7754	±	0.4260
Cl	0.0000	±	0.0588	0.9316	±	0.2715	0.9316	±	0.2778
K	0.2465	±	0.0128	0.4221	±	0.0905	0.6686	±	0.0914
Ca	0.5263	±	0.0266	10.4957	±	1.7650	11.0220	±	1.7652
Ti	0.0111	±	0.0138	0.1359	±	0.0085	0.1470	±	0.0162
V	0.0046	±	0.0060	0.0070	±	0.0077	0.0116	±	0.0098
Cr	0.0005	±	0.0021	0.0056	±	0.0010	0.0061	±	0.0023
Mn	0.0053	±	0.0006	0.0250	±	0.0016	0.0303	±	0.0017
Fe	0.1593	±	0.0081	1.4930	±	0.0755	1.6523	±	0.0759
Co	0.0000	±	0.0027	0.0040	±	0.0230	0.0040	±	0.0232
Ni	0.0027	±	0.0004	0.0032	±	0.0005	0.0059	±	0.0006
Cu	0.0078	±	0.0006	0.0089	±	0.0008	0.0167	±	0.0010
Zn	0.0964	±	0.0049	0.0397	±	0.0068	0.1361	±	0.0084
Ga	0.0000	±	0.0017	0.0000	±	0.0013	0.0000	±	0.0021
As	0.0016	±	0.0160	0.0001	±	0.0067	0.0017	±	0.0173
Se	0.0010	±	0.0003	0.0000	±	0.0007	0.0010	±	0.0008
Br	0.0257	±	0.0014	0.0125	±	0.0019	0.0382	±	0.0024
Rb	0.0001	±	0.0011	0.0008	±	0.0009	0.0009	±	0.0014
Sr	0.0035	±	0.0003	0.0542	±	0.0028	0.0577	±	0.0028
Y	0.0000	±	0.0012	0.0007	±	0.0009	0.0007	±	0.0015
Zr	0.0010	±	0.0003	0.0051	±	0.0008	0.0061	±	0.0009
Mo	0.0000	±	0.0016	0.0007	±	0.0016	0.0007	±	0.0023
Pd	0.0011	±	0.0056	0.0000	±	0.0062	0.0011	±	0.0084
Ag	0.0000	±	0.0062	0.0000	±	0.0069	0.0000	±	0.0093
Cd	0.0011	±	0.0063	0.0022	±	0.0069	0.0033	±	0.0093
In	0.0000	±	0.0074	0.0001	±	0.0078	0.0001	±	0.0108
Sn	0.0066	±	0.0093	0.0000	±	0.0096	0.0066	±	0.0134
Sb	0.0105	±	0.0110	0.0060	±	0.0111	0.0165	±	0.0156
Ba	0.0142	±	0.0398	0.0239	±	0.0392	0.0381	±	0.0559
La	0.0000	±	0.0522	0.0000	±	0.0503	0.0000	±	0.0725
Au	0.0000	±	0.0040	0.0000	±	0.0028	0.0000	±	0.0049
Hg	0.0000	±	0.0017	0.0000	±	0.0016	0.0000	±	0.0023
Tl	0.0000	±	0.0033	0.0000	±	0.0020	0.0000	±	0.0039
Pb	0.1024	±	0.0053	0.0293	±	0.0071	0.1317	±	0.0089
U	0.0000	±	0.0015	0.0005	±	0.0015	0.0005	±	0.0021
Sum	4.7490	±	0.1874	20.8467	±	2.4546	25.5957	±	2.4618

XRF: Metallic particles.

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: M Date: 04/29/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31110	20.7			
Coarse:	31111	23.1			i3

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine		Coarse		PM_{10}	
Mass	15.8883 ±	1.2483	65.4970 ±	3.5541	81.3853 ±	3.7669
Al	0.0845 ±	0.0069	1.4740 ±	0.4386	1.5585 ±	0.4387
Si	0.3177 ±	0.0166	4.9863 ±	1.5788	5.3040 ±	1.5789
P	0.0000 ±	0.0085	0.0000 ±	0.0183	0.0000 ±	0.0202
S	1.1963 ±	0.0601	0.7435 ±	0.2875	1.9398 ±	0.2937
Cl	0.0070 ±	0.0233	2.2019 ±	0.6392	2.2089 ±	0.6396
K	0.1088 ±	0.0060	0.4556 ±	0.0945	0.5644 ±	0.0947
Ca	0.4466 ±	0.0226	9.9981 ±	1.6812	10.4447 ±	1.6814
Ti	0.0128 ±	0.0129	0.1297 ±	0.0080	0.1425 ±	0.0152
V	0.0030 ±	0.0056	0.0045 ±	0.0072	0.0075 ±	0.0091
Cr	0.0004 ±	0.0018	0.0058 ±	0.0010	0.0062 ±	0.0021
Mn	0.0030 ±	0.0005	0.0221 ±	0.0015	0.0251 ±	0.0016
Fe	0.1348 ±	0.0068	1.4462 ±	0.0730	1.5810 ±	0.0733
Co	0.0000 ±	0.0024	0.0019 ±	0.0222	0.0019 ±	0.0223
Ni	0.0015 ±	0.0004	0.0048 ±	0.0005	0.0063 ±	0.0006
Cu	0.0040 ±	0.0004	0.0077 ±	0.0006	0.0117 ±	0.0007
Zn	0.0102 ±	0.0007	0.0307 ±	0.0017	0.0409 ±	0.0018
Ga	0.0000 ±	0.0014	0.0000 ±	0.0011	0.0000 ±	0.0018
As	0.0006 ±	0.0100	0.0000 ±	0.0051	0.0006 ±	0.0112
Se	0.0000 ±	0.0008	0.0001 ±	0.0006	0.0001 ±	0.0010
Br	0.0180 ±	0.0010	0.0091 ±	0.0013	0.0271 ±	0.0016
Rb	0.0000 ±	0.0009	0.0014 ±	0.0003	0.0014 ±	0.0009
Sr	0.0033 ±	0.0003	0.0606 ±	0.0031	0.0639 ±	0.0031
Y	0.0000 ±	0.0009	0.0009 ±	0.0003	0.0009 ±	0.0009
Zr	0.0005 ±	0.0009	0.0048 ±	0.0009	0.0053 ±	0.0013
Mo	0.0000 ±	0.0015	0.0000 ±	0.0013	0.0000 ±	0.0020
Pd	0.0000 ±	0.0052	0.0000 ±	0.0056	0.0000 ±	0.0076
Ag	0.0000 ±	0.0058	0.0000 ±	0.0061	0.0000 ±	0.0084
Cd	0.0000 ±	0.0059	0.0012 ±	0.0062	0.0012 ±	0.0086
In	0.0000 ±	0.0069	0.0000 ±	0.0069	0.0000 ±	0.0098
Sn	0.0075 ±	0.0085	0.0000 ±	0.0083	0.0075 ±	0.0119
Sb	0.0113 ±	0.0034	0.0010 ±	0.0096	0.0123 ±	0.0102
Ba	0.0045 ±	0.0374	0.0457 ±	0.0121	0.0502 ±	0.0393
La	0.0072 ±	0.0496	0.0000 ±	0.0434	0.0072 ±	0.0659
Au	0.0000 ±	0.0020	0.0000 ±	0.0021	0.0000 ±	0.0029
Hg	0.0000 ±	0.0016	0.0001 ±	0.0013	0.0001 ±	0.0021
Tl	0.0000 ±	0.0024	0.0000 ±	0.0016	0.0000 ±	0.0029
Pb	0.0637 ±	0.0034	0.0238 ±	0.0045	0.0875 ±	0.0056
U	0.0000 ±	0.0014	0.0007 ±	0.0013	0.0007 ±	0.0019
Sum	2.4472 ±	0.0978	21.6622 ±	2.4536	24.1094 ±	2.4556

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: S Date: 08/01/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Flags Mass	Flags XRF
Fine:	31130	18.9			n
Coarse:	31131	21.2			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	60.0949	±	3.1843	161.1857	±	9.0656	221.2806	±	9.6086
Al	0.2069	±	0.0137	3.8359	±	1.1402	4.0428	±	1.1403
Si	2.1940	±	0.1103	12.2674	±	3.8947	14.4614	±	3.8963
P	0.0000	±	0.0139	0.0309	±	0.0164	0.0309	±	0.0215
S	2.0444	±	0.1029	1.1341	±	0.4489	3.1785	±	0.4605
Cl	0.9450	±	0.0505	4.5442	±	1.3217	5.4892	±	1.3227
K	1.0362	±	0.0522	1.3672	±	0.2881	2.4034	±	0.2928
Ca	0.6029	±	0.0308	13.7352	±	2.3096	14.3381	±	2.3098
Ti	0.0287	±	0.0051	0.4942	±	0.0258	0.5229	±	0.0263
V	0.0277	±	0.0026	0.0210	±	0.0067	0.0487	±	0.0072
Cr	0.0060	±	0.0011	0.0206	±	0.0028	0.0266	±	0.0030
Mn	0.1160	±	0.0060	0.1276	±	0.0105	0.2436	±	0.0121
Fe	1.1648	±	0.0583	5.4854	±	0.2853	6.6502	±	0.2912
Co	0.0006	±	0.0178	0.0081	±	0.0849	0.0087	±	0.0867
Ni	0.0143	±	0.0009	0.0123	±	0.0014	0.0266	±	0.0017
Cu	0.0249	±	0.0014	0.0293	±	0.0023	0.0542	±	0.0027
Zn	0.8087	±	0.0405	0.2862	±	0.0563	1.0949	±	0.0694
Ga	0.0000	±	0.0040	0.0000	±	0.0026	0.0000	±	0.0048
As	0.0548	±	0.0167	0.0000	±	0.0282	0.0548	±	0.0328
Se	0.0010	±	0.0017	0.0000	±	0.0012	0.0010	±	0.0021
Br	0.0411	±	0.0023	0.0191	±	0.0030	0.0602	±	0.0038
Rb	0.0035	±	0.0006	0.0042	±	0.0005	0.0077	±	0.0008
Sr	0.0039	±	0.0003	0.0927	±	0.0047	0.0966	±	0.0047
Y	0.0000	±	0.0028	0.0031	±	0.0007	0.0031	±	0.0029
Zr	0.0008	±	0.0010	0.0175	±	0.0015	0.0183	±	0.0018
Mo	0.0004	±	0.0017	0.0026	±	0.0007	0.0030	±	0.0018
Pd	0.0029	±	0.0063	0.0000	±	0.0076	0.0029	±	0.0099
Ag	0.0012	±	0.0071	0.0000	±	0.0084	0.0012	±	0.0110
Cd	0.0046	±	0.0074	0.0084	±	0.0031	0.0130	±	0.0080
In	0.0000	±	0.0085	0.0011	±	0.0097	0.0011	±	0.0129
Sn	0.0722	±	0.0054	0.0100	±	0.0063	0.0822	±	0.0083
Sb	0.0193	±	0.0042	0.0083	±	0.0132	0.0276	±	0.0139
Ba	0.0014	±	0.0419	0.1112	±	0.0165	0.1126	±	0.0450
La	0.0000	±	0.0552	0.0054	±	0.0569	0.0054	±	0.0793
Au	0.0000	±	0.0267	0.0000	±	0.0135	0.0000	±	0.0299
Hg	0.0002	±	0.0033	0.0021	±	0.0024	0.0023	±	0.0041
Tl	0.0000	±	0.0093	0.0017	±	0.0055	0.0017	±	0.0108
Pb	0.3210	±	0.0162	0.1457	±	0.0228	0.4667	±	0.0280
U	0.0000	±	0.0018	0.0011	±	0.0020	0.0011	±	0.0027
Sum	9.7494	±	0.2031	43.8338	±	4.8921	53.5832	±	4.8964

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: S Date: 08/05/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Flags Mass	Flags XRF
Fine:	31136	20.2			
Coarse:	31137	22.5			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	69.1017	±	3.5933	101.0357	±	6.9280	170.1374	±	7.8044
Al	0.1950	±	0.0137	3.3968	±	1.0097	3.5918	±	1.0098
Si	3.9493	±	0.1980	9.6616	±	3.1077	13.6109	±	3.1140
P	0.0000	±	0.0150	0.0488	±	0.0224	0.0488	±	0.0270
S	2.4577	±	0.1235	0.8866	±	0.4024	3.3443	±	0.4209
Cl	0.7153	±	0.0411	2.8515	±	0.8304	3.5668	±	0.8314
K	1.0919	±	0.0549	0.9684	±	0.2154	2.0603	±	0.2223
Ca	0.4318	±	0.0224	8.3742	±	1.4083	8.8060	±	1.4085
Ti	0.0108	±	0.0138	0.3387	±	0.0181	0.3495	±	0.0228
V	0.0219	±	0.0024	0.0095	±	0.0157	0.0314	±	0.0159
Cr	0.0089	±	0.0011	0.0104	±	0.0022	0.0193	±	0.0025
Mn	0.1747	±	0.0089	0.0798	±	0.0126	0.2545	±	0.0154
Fe	1.1945	±	0.0598	3.8875	±	0.2105	5.0820	±	0.2188
Co	0.0001	±	0.0182	0.0068	±	0.0607	0.0069	±	0.0634
Ni	0.0127	±	0.0008	0.0086	±	0.0011	0.0213	±	0.0014
Cu	0.0214	±	0.0012	0.0206	±	0.0018	0.0420	±	0.0022
Zn	1.1235	±	0.0562	0.1802	±	0.0762	1.3037	±	0.0947
Ga	0.0037	±	0.0045	0.0000	±	0.0027	0.0037	±	0.0052
As	0.0390	±	0.0530	0.0004	±	0.0319	0.0394	±	0.0619
Se	0.0008	±	0.0017	0.0000	±	0.0012	0.0008	±	0.0021
Br	0.0358	±	0.0021	0.0118	±	0.0026	0.0476	±	0.0033
Rb	0.0046	±	0.0006	0.0027	±	0.0005	0.0073	±	0.0008
Sr	0.0040	±	0.0003	0.0479	±	0.0025	0.0519	±	0.0025
Y	0.0000	±	0.0030	0.0020	±	0.0007	0.0020	±	0.0031
Zr	0.0018	±	0.0003	0.0110	±	0.0009	0.0128	±	0.0009
Mo	0.0016	±	0.0005	0.0005	±	0.0016	0.0021	±	0.0017
Pd	0.0006	±	0.0061	0.0000	±	0.0063	0.0006	±	0.0088
Ag	0.0000	±	0.0067	0.0004	±	0.0072	0.0004	±	0.0098
Cd	0.0043	±	0.0069	0.0065	±	0.0075	0.0108	±	0.0102
In	0.0000	±	0.0080	0.0010	±	0.0083	0.0010	±	0.0115
Sn	0.0910	±	0.0061	0.0143	±	0.0071	0.1053	±	0.0094
Sb	0.0123	±	0.0039	0.0112	±	0.0040	0.0235	±	0.0056
Ba	0.0363	±	0.0383	0.0872	±	0.0143	0.1235	±	0.0409
La	0.0157	±	0.0497	0.0434	±	0.0496	0.0591	±	0.0702
Au	0.0000	±	0.0386	0.0000	±	0.0110	0.0000	±	0.0401
Hg	0.0026	±	0.0042	0.0009	±	0.0021	0.0035	±	0.0047
Tl	0.0000	±	0.0097	0.0000	±	0.0059	0.0000	±	0.0114
Pb	0.3441	±	0.0174	0.1680	±	0.0247	0.5121	±	0.0302
U	0.0000	±	0.0017	0.0008	±	0.0016	0.0008	±	0.0023
Sum	12.0077	±	0.2763	31.1400	±	3.6903	43.1477	±	3.7006

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: T Date: / / Time: -

	Filter IDs	Volume(m^3)	Flags Field	Flags Mass	Flags XRF
Fine:	31120	20.6			
Coarse:	31121	22.9			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	41.2021	±	2.2768	142.2401	±	7.6855	183.4422	±	8.0157
Al	0.3158	±	0.0179	3.5324	±	1.0508	3.8482	±	1.0510
Si	0.7918	±	0.0404	10.0579	±	3.1852	10.8497	±	3.1855
P	0.0000	±	0.0129	0.0062	±	0.0240	0.0062	±	0.0272
S	2.6681	±	0.1338	0.8770	±	0.4146	3.5451	±	0.4357
Cl	0.0479	±	0.0533	2.6281	±	0.7631	2.6760	±	0.7650
K	0.6436	±	0.0326	1.1330	±	0.2343	1.7766	±	0.2366
Ca	0.7501	±	0.0379	13.2704	±	2.2317	14.0205	±	2.2320
Ti	0.0335	±	0.0046	0.3479	±	0.0185	0.3814	±	0.0191
V	0.0125	±	0.0020	0.0131	±	0.0047	0.0256	±	0.0051
Cr	0.0037	±	0.0008	0.0121	±	0.0018	0.0158	±	0.0020
Mn	0.0157	±	0.0010	0.0665	±	0.0039	0.0822	±	0.0040
Fe	0.3390	±	0.0170	3.3872	±	0.1710	3.7262	±	0.1718
Co	0.0007	±	0.0053	0.0076	±	0.0518	0.0083	±	0.0521
Ni	0.0055	±	0.0005	0.0069	±	0.0007	0.0124	±	0.0009
Cu	0.0347	±	0.0018	0.0243	±	0.0027	0.0590	±	0.0032
Zn	0.5613	±	0.0281	0.1188	±	0.0383	0.6801	±	0.0475
Ga	0.0000	±	0.0033	0.0000	±	0.0020	0.0000	±	0.0039
As	0.0032	±	0.0411	0.0000	±	0.0201	0.0032	±	0.0458
Se	0.0007	±	0.0014	0.0000	±	0.0010	0.0007	±	0.0017
Br	0.0188	±	0.0012	0.0091	±	0.0014	0.0279	±	0.0018
Rb	0.0019	±	0.0003	0.0042	±	0.0004	0.0061	±	0.0005
Sr	0.0056	±	0.0004	0.0829	±	0.0042	0.0885	±	0.0042
Y	0.0001	±	0.0024	0.0017	±	0.0005	0.0018	±	0.0025
Zr	0.0014	±	0.0003	0.0130	±	0.0013	0.0144	±	0.0013
Mo	0.0005	±	0.0015	0.0000	±	0.0017	0.0005	±	0.0023
Pd	0.0000	±	0.0053	0.0000	±	0.0068	0.0000	±	0.0086
Ag	0.0000	±	0.0060	0.0013	±	0.0074	0.0013	±	0.0095
Cd	0.0000	±	0.0061	0.0045	±	0.0076	0.0045	±	0.0097
In	0.0000	±	0.0071	0.0000	±	0.0085	0.0000	±	0.0111
Sn	0.0089	±	0.0090	0.0059	±	0.0104	0.0148	±	0.0138
Sb	0.0052	±	0.0104	0.0033	±	0.0117	0.0085	±	0.0157
Ba	0.0068	±	0.0363	0.0660	±	0.0142	0.0728	±	0.0390
La	0.0026	±	0.0480	0.0006	±	0.0511	0.0032	±	0.0701
Au	0.0000	±	0.0190	0.0000	±	0.0067	0.0000	±	0.0201
Hg	0.0000	±	0.0025	0.0012	±	0.0019	0.0012	±	0.0031
Tl	0.0000	±	0.0075	0.0000	±	0.0040	0.0000	±	0.0085
Pb	0.2672	±	0.0135	0.0995	±	0.0187	0.3667	±	0.0231
U	0.0002	±	0.0015	0.0004	±	0.0017	0.0006	±	0.0023
Sum	6.5470	±	0.1811	35.7830	±	4.1325	42.3300	±	4.1365

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: T Date: 06/03/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31124	22.1	F		f5
Coarse:	31125	24.5			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	65.0113	±	3.3736	178.8812	±	9.9965	243.8925	±	10.5504
Al	0.5570	±	0.0296	3.9430	±	1.1750	4.5000	±	1.1754
Si	1.2030	±	0.0608	10.6710	±	3.3815	11.8740	±	3.3820
P	0.0000	±	0.0139	0.0000	±	0.0280	0.0000	±	0.0313
S	2.8071	±	0.1408	1.1216	±	0.4895	3.9287	±	0.5093
Cl	0.6186	±	0.0378	6.1892	±	1.7970	6.8078	±	1.7974
K	1.6519	±	0.0830	1.8257	±	0.3938	3.4776	±	0.4025
Ca	1.6106	±	0.0811	21.7789	±	3.6636	23.3895	±	3.6645
Ti	0.0583	±	0.0050	0.4533	±	0.0237	0.5116	±	0.0242
V	0.0167	±	0.0021	0.0198	±	0.0058	0.0365	±	0.0062
Cr	0.0065	±	0.0008	0.0203	±	0.0022	0.0268	±	0.0023
Mn	0.0144	±	0.0010	0.0775	±	0.0045	0.0919	±	0.0046
Fe	0.4964	±	0.0249	4.0962	±	0.2076	4.5926	±	0.2091
Co	0.0006	±	0.0077	0.0128	±	0.0628	0.0134	±	0.0633
Ni	0.0081	±	0.0006	0.0125	±	0.0010	0.0206	±	0.0012
Cu	0.0400	±	0.0021	0.0230	±	0.0030	0.0630	±	0.0037
Zn	0.4361	±	0.0218	0.1126	±	0.0300	0.5487	±	0.0371
Ga	0.0000	±	0.0037	0.0000	±	0.0019	0.0000	±	0.0042
As	0.0035	±	0.0482	0.0000	±	0.0196	0.0035	±	0.0520
Se	0.0011	±	0.0015	0.0002	±	0.0009	0.0013	±	0.0017
Br	0.0362	±	0.0020	0.0147	±	0.0026	0.0509	±	0.0033
Rb	0.0080	±	0.0007	0.0078	±	0.0008	0.0158	±	0.0011
Sr	0.0120	±	0.0007	0.1440	±	0.0073	0.1560	±	0.0073
Y	0.0003	±	0.0027	0.0030	±	0.0006	0.0033	±	0.0028
Zr	0.0036	±	0.0004	0.0189	±	0.0021	0.0225	±	0.0021
Mo	0.0008	±	0.0014	0.0000	±	0.0017	0.0008	±	0.0022
Pd	0.0000	±	0.0053	0.0000	±	0.0071	0.0000	±	0.0089
Ag	0.0000	±	0.0059	0.0007	±	0.0077	0.0007	±	0.0097
Cd	0.0061	±	0.0020	0.0062	±	0.0079	0.0123	±	0.0081
In	0.0000	±	0.0068	0.0002	±	0.0087	0.0002	±	0.0110
Sn	0.0177	±	0.0031	0.0043	±	0.0102	0.0220	±	0.0107
Sb	0.0094	±	0.0098	0.0042	±	0.0116	0.0136	±	0.0152
Ba	0.0062	±	0.0346	0.0608	±	0.0135	0.0670	±	0.0371
La	0.0000	±	0.0453	0.0000	±	0.0483	0.0000	±	0.0662
Au	0.0000	±	0.0150	0.0000	±	0.0060	0.0000	±	0.0162
Hg	0.0000	±	0.0023	0.0000	±	0.0019	0.0000	±	0.0030
Tl	0.0000	±	0.0087	0.0026	±	0.0039	0.0026	±	0.0095
Pb	0.3135	±	0.0158	0.0907	±	0.0217	0.4042	±	0.0268
U	0.0000	±	0.0018	0.0017	±	0.0021	0.0017	±	0.0028
Sum	9.9437	±	0.2169	50.7174	±	5.4694	60.6611	±	5.4737

Field: Hole (OK).

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: T Date: 06/04/95 Time: -

	Filter IDs	Volume(m^3)	Flags Field	Flags Mass	Flags XRF
Fine:	31126	19.8	G		g2
Coarse:	31127	22.1			

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine			Coarse			PM_{10}		
Mass	49.3952	±	2.6676	155.8371	±	8.5200	205.2323	±	8.9278
Al	0.3028	±	0.0174	3.9964	±	1.1883	4.2992	±	1.1884
Si	0.7738	±	0.0395	11.2621	±	3.5660	12.0359	±	3.5662
P	0.0000	±	0.0133	0.0000	±	0.0276	0.0000	±	0.0306
S	2.4565	±	0.1234	0.9298	±	0.4137	3.3863	±	0.4317
Cl	0.2853	±	0.0236	4.2198	±	1.2250	4.5051	±	1.2252
K	1.3079	±	0.0658	1.5442	±	0.3298	2.8521	±	0.3363
Ca	0.9697	±	0.0491	17.2128	±	2.8947	18.1825	±	2.8951
Ti	0.0420	±	0.0049	0.4216	±	0.0222	0.4636	±	0.0227
V	0.0163	±	0.0022	0.0143	±	0.0165	0.0306	±	0.0166
Cr	0.0071	±	0.0010	0.0153	±	0.0021	0.0224	±	0.0023
Mn	0.0235	±	0.0014	0.0769	±	0.0047	0.1004	±	0.0049
Fe	0.4106	±	0.0206	4.0661	±	0.2053	4.4767	±	0.2063
Co	0.0000	±	0.0064	0.0075	±	0.0622	0.0075	±	0.0625
Ni	0.0088	±	0.0007	0.0094	±	0.0010	0.0182	±	0.0012
Cu	0.0633	±	0.0032	0.0287	±	0.0045	0.0920	±	0.0055
Zn	1.1020	±	0.0551	0.2246	±	0.0750	1.3266	±	0.0931
Ga	0.0000	±	0.0040	0.0000	±	0.0020	0.0000	±	0.0045
As	0.0000	±	0.0475	0.0000	±	0.0174	0.0000	±	0.0506
Se	0.0007	±	0.0015	0.0000	±	0.0009	0.0007	±	0.0017
Br	0.0290	±	0.0017	0.0130	±	0.0021	0.0420	±	0.0027
Rb	0.0045	±	0.0005	0.0058	±	0.0005	0.0103	±	0.0007
Sr	0.0074	±	0.0005	0.1063	±	0.0054	0.1137	±	0.0054
Y	0.0000	±	0.0027	0.0028	±	0.0005	0.0028	±	0.0027
Zr	0.0018	±	0.0003	0.0165	±	0.0016	0.0183	±	0.0016
Mo	0.0014	±	0.0015	0.0000	±	0.0018	0.0014	±	0.0023
Pd	0.0000	±	0.0061	0.0000	±	0.0074	0.0000	±	0.0096
Ag	0.0000	±	0.0067	0.0000	±	0.0079	0.0000	±	0.0104
Cd	0.0032	±	0.0069	0.0004	±	0.0082	0.0036	±	0.0107
In	0.0000	±	0.0078	0.0000	±	0.0092	0.0000	±	0.0121
Sn	0.0175	±	0.0035	0.0061	±	0.0109	0.0236	±	0.0114
Sb	0.0097	±	0.0111	0.0034	±	0.0122	0.0131	±	0.0165
Ba	0.0072	±	0.0381	0.0994	±	0.0151	0.1066	±	0.0410
La	0.0100	±	0.0503	0.0000	±	0.0527	0.0100	±	0.0729
Au	0.0000	±	0.0354	0.0000	±	0.0126	0.0000	±	0.0376
Hg	0.0000	±	0.0038	0.0000	±	0.0022	0.0000	±	0.0044
Tl	0.0000	±	0.0086	0.0003	±	0.0036	0.0003	±	0.0093
Pb	0.3089	±	0.0156	0.0739	±	0.0212	0.3828	±	0.0263
U	0.0002	±	0.0017	0.0005	±	0.0019	0.0007	±	0.0025
Sum	8.1711	±	0.1905	44.3579	±	4.9342	52.5290	±	4.9378

Field: Smudge.

Table 1 (continued)

Research Triangle Institute - Cairo, Egypt Dichotomous Sample Concentrations

Site: T Date: 06/06/95 Time: -

	Filter IDs	Volume(m^3)	Field	Flags Mass	XRF
Fine:	31128	22.0			n
Coarse:	31129	24.5			n,gl

Fine, Coarse, and PM_{10} Concentrations ($\mu g/m^3$)

	Fine		Coarse		PM_{10}	
Mass	62.5000 ±	3.2536	218.4951 ±	11.7390	280.9951 ±	12.1815
Al	0.2938 ±	0.0171	4.4342 ±	1.3181	4.7280 ±	1.3182
Si	0.8139 ±	0.0415	11.5851 ±	3.6683	12.3990 ±	3.6685
P	0.0000 ±	0.0147	0.0000 ±	0.0274	0.0000 ±	0.0311
S	2.2840 ±	0.1158	1.0090 ±	0.4254	3.2930 ±	0.4409
Cl	2.9309 ±	0.1483	4.3825 ±	1.3031	7.3134 ±	1.3115
K	1.5318 ±	0.0770	1.6352 ±	0.3547	3.1670 ±	0.3630
Ca	1.4157 ±	0.0714	20.5245 ±	3.4523	21.9402 ±	3.4530
Ti	0.0412 ±	0.0051	0.5186 ±	0.0267	0.5598 ±	0.0272
V	0.0162 ±	0.0031	0.0211 ±	0.0065	0.0373 ±	0.0072
Cr	0.0086 ±	0.0013	0.0213 ±	0.0025	0.0299 ±	0.0028
Mn	0.0201 ±	0.0013	0.0897 ±	0.0053	0.1098 ±	0.0055
Fe	0.4702 ±	0.0236	4.8020 ±	0.2423	5.2722 ±	0.2434
Co	0.0002 ±	0.0073	0.0116 ±	0.0734	0.0118 ±	0.0738
Ni	0.0097 ±	0.0007	0.0133 ±	0.0011	0.0230 ±	0.0013
Cu	0.0692 ±	0.0035	0.0295 ±	0.0049	0.0987 ±	0.0060
Zn	1.0143 ±	0.0508	0.2104 ±	0.0692	1.2247 ±	0.0858
Ga	0.0000 ±	0.0073	0.0000 ±	0.0030	0.0000 ±	0.0079
As	0.0029 ±	0.0996	0.0000 ±	0.0362	0.0029 ±	0.1060
Se	0.0003 ±	0.0028	0.0000 ±	0.0013	0.0003 ±	0.0031
Br	0.0327 ±	0.0023	0.0128 ±	0.0024	0.0455 ±	0.0033
Rb	0.0051 ±	0.0006	0.0069 ±	0.0006	0.0120 ±	0.0008
Sr	0.0106 ±	0.0006	0.1413 ±	0.0071	0.1519 ±	0.0071
Y	0.0000 ±	0.0054	0.0034 ±	0.0009	0.0034 ±	0.0055
Zr	0.0020 ±	0.0004	0.0197 ±	0.0021	0.0217 ±	0.0021
Mo	0.0007 ±	0.0014	0.0000 ±	0.0018	0.0007 ±	0.0023
Pd	0.0000 ±	0.0057	0.0000 ±	0.0073	0.0000 ±	0.0093
Ag	0.0000 ±	0.0063	0.0028 ±	0.0080	0.0028 ±	0.0102
Cd	0.0021 ±	0.0064	0.0080 ±	0.0028	0.0101 ±	0.0070
In	0.0000 ±	0.0075	0.0000 ±	0.0089	0.0000 ±	0.0116
Sn	0.0172 ±	0.0033	0.0031 ±	0.0108	0.0203 ±	0.0113
Sb	0.0234 ±	0.0038	0.0000 ±	0.0120	0.0234 ±	0.0126
Ba	0.0000 ±	0.0359	0.0581 ±	0.0138	0.0581 ±	0.0385
La	0.0225 ±	0.0472	0.0000 ±	0.0500	0.0225 ±	0.0688
Au	0.0007 ±	0.0337	0.0000 ±	0.0116	0.0007 ±	0.0356
Hg	0.0000 ±	0.0042	0.0000 ±	0.0023	0.0000 ±	0.0048
Tl	0.0000 ±	0.0177	0.0000 ±	0.0067	0.0000 ±	0.0189
Pb	0.6505 ±	0.0327	0.1603 ±	0.0447	0.8108 ±	0.0554
U	0.0000 ±	0.0018	0.0007 ±	0.0020	0.0007 ±	0.0027
Sum	11.6905 ±	0.2611	49.7051 ±	5.4032	61.3956 ±	5.4094

Table 2

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Automotive - Petrol Run: 1 Date: 11/27/95

Filter ID: 142 Volume (m^3): 0.097 Particle Size: 2.5

	Field	Mass	XRF
Flag:			i2

Concentrations (mass percent)

Al	0.8570	±	0.1544
Si	0.0000	±	0.1025
P	0.0744	±	0.0130
S	0.0970	±	0.7114
Cl	0.0000	±	0.1049
K	0.0277	±	0.0033
Ca	0.2842	±	0.0208
Ti	0.0046	±	0.0203
V	0.0019	±	0.0084
Cr	0.0013	±	0.0020
Mn	0.0018	±	0.0006
Fe	0.1513	±	0.0110
Co	0.0014	±	0.0026
Ni	0.0015	±	0.0004
Cu	0.0065	±	0.0006
Zn	0.1987	±	0.0143
Ga	0.0005	±	0.0927
As	0.0000	±	1.3399
Se	0.0000	±	0.0370
Br	5.0320	±	0.3625
Rb	0.0000	±	0.1725
Sr	0.0000	±	0.0067
Y	0.0000	±	0.0759
Zr	0.0000	±	0.0061
Mo	0.0000	±	0.0032
Pd	0.0000	±	0.0419
Ag	0.0000	±	0.0140
Cd	0.0000	±	0.0159
In	0.0000	±	0.0177
Sn	0.0026	±	0.0204
Sb	0.0024	±	0.0198
Ba	0.0000	±	0.0598
La	0.0000	±	0.0749
Au	0.0000	±	0.0206
Hg	0.0000	±	0.0323
Tl	0.0000	±	0.2354
Pb	8.7233	±	0.6275
U	0.0000	±	0.0780
Sum	15.4700	±	1.7304

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Automotive - Petrol Run: 2 Date: 11/27/95

Filter ID: 143 Volume (m^3): 0.100 Particle Size: 2.5

	Field	Mass	XRF
Flag:			n

	Concentrations (mass percent)		
Al	0.8132	±	0.2035
Si	0.0000	±	0.1534
P	0.0825	±	0.0174
S	0.0000	±	1.1469
Cl	0.0000	±	0.1675
K	0.0000	±	0.0076
Ca	0.3070	±	0.0221
Ti	0.0043	±	0.0173
V	0.0020	±	0.0072
Cr	0.0025	±	0.0007
Mn	0.0057	±	0.0008
Fe	0.8636	±	0.0613
Co	0.0018	±	0.0132
Ni	0.0021	±	0.0003
Cu	0.0028	±	0.0003
Zn	0.2197	±	0.0156
Ga	0.0000	±	0.1493
As	0.0000	±	2.1599
Se	0.0000	±	0.0593
Br	6.9819	±	0.4963
Rb	0.0000	±	0.2394
Sr	0.0000	±	0.0105
Y	0.0000	±	0.1205
Zr	0.0000	±	0.0095
Mo	0.0000	±	0.0038
Pd	0.0000	±	0.1632
Ag	0.0000	±	0.0160
Cd	0.0000	±	0.0231
In	0.0000	±	0.0217
Sn	0.0178	±	0.0239
Sb	0.0000	±	0.0193
Ba	0.0000	±	0.0492
La	0.0000	±	0.0599
Au	0.0000	±	0.0310
Hg	0.0000	±	0.0513
Tl	0.0000	±	0.3793
Pb	14.0748	±	0.9981
U	0.0000	±	0.1083
Sum	23.3815	±	2.7592

Comments: XRF: Large white spec.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Automotive - Petrol Run: 1 Date: 11/27/95

Filter ID: 141 Volume (m^3): 0.095 Particle Size: TSP

	Field	Mass	XRF
Flag:			i,n

Concentrations (mass percent)

Al	0.6585	±	0.4899
Si	0.0000	±	0.2926
P	0.0904	±	0.0327
S	0.0000	±	1.5704
Cl	0.0000	±	0.2140
K	0.0105	±	0.0058
Ca	0.5259	±	0.0721
Ti	0.0096	±	0.0292
V	0.0029	±	0.0121
Cr	0.0019	±	0.0030
Mn	0.0027	±	0.0008
Fe	0.2489	±	0.0245
Co	0.0012	±	0.0050
Ni	0.0022	±	0.0005
Cu	0.0023	±	0.0007
Zn	0.1975	±	0.0214
Ga	0.0034	±	0.1426
As	0.0000	±	2.0608
Se	0.0000	±	0.0569
Br	5.3789	±	0.5711
Rb	0.0000	±	0.2671
Sr	0.0000	±	0.0103
Y	0.0000	±	0.1168
Zr	0.0000	±	0.0093
Mo	0.0000	±	0.0048
Pd	0.0000	±	0.0696
Ag	0.0000	±	0.0205
Cd	0.0000	±	0.0236
In	0.0000	±	0.0263
Sn	0.0023	±	0.0300
Sb	0.0000	±	0.0286
Ba	0.0169	±	0.0859
La	0.0194	±	0.1076
Au	0.0000	±	0.0317
Hg	0.0000	±	0.0497
Tl	0.0000	±	0.3620
Pb	9.1968	±	0.9785
U	0.0000	±	0.1207
Sum	16.3721	±	2.9431

Comments: XRF: Large white line of no deposit. Large white spec.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Automotive - Petrol Run: 2 Date: 11/27/95

Filter ID: 144 Volume (m^3): 0.098 Particle Size: TSP

	Field	Mass	XRF
Flag:			n

Concentrations (mass percent)

Al	0.6273	±	1.6945
Si	0.0000	±	0.4694
P	0.0737	±	0.0430
S	0.0000	±	2.7046
Cl	0.0000	±	0.3655
K	0.0000	±	0.0142
Ca	0.3276	±	0.0405
Ti	0.0042	±	0.0264
V	0.0015	±	0.0110
Cr	0.0031	±	0.0011
Mn	0.0062	±	0.0012
Fe	1.0543	±	0.1118
Co	0.0008	±	0.0227
Ni	0.0022	±	0.0005
Cu	0.0035	±	0.0005
Zn	0.2386	±	0.0261
Ga	0.0000	±	0.2459
As	0.0000	±	3.5579
Se	0.0000	±	0.0977
Br	7.9812	±	0.8603
Rb	0.0000	±	0.3993
Sr	0.0000	±	0.0173
Y	0.0000	±	0.1987
Zr	0.0000	±	0.0156
Mo	0.0000	±	0.0060
Pd	0.0000	±	0.3109
Ag	0.0000	±	0.0260
Cd	0.0000	±	0.0356
In	0.0000	±	0.0357
Sn	0.0000	±	0.0458
Sb	0.0000	±	0.0305
Ba	0.0000	±	0.0740
La	0.0000	±	0.0906
Au	0.0000	±	0.0511
Hg	0.0000	±	0.0845
Tl	0.0000	±	0.6247
Pb	15.6657	±	1.6964
U	0.0066	±	0.1806
Sum	25.9966	±	5.2587

Comments: XRF: Large white specs.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Wetkl Run: 2 Date: 06/17/95

Filter ID: 09 Volume (m^3): 0.607 Particle Size: 2.5

	Field	Mass	XRF
Flag:			

	Concentrations (mass percent)		
Al	0.0088	±	0.0987
Si	0.0000	±	0.1860
P	0.0000	±	0.0457
S	2.7043	±	0.1927
Cl	9.0745	±	0.6449
K	8.2604	±	0.5858
Ca	2.2430	±	0.1637
Ti	0.0158	±	0.0032
V	0.0009	±	0.0054
Cr	0.0036	±	0.0007
Mn	0.0074	±	0.0006
Fe	0.2666	±	0.0189
Co	0.0023	±	0.0041
Ni	0.0009	±	0.0001
Cu	0.0109	±	0.0008
Zn	0.0228	±	0.0016
Ga	0.0000	±	0.0010
As	0.0000	±	0.0096
Se	0.0000	±	0.0006
Br	0.0562	±	0.0040
Rb	0.2109	±	0.0150
Sr	0.0238	±	0.0017
Y	0.0003	±	0.0092
Zr	0.0014	±	0.0004
Mo	0.0000	±	0.0010
Pd	0.0000	±	0.0039
Ag	0.0000	±	0.0043
Cd	0.0061	±	0.0015
In	0.0003	±	0.0048
Sn	0.0010	±	0.0058
Sb	0.0000	±	0.0065
Ba	0.0073	±	0.0218
La	0.0177	±	0.0277
Au	0.0000	±	0.0015
Hg	0.0002	±	0.0012
Tl	0.0000	±	0.0020
Pb	0.0580	±	0.0042
U	0.0068	±	0.0252
Sum	23.0122	±	0.9339

Comments:

B1

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Wetkl Run: 2 Date: 06/17/95

Filter ID: 08 Volume (m^3): 0.529 Particle Size: TSP

	Field	Mass	XRF
Flag:			f3,i1

Concentrations
(mass percent)

Al	1.6015	±	0.5351
Si	3.9044	±	1.3151
P	0.0000	±	0.1125
S	5.2192	±	1.2285
Cl	12.4974	±	2.1264
K	15.6374	±	2.3792
Ca	24.1741	±	4.2038
Ti	0.1283	±	0.0123
V	0.0086	±	0.0061
Cr	0.0130	±	0.0016
Mn	0.0316	±	0.0030
Fe	1.6100	±	0.1425
Co	0.0143	±	0.0245
Ni	0.0000	±	0.0119
Cu	0.0108	±	0.0011
Zn	0.0357	±	0.0034
Ga	0.0000	±	0.0014
As	0.0000	±	0.0124
Se	0.0002	±	0.0008
Br	0.0327	±	0.0042
Rb	0.1313	±	0.0160
Sr	0.1425	±	0.0126
Y	0.0011	±	0.0112
Zr	0.0043	±	0.0054
Mo	0.0000	±	0.0017
Pd	0.0000	±	0.0063
Ag	0.0018	±	0.0069
Cd	0.0045	±	0.0055
In	0.0000	±	0.0075
Sn	0.0003	±	0.0089
Sb	0.0051	±	0.0101
Ba	0.0000	±	0.0327
La	0.0050	±	0.0410
Au	0.0000	±	0.0025
Hg	0.0000	±	0.0017
Tl	0.0000	±	0.0027
Pb	0.0438	±	0.0050
U	0.0035	±	0.0306
Sum	65.2627	±	5.6051

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Wetkl Run: 3 Date: 06/17/95

Filter ID: 12 Volume (m^3): 0.450 Particle Size: 2.5

	Field	Mass	XRF
Flag:			f5,i

	Concentrations (mass percent)		
Al	0.0448	±	0.1260
Si	0.0000	±	0.2279
P	0.0000	±	0.0575
S	2.7055	±	0.1927
Cl	22.3714	±	1.5844
K	16.7620	±	1.1862
Ca	3.3670	±	0.2511
Ti	0.0263	±	0.0036
V	0.0031	±	0.0057
Cr	0.0055	±	0.0008
Mn	0.0171	±	0.0013
Fe	0.2953	±	0.0209
Co	0.0038	±	0.0045
Ni	0.0012	±	0.0002
Cu	0.0074	±	0.0006
Zn	0.1763	±	0.0125
Ga	0.0000	±	0.0011
As	0.0000	±	0.0106
Se	0.0001	±	0.0006
Br	0.0609	±	0.0043
Rb	0.2369	±	0.0168
Sr	0.0192	±	0.0014
Y	0.0008	±	0.0103
Zr	0.0015	±	0.0003
Mo	0.0000	±	0.0010
Pd	0.0000	±	0.0044
Ag	0.0019	±	0.0048
Cd	0.0098	±	0.0018
In	0.0000	±	0.0052
Sn	0.0000	±	0.0061
Sb	0.0011	±	0.0070
Ba	0.0000	±	0.0208
La	0.0240	±	0.0265
Au	0.0000	±	0.0059
Hg	0.0000	±	0.0012
Tl	0.0000	±	0.0022
Pb	0.0646	±	0.0047
U	0.0072	±	0.0281
Sum	46.2148	±	2.0228

Comments: XRF: Line of no deposit bisects filter.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Wetkl Run: 3 Date: 06/17/95

Filter ID: 10 Volume (m^3): 0.339 Particle Size: TSP

	Field	Mass	XRF
Flag:			f3,i1

Concentrations (mass percent)

Al	1.8581	±	0.5967
Si	4.0796	±	1.3601
P	0.0000	±	0.1126
S	4.3703	±	1.0794
Cl	12.6429	±	1.6064
K	11.8023	±	1.3777
Ca	21.1607	±	3.5526
Ti	0.1063	±	0.0095
V	0.0066	±	0.0048
Cr	0.0110	±	0.0013
Mn	0.0269	±	0.0024
Fe	1.3013	±	0.1054
Co	0.0130	±	0.0197
Ni	0.0000	±	0.0109
Cu	0.0069	±	0.0007
Zn	0.1245	±	0.0121
Ga	0.0000	±	0.0012
As	0.0000	±	0.0110
Se	0.0002	±	0.0007
Br	0.0431	±	0.0042
Rb	0.1685	±	0.0163
Sr	0.1238	±	0.0100
Y	0.0008	±	0.0107
Zr	0.0038	±	0.0047
Mo	0.0000	±	0.0015
Pd	0.0000	±	0.0050
Ag	0.0017	±	0.0054
Cd	0.0063	±	0.0019
In	0.0000	±	0.0059
Sn	0.0005	±	0.0069
Sb	0.0011	±	0.0078
Ba	0.0000	±	0.0235
La	0.0117	±	0.0299
Au	0.0000	±	0.0061
Hg	0.0000	±	0.0014
Tl	0.0000	±	0.0023
Pb	0.0450	±	0.0045
U	0.0061	±	0.0293
Sum	57.9233	±	4.5276

Comments: XRF: Line of no deposit bisects filter.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Dry, Bypass, K7 Run: 3 Date: 06/19/95

Filter ID:17 Volume (m^3): 0.177 Particle Size: 2.5

	Field	Mass	XRF
Flag:			g4,i2

	Concentrations (mass percent)		
Al	0.0000	±	0.1481
Si	0.0000	±	0.3025
P	0.0401	±	0.0720
S	3.2876	±	0.2351
Cl	36.4618	±	2.5973
K	36.2404	±	2.5788
Ca	1.2023	±	0.1988
Ti	0.0183	±	0.0037
V	0.0104	±	0.0016
Cr	0.0085	±	0.0007
Mn	0.0277	±	0.0020
Fe	0.0636	±	0.0046
Co	0.0000	±	0.0059
Ni	0.0013	±	0.0002
Cu	0.0126	±	0.0009
Zn	0.0433	±	0.0031
Ga	0.0000	±	0.0009
As	0.0000	±	0.0068
Se	0.0003	±	0.0006
Br	0.0806	±	0.0058
Rb	0.3499	±	0.0249
Sr	0.0147	±	0.0011
Y	0.0009	±	0.0151
Zr	0.0014	±	0.0003
Mo	0.0000	±	0.0010
Pd	0.0000	±	0.0055
Ag	0.0009	±	0.0060
Cd	0.0075	±	0.0021
In	0.0000	±	0.0064
Sn	0.0000	±	0.0074
Sb	0.0000	±	0.0084
Ba	0.0000	±	0.0236
La	0.0000	±	0.0293
Au	0.0000	±	0.0021
Hg	0.0011	±	0.0013
Tl	0.0000	±	0.0017
Pb	0.0378	±	0.0028
U	0.0112	±	0.0412
Sum	77.9242	±	3.6898

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Cement, Dry, Bypass, K7 Run: 3 Date: 06/19/95

Filter ID:18 Volume (m^3): 0.122 Particle Size: TSP

	Field	Mass	XRF
Flag:			g4

Concentrations (mass percent)

Al	0.0000	±	0.4241
Si	0.0000	±	0.7667
P	0.0000	±	0.1361
S	4.4985	±	1.0844
Cl	31.9588	±	5.1985
K	29.1239	±	3.6201
Ca	12.3136	±	2.1306
Ti	0.0457	±	0.0052
V	0.0141	±	0.0020
Cr	0.0093	±	0.0009
Mn	0.0278	±	0.0024
Fe	0.3509	±	0.0277
Co	0.0000	±	0.0147
Ni	0.0048	±	0.0004
Cu	0.0107	±	0.0010
Zn	0.0364	±	0.0032
Ga	0.0000	±	0.0010
As	0.0000	±	0.0076
Se	0.0000	±	0.0007
Br	0.0669	±	0.0060
Rb	0.2801	±	0.0251
Sr	0.0785	±	0.0062
Y	0.0008	±	0.0158
Zr	0.0024	±	0.0030
Mo	0.0000	±	0.0011
Pd	0.0000	±	0.0056
Ag	0.0003	±	0.0061
Cd	0.0020	±	0.0047
In	0.0004	±	0.0065
Sn	0.0030	±	0.0075
Sb	0.0001	±	0.0084
Ba	0.0107	±	0.0245
La	0.0021	±	0.0304
Au	0.0000	±	0.0023
Hg	0.0010	±	0.0014
Tl	0.0000	±	0.0019
Pb	0.0328	±	0.0030
U	0.0085	±	0.0432
Sum	78.8842	±	6.8291

Comments: XRF: ~ 1 cm2 area has only fragments of deposit remaining on filter.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Heavy Duty Diesel Exhaust Run: 3 Date: 10/05/95

Filter ID: 135 Volume (m^3): 2.130 Particle Size: 2.5

	Field	Mass	XRF
Flag:			i2

	Concentrations (mass percent)		
Al	0.0685	±	0.0701
Si	0.4505	±	0.0428
P	0.0000	±	0.0410
S	1.9567	±	0.1645
Cl	0.5189	±	0.0494
K	0.7244	±	0.0620
Ca	0.5698	±	0.0492
Ti	0.0024	±	0.0896
V	0.0000	±	0.0370
Cr	0.0042	±	0.0093
Mn	0.0245	±	0.0035
Fe	0.9131	±	0.0758
Co	0.0000	±	0.0153
Ni	0.0058	±	0.0016
Cu	0.0307	±	0.0031
Zn	0.8462	±	0.0701
Ga	0.0013	±	0.0121
As	0.0000	±	0.1201
Se	0.0000	±	0.0056
Br	0.0778	±	0.0071
Rb	0.0000	±	0.0052
Sr	0.0023	±	0.0046
Y	0.0000	±	0.0086
Zr	0.0000	±	0.0061
Mo	0.0000	±	0.0110
Pd	0.0009	±	0.0349
Ag	0.0068	±	0.0403
Cd	0.0079	±	0.0394
In	0.0075	±	0.0475
Sn	0.0070	±	0.0600
Sb	0.0921	±	0.0250
Ba	0.1163	±	0.2612
La	0.0000	±	0.3409
Au	0.0000	±	0.0331
Hg	0.0000	±	0.0109
Tl	0.0000	±	0.0242
Pb	0.7712	±	0.0646
U	0.0000	±	0.0097
Sum	7.2069	±	0.5301

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Heavy Duty Diesel Exhaust Run: 3 Date: 10/05/95

Filter ID: 134 Volume (m^3): 2.050 Particle Size: TSP

	Field	Mass	XRF
Flag:			i2,i4

Concentrations (mass percent)

Al	1.4474	±	0.4598
Si	5.7934	±	1.8137
P	0.0442	±	0.0903
S	2.1215	±	0.3811
Cl	1.5490	±	0.3811
K	1.1215	±	0.1752
Ca	8.6407	±	1.5825
Ti	0.1614	±	0.0912
V	0.0096	±	0.0463
Cr	0.0304	±	0.0101
Mn	0.1018	±	0.0112
Fe	3.5170	±	0.3543
Co	0.0011	±	0.0559
Ni	0.0119	±	0.0024
Cu	0.0426	±	0.0051
Zn	0.7965	±	0.0898
Ga	0.0000	±	0.0158
As	0.0000	±	0.1646
Se	0.0000	±	0.0072
Br	0.0648	±	0.0085
Rb	0.0032	±	0.0066
Sr	0.0621	±	0.0078
Y	0.0007	±	0.0113
Zr	0.0049	±	0.0081
Mo	0.0018	±	0.0135
Pd	0.0123	±	0.0428
Ag	0.0130	±	0.0499
Cd	0.0086	±	0.0497
In	0.0058	±	0.0592
Sn	0.0222	±	0.0748
Sb	0.0450	±	0.0596
Ba	0.1338	±	0.3188
La	0.0000	±	0.4143
Au	0.0031	±	0.0474
Hg	0.0000	±	0.0139
Tl	0.0000	±	0.0325
Pb	0.7499	±	0.0848
U	0.0000	±	0.0121
Sum	26.5211	±	2.6103

Comments: XRF: Large black particles in PetriSlide.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Heavy Oil (Mazut) Combustion Run: 3 Date: 10/25/95

Filter ID: 132 Volume (m^3): 0.063 Particle Size: 2.5

	Field	Mass	XRF
Flag:			i2,n

	Concentrations (mass percent)		
Al	0.0231	±	0.0063
Si	0.1163	±	0.0101
P	0.0000	±	0.0136
S	2.0961	±	0.1515
Cl	0.0000	±	0.0405
K	0.0184	±	0.0021
Ca	0.0316	±	0.0029
Ti	0.0007	±	0.0160
V	0.0764	±	0.0061
Cr	0.0005	±	0.0033
Mn	0.0001	±	0.0013
Fe	0.0919	±	0.0067
Co	0.0000	±	0.0017
Ni	0.0396	±	0.0029
Cu	0.0180	±	0.0014
Zn	0.1144	±	0.0083
Ga	0.0002	±	0.0016
As	0.0019	±	0.0065
Se	0.0000	±	0.0009
Br	0.0005	±	0.0009
Rb	0.0000	±	0.0008
Sr	0.0005	±	0.0009
Y	0.0000	±	0.0011
Zr	0.0000	±	0.0012
Mo	0.0000	±	0.0022
Pd	0.0016	±	0.0059
Ag	0.0047	±	0.0069
Cd	0.0006	±	0.0071
In	0.0016	±	0.0087
Sn	0.1056	±	0.0090
Sb	0.0107	±	0.0128
Ba	0.0000	±	0.0473
La	0.0003	±	0.0623
Au	0.0000	±	0.0048
Hg	0.0000	±	0.0020
Tl	0.0000	±	0.0023
Pb	0.0387	±	0.0031
U	0.0000	±	0.0019
Sum	2.7941	±	0.1790

Comments: XRF: Large white spec. Large black particles in PetriSlide.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Heavy Oil (Mazut) Combustion Run: 3 Date: 10/25/95

Filter ID: 133 Volume (m^3): 0.061 Particle Size: TSP

	Field	Mass	XRF
Flag:			i1,i2

	Concentrations (mass percent)		
Al	0.0866	±	0.0302
Si	0.3050	±	0.0759
P	0.0000	±	0.0322
S	3.0549	±	0.5890
Cl	0.0000	±	0.0870
K	0.0261	±	0.0046
Ca	0.1497	±	0.0248
Ti	0.0000	±	0.0249
V	0.0826	±	0.0100
Cr	0.0000	±	0.0060
Mn	0.0019	±	0.0017
Fe	0.5642	±	0.0526
Co	0.0000	±	0.0089
Ni	0.0651	±	0.0065
Cu	0.0259	±	0.0027
Zn	0.0833	±	0.0102
Ga	0.0000	±	0.0024
As	0.0026	±	0.0114
Se	0.0000	±	0.0013
Br	0.0010	±	0.0011
Rb	0.0000	±	0.0011
Sr	0.0025	±	0.0011
Y	0.0000	±	0.0017
Zr	0.0000	±	0.0018
Mo	0.0000	±	0.0033
Pd	0.0000	±	0.0085
Ag	0.0038	±	0.0102
Cd	0.0017	±	0.0103
In	0.0000	±	0.0124
Sn	0.1080	±	0.0136
Sb	0.0034	±	0.0187
Ba	0.0420	±	0.0693
La	0.0365	±	0.0911
Au	0.0000	±	0.0069
Hg	0.0000	±	0.0031
Tl	0.0000	±	0.0037
Pb	0.0543	±	0.0058
U	0.0000	±	0.0028
Sum	4.7015	±	0.6172

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lead Smelter Run: 2 Date: 06/21/95

Filter ID: 23 Volume (m^3): 0.159 Particle Size: 2.5

	Field	Mass	XRF
Flag:			f3

	Concentrations (mass percent)		
Al	0.0000	±	1.0221
Si	0.0000	±	2.3312
P	0.0000	±	0.6636
S	0.0000	±	15.3766
Cl	5.5777	±	0.4919
K	0.0000	±	0.2439
Ca	0.0000	±	0.4651
Ti	0.0039	±	0.0045
V	0.0019	±	0.0029
Cr	0.0000	±	0.0022
Mn	0.0260	±	0.0020
Fe	0.6653	±	0.0474
Co	0.0316	±	0.0917
Ni	0.0023	±	0.0003
Cu	0.0390	±	0.0028
Zn	0.1647	±	0.0117
Ga	0.0000	±	0.4347
As	0.0000	±	6.2718
Se	0.0007	±	0.1706
Br	0.0000	±	0.2967
Rb	0.0000	±	0.0517
Sr	0.0000	±	0.0280
Y	0.0000	±	0.3348
Zr	0.0000	±	0.0272
Mo	0.0000	±	0.0082
Pd	-99.0000	±	-99.000
Ag	-99.0000	±	-99.000
Cd	-99.0000	±	-99.000
In	-99.0000	±	-99.000
Sn	-99.0000	±	-99.000
Sb	-99.0000	±	-99.000
Ba	-99.0000	±	-99.000
La	-99.0000	±	-99.000
Au	0.0000	±	0.0800
Hg	0.0000	±	0.1457
Tl	0.0000	±	1.1035
Pb	57.3435	±	4.0806
U	0.0000	±	0.0451
Sum	63.8565	±	17.3650

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lead Smelter Run: 2 Date: 06/21/95

Filter ID: 22 Volume (m^3): 0.148 Particle Size: TSP

	Field	Mass	XRF
Flag:			f3

	Concentrations (mass percent)		
Al	0.0000	±	3.6300
Si	0.0000	±	7.1741
P	0.0000	±	1.7266
S	0.0000	±	36.8069
Cl	5.6553	±	1.0096
K	0.0000	±	0.4827
Ca	0.0000	±	0.9477
Ti	0.0021	±	0.0076
V	0.0017	±	0.0049
Cr	0.0000	±	0.0038
Mn	0.0343	±	0.0039
Fe	0.9494	±	0.1024
Co	0.0468	±	0.1782
Ni	0.0039	±	0.0006
Cu	0.0409	±	0.0048
Zn	0.1757	±	0.0203
Ga	0.0000	±	0.7303
As	0.0000	±	10.5361
Se	0.0008	±	0.2866
Br	0.0000	±	0.4984
Rb	0.0000	±	0.0869
Sr	0.0000	±	0.0471
Y	0.0000	±	0.5624
Zr	0.0000	±	0.0456
Mo	0.0000	±	0.0137
Pd	-99.0000	±	-99.000
Ag	-99.0000	±	-99.000
Cd	-99.0000	±	-99.000
In	-99.0000	±	-99.000
Sn	-99.0000	±	-99.000
Sb	-99.0000	±	-99.000
Ba	-99.0000	±	-99.000
La	-99.0000	±	-99.000
Au	0.0000	±	0.1344
Hg	0.0000	±	0.2447
Tl	0.0000	±	1.8539
Pb	59.8155	±	6.9601
U	0.0000	±	0.0758
Sum	66.7265	±	39.8589

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lead Smelter Run: 3 Date: 06/21/95

Filter ID:24 Volume (m^3): 0.110 Particle Size: 2.5

	Field	Mass	XRF
Flag:			h2

	Concentrations (mass percent)		
Al	0.4144	±	1.0019
Si	0.0000	±	2.2888
P	0.0000	±	0.6570
S	0.0000	±	15.2521
Cl	6.3481	±	0.5428
K	0.0000	±	0.2532
Ca	0.0000	±	0.4861
Ti	0.0027	±	0.0049
V	0.0044	±	0.0011
Cr	0.0000	±	0.0025
Mn	0.0290	±	0.0022
Fe	0.8258	±	0.0584
Co	0.0320	±	0.1146
Ni	0.0022	±	0.0003
Cu	0.0591	±	0.0042
Zn	0.1760	±	0.0125
Ga	0.0000	±	0.5051
As	0.0000	±	7.2871
Se	0.0000	±	0.1981
Br	0.0000	±	0.3445
Rb	0.0000	±	0.0601
Sr	0.0000	±	0.0327
Y	0.0000	±	0.3890
Zr	0.0000	±	0.0316
Mo	0.0000	±	0.0095
Pd	-99.0000	±	-99.000
Ag	-99.0000	±	-99.000
Cd	-99.0000	±	-99.000
In	-99.0000	±	-99.000
Sn	-99.0000	±	-99.000
Sb	-99.0000	±	-99.000
Ba	-99.0000	±	-99.000
La	-99.0000	±	-99.000
Au	0.0000	±	0.0929
Hg	0.0000	±	0.1692
Tl	0.0000	±	1.2819
Pb	64.3421	±	4.5501
U	0.0000	±	0.0524
Sum	72.2358	±	17.7755

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lead Smelter Run: 3 Date: 06/21/95

Filter ID: 25 Volume (m^3): 0.101 Particle Size: TSP

	Field	Mass	XRF
Flag:			f1

	Concentrations (mass percent)		
Al	0.0453	±	3.5961
Si	0.0000	±	7.1118
P	0.0000	±	1.7241
S	0.0000	±	36.8273
Cl	6.3550	±	1.1009
K	0.0000	±	0.5105
Ca	0.0000	±	0.9665
Ti	0.0000	±	0.0084
V	0.0006	±	0.0039
Cr	0.0000	±	0.0044
Mn	0.0371	±	0.0043
Fe	1.2080	±	0.1283
Co	0.0517	±	0.2233
Ni	0.0042	±	0.0006
Cu	0.0630	±	0.0072
Zn	0.1981	±	0.0223
Ga	0.0000	±	0.8424
As	0.0000	±	12.1536
Se	0.0000	±	0.3304
Br	0.0000	±	0.5746
Rb	0.0000	±	0.1003
Sr	0.0000	±	0.0545
Y	0.0000	±	0.6488
Zr	0.0000	±	0.0527
Mo	0.0000	±	0.0158
Pd	-99.0000	±	-99.000
Ag	-99.0000	±	-99.000
Cd	-99.0000	±	-99.000
In	-99.0000	±	-99.000
Sn	-99.0000	±	-99.000
Sb	-99.0000	±	-99.000
Ba	-99.0000	±	-99.000
La	-99.0000	±	-99.000
Au	0.0000	±	0.1550
Hg	0.0000	±	0.2822
Tl	0.0000	±	2.1380
Pb	68.7229	±	7.8342
U	0.0000	±	0.0874
Sum	76.6860	±	40.5038

Comments: XRF: Tear near edge of filter.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Light Oil, Solaar Run: 2 Date: 10/23/95

Filter ID: 114 Volume (m^3): 0.311 Particle Size: 2.5

	Field	Mass	XRF
Flag:			f2,g2

	Concentrations (mass percent)		
Al	0.0171	±	0.0277
Si	0.0800	±	0.0098
P	0.0000	±	0.0213
S	8.8626	±	0.6301
Cl	0.0000	±	0.1792
K	0.0073	±	0.0011
Ca	0.0259	±	0.0022
Ti	0.0000	±	0.0109
V	0.0000	±	0.0069
Cr	0.0000	±	0.0022
Mn	0.0000	±	0.0009
Fe	0.0123	±	0.0009
Co	0.0000	±	0.0005
Ni	0.0000	±	0.0004
Cu	0.0003	±	0.0004
Zn	0.0055	±	0.0004
Ga	0.0000	±	0.0008
As	0.0000	±	0.0016
Se	0.0010	±	0.0002
Br	0.0003	±	0.0005
Rb	0.0000	±	0.0004
Sr	0.0001	±	0.0005
Y	0.0001	±	0.0006
Zr	0.0000	±	0.0007
Mo	0.0000	±	0.0012
Pd	0.0021	±	0.0042
Ag	0.0007	±	0.0047
Cd	0.0017	±	0.0047
In	0.0000	±	0.0057
Sn	0.0415	±	0.0041
Sb	0.0036	±	0.0080
Ba	0.0000	±	0.0290
La	0.0289	±	0.0381
Au	0.0000	±	0.0013
Hg	0.0000	±	0.0011
Tl	0.0002	±	0.0011
Pb	0.0072	±	0.0008
U	0.0000	±	0.0011
Sum	9.0984	±	0.6581

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Light Oil, Solaar Run: 2 Date: 10/23/95

Filter ID: 113 Volume (m^3): 0.323 Particle Size: TSP

	Field	Mass	XRF
Flag:			g2,i2

Concentrations (mass percent)

Al	0.0654	±	0.0887
Si	0.1313	±	0.0356
P	0.0000	±	0.0600
S	6.7344	±	2.2976
Cl	0.0000	±	0.4104
K	0.0179	±	0.0040
Ca	0.1476	±	0.0252
Ti	0.0000	±	0.0217
V	0.0000	±	0.0135
Cr	0.0002	±	0.0044
Mn	0.0009	±	0.0019
Fe	0.1061	±	0.0117
Co	0.0000	±	0.0019
Ni	0.0008	±	0.0008
Cu	0.0013	±	0.0007
Zn	0.0184	±	0.0021
Ga	0.0003	±	0.0016
As	0.0006	±	0.0037
Se	0.0018	±	0.0004
Br	0.0019	±	0.0008
Rb	0.0000	±	0.0009
Sr	0.0018	±	0.0009
Y	0.0001	±	0.0012
Zr	0.0010	±	0.0012
Mo	0.0004	±	0.0024
Pd	0.0023	±	0.0084
Ag	0.0022	±	0.0093
Cd	0.0000	±	0.0095
In	0.0025	±	0.0114
Sn	0.0205	±	0.0068
Sb	0.0029	±	0.0161
Ba	0.0000	±	0.0570
La	0.0153	±	0.0748
Au	0.0006	±	0.0028
Hg	0.0000	±	0.0021
Tl	0.0000	±	0.0023
Pb	0.0129	±	0.0019
U	0.0000	±	0.0021
Sum	7.2915	±	2.3390

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lime Kiln Run: 1 Date: 07/26/95

Filter ID: 44 Volume (m^3): 0.081 Particle Size: 2.5

	Field	Mass	XRF
Flag:			g2

	Concentrations (mass percent)		
Al	0.0836	±	0.1268
Si	0.0000	±	0.0921
P	0.0779	±	0.0233
S	0.0000	±	0.0650
Cl	37.0656	±	2.6592
K	10.0061	±	0.7188
Ca	12.5551	±	0.9019
Ti	0.0140	±	0.0148
V	0.0023	±	0.0089
Cr	0.0085	±	0.0012
Mn	0.0206	±	0.0016
Fe	0.5686	±	0.0408
Co	0.0024	±	0.0087
Ni	0.0031	±	0.0003
Cu	0.0110	±	0.0008
Zn	0.0242	±	0.0018
Ga	0.0000	±	0.0012
As	0.0000	±	0.0087
Se	0.0000	±	0.0007
Br	0.0110	±	0.0009
Rb	0.0559	±	0.0040
Sr	0.0196	±	0.0014
Y	0.0002	±	0.0026
Zr	0.0008	±	0.0011
Mo	0.0000	±	0.0015
Pd	0.0012	±	0.0075
Ag	0.0011	±	0.0082
Cd	0.0123	±	0.0029
In	0.0065	±	0.0092
Sn	0.0000	±	0.0108
Sb	0.0000	±	0.0121
Ba	0.0068	±	0.0354
La	0.0158	±	0.0445
Au	0.0000	±	0.0019
Hg	0.0000	±	0.0014
Tl	0.0000	±	0.0022
Pb	0.0542	±	0.0040
U	0.0010	±	0.0069
Sum	60.6296	±	2.9046

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Lime Kiln Run: 1 Date: 07/26/95

Filter ID: 43 Volume (m^3): 0.053 Particle Size: TSP

	Field	Mass	XRF
Flag:			gl,n

Concentrations (mass percent)

Al	0.2870	±	0.1504
Si	0.0000	±	0.2111
P	0.0105	±	0.0665
S	0.0213	±	0.0615
Cl	11.2100	±	1.4377
K	2.7800	±	0.3702
Ca	41.7914	±	6.8786
Ti	0.0205	±	0.0074
V	0.0023	±	0.0072
Cr	0.0048	±	0.0009
Mn	0.0146	±	0.0013
Fe	0.4575	±	0.0367
Co	0.0000	±	0.0087
Ni	0.0000	±	0.0499
Cu	0.0056	±	0.0005
Zn	0.0099	±	0.0009
Ga	0.0000	±	0.0009
As	0.0003	±	0.0042
Se	0.0000	±	0.0006
Br	0.0033	±	0.0004
Rb	0.0163	±	0.0018
Sr	0.0741	±	0.0056
Y	0.0005	±	0.0015
Zr	0.0029	±	0.0030
Mo	0.0000	±	0.0014
Pd	0.0000	±	0.0054
Ag	0.0000	±	0.0059
Cd	0.0023	±	0.0047
In	0.0000	±	0.0061
Sn	0.0000	±	0.0073
Sb	0.0000	±	0.0084
Ba	0.0101	±	0.0263
La	0.0234	±	0.0340
Au	0.0000	±	0.0016
Hg	0.0000	±	0.0013
Tl	0.0000	±	0.0015
Pb	0.0098	±	0.0016
U	0.0008	±	0.0038
Sum	56.7593	±	7.0428

Comments: XRF: Lots of red-brown particles on filter ring- deposit is white.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Sintering, Iron and Steel Run: 1 Date: / /

Filter ID: 32 Volume (m^3): 0.266 Particle Size: 2.5

	Field	Mass	XRF
Flag:			g2,g4

	Concentrations (mass percent)		
Al	0.1778	±	0.0369
Si	0.0498	±	0.1299
P	0.0744	±	0.0192
S	0.0000	±	0.4742
Cl	26.2174	±	1.8576
K	16.1016	±	1.1404
Ca	0.6298	±	0.0873
Ti	0.0140	±	0.0165
V	0.0041	±	0.0092
Cr	0.0006	±	0.0089
Mn	0.5052	±	0.0360
Fe	6.4186	±	0.4545
Co	0.0014	±	0.0966
Ni	0.0000	±	0.0031
Cu	0.0367	±	0.0027
Zn	4.2399	±	0.3002
Ga	0.0000	±	0.0136
As	0.0920	±	0.1704
Se	0.0346	±	0.0030
Br	0.0170	±	0.0037
Rb	0.1512	±	0.0107
Sr	0.0071	±	0.0011
Y	0.0034	±	0.0113
Zr	0.0019	±	0.0004
Mo	0.0134	±	0.0011
Pd	0.0000	±	0.0074
Ag	0.0000	±	0.0079
Cd	0.0510	±	0.0047
In	0.0000	±	0.0089
Sn	0.0161	±	0.0037
Sb	0.0083	±	0.0119
Ba	0.0864	±	0.0123
La	0.0000	±	0.0377
Au	0.0219	±	0.1374
Hg	0.0000	±	0.0146
Tl	0.2739	±	0.0220
Pb	1.1129	±	0.0789
U	0.0026	±	0.0181
Sum	56.3649	±	2.3168

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Sintering, Iron and Steel Run: 1 Date: / /

Filter ID: 31 Volume (m^3): 0.095 Particle Size: TSP

	Field	Mass	XRF
Flag:			g2,g4

Concentrations (mass percent)

Al	0.6518	±	0.2149
Si	0.5760	±	0.3316
P	0.1546	±	0.0694
S	0.0000	±	0.9997
Cl	25.2909	±	3.4414
K	15.9531	±	2.0351
Ca	0.9542	±	0.1848
Ti	0.0257	±	0.0225
V	0.0063	±	0.0172
Cr	0.0005	±	0.0148
Mn	0.4916	±	0.0570
Fe	6.9841	±	0.7783
Co	0.0000	±	0.1604
Ni	0.0022	±	0.0052
Cu	0.0369	±	0.0044
Zn	3.7377	±	0.4446
Ga	0.0000	±	0.0213
As	0.1034	±	0.2640
Se	0.0388	±	0.0050
Br	0.0151	±	0.0058
Rb	0.1411	±	0.0165
Sr	0.0093	±	0.0019
Y	0.0014	±	0.0176
Zr	0.0021	±	0.0008
Mo	0.0122	±	0.0018
Pd	0.0053	±	0.0159
Ag	0.0000	±	0.0172
Cd	0.0405	±	0.0081
In	0.0000	±	0.0197
Sn	0.0063	±	0.0199
Sb	0.0131	±	0.0265
Ba	0.0564	±	0.0692
La	0.0000	±	0.0963
Au	0.0146	±	0.2155
Hg	0.0000	±	0.0231
Tl	0.2610	±	0.0343
Pb	1.0060	±	0.1189
U	0.0020	±	0.0285
Sum	56.5945	±	4.2618

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Steel Converter, Iron and Steel Run: 2 Date: / /

Filter ID: 39 Volume (m^3): 0.116 Particle Size: 2.5

	Field	Mass	XRF
Flag:			f5,g2

	Concentrations (mass percent)		
Al	0.0030	±	0.0523
Si	0.3535	±	0.0313
P	0.0546	±	0.0110
S	0.9236	±	0.0728
Cl	2.0462	±	0.1598
K	1.9697	±	0.1525
Ca	1.4052	±	0.1092
Ti	0.0292	±	0.0672
V	0.0000	±	0.0403
Cr	0.0000	±	0.0394
Mn	1.5715	±	0.1217
Fe	32.1945	±	2.4660
Co	0.0000	±	0.4873
Ni	0.0000	±	0.0107
Cu	0.0080	±	0.0013
Zn	0.5185	±	0.0399
Ga	0.0059	±	0.0070
As	0.0047	±	0.0508
Se	0.0004	±	0.0038
Br	0.0000	±	0.0046
Rb	0.0074	±	0.0012
Sr	0.0145	±	0.0016
Y	0.0006	±	0.0047
Zr	0.0006	±	0.0042
Mo	0.0066	±	0.0075
Pd	0.0000	±	0.0322
Ag	0.0000	±	0.0364
Cd	0.0000	±	0.0364
In	0.0194	±	0.0414
Sn	0.0411	±	0.0520
Sb	0.0295	±	0.0571
Ba	0.0474	±	0.1834
La	0.0511	±	0.2432
Au	0.0069	±	0.0207
Hg	0.0067	±	0.0078
Tl	0.0000	±	0.0119
Pb	0.3210	±	0.0253
U	0.0039	±	0.0069
Sum	41.6454	±	2.5536

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Steel Converter, Iron and Steel Run: 2 Date: / /

Filter ID: 38 Volume (m^3): 0.100 Particle Size: TSP

	Field	Mass	XRF
Flag:			g2,i2

	Concentrations (mass percent)		
Al	0.3593	±	0.1387
Si	1.0031	±	0.2725
P	0.0158	±	0.0470
S	0.6835	±	0.1251
Cl	1.7549	±	0.2668
K	1.4550	±	0.1782
Ca	3.0053	±	0.4497
Ti	0.0000	±	0.0703
V	0.0000	±	0.0448
Cr	0.0000	±	0.0459
Mn	1.4586	±	0.1413
Fe	28.1857	±	2.7345
Co	0.0000	±	0.5720
Ni	0.0000	±	0.0124
Cu	0.0074	±	0.0014
Zn	0.6634	±	0.0608
Ga	0.0023	±	0.0186
As	0.0000	±	0.2470
Se	0.0027	±	0.0077
Br	0.0000	±	0.0124
Rb	0.0057	±	0.0014
Sr	0.0160	±	0.0020
Y	0.0000	±	0.0139
Zr	0.0009	±	0.0044
Mo	0.0019	±	0.0075
Pd	0.0000	±	0.0337
Ag	0.0000	±	0.0373
Cd	0.0060	±	0.0381
In	0.0047	±	0.0428
Sn	0.0571	±	0.0425
Sb	0.0566	±	0.0466
Ba	0.0873	±	0.1869
La	0.0000	±	0.2442
Au	0.0007	±	0.0347
Hg	0.0020	±	0.0102
Tl	0.0000	±	0.0446
Pb	1.5889	±	0.1378
U	0.0000	±	0.0072
Sum	40.4247	±	2.9056

Comments:

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Vegative/Trash Burning Run: 3 Date: 11/25/95

Filter ID: 152 Volume (m^3): 0.090 Particle Size: 2.5

	Field	Mass	XRF
Flag:			f5,i3

	Concentrations (mass percent)		
Al	0.0098	±	0.0033
Si	0.0406	±	0.0040
P	0.0000	±	0.0064
S	0.1822	±	0.0132
Cl	0.9197	±	0.0657
K	0.0528	±	0.0041
Ca	0.0841	±	0.0062
Ti	0.0000	±	0.0134
V	0.0000	±	0.0084
Cr	0.0000	±	0.0028
Mn	0.0000	±	0.0012
Fe	0.0497	±	0.0036
Co	0.0000	±	0.0010
Ni	0.0007	±	0.0002
Cu	0.0000	±	0.0005
Zn	0.0034	±	0.0003
Ga	0.0000	±	0.0011
As	0.0000	±	0.0019
Se	0.0000	±	0.0006
Br	0.0096	±	0.0007
Rb	0.0000	±	0.0007
Sr	0.0008	±	0.0002
Y	0.0000	±	0.0008
Zr	0.0000	±	0.0009
Mo	0.0000	±	0.0016
Pd	0.0000	±	0.0045
Ag	0.0000	±	0.0051
Cd	0.0000	±	0.0054
In	0.0001	±	0.0064
Sn	0.0012	±	0.0081
Sb	0.0000	±	0.0093
Ba	0.0151	±	0.0355
La	0.0235	±	0.0470
Au	0.0000	±	0.0017
Hg	0.0000	±	0.0014
Tl	0.0000	±	0.0014
Pb	0.0076	±	0.0009
U	0.0000	±	0.0014
Sum	1.4009	±	0.0930

Comments: XRF: Lots of tears around edge of filter- outside deposit.

Table 2 (continued)

Research Triangle Institute - Cairo, Egypt Source Sample Concentrations

Source: Vegative/Trash Burning Run: 3 Date: 11/25/95

Filter ID:153 Volume (m^3): 0.081 Particle Size: TSP

	Field	Mass	XRF
Flag:			i3

Concentrations
(mass percent)

Al	0.0271	±	0.0109
Si	0.0721	±	0.0171
P	0.0045	±	0.0128
S	0.1618	±	0.0239
Cl	0.7140	±	0.0942
K	0.0419	±	0.0058
Ca	0.2113	±	0.0314
Ti	0.0007	±	0.0167
V	0.0000	±	0.0094
Cr	0.0001	±	0.0029
Mn	0.0004	±	0.0015
Fe	0.0762	±	0.0072
Co	0.0000	±	0.0017
Ni	0.0001	±	0.0005
Cu	0.0001	±	0.0007
Zn	0.0056	±	0.0006
Ga	0.0000	±	0.0014
As	0.0006	±	0.0022
Se	0.0000	±	0.0008
Br	0.0094	±	0.0010
Rb	0.0000	±	0.0009
Sr	0.0010	±	0.0003
Y	0.0000	±	0.0010
Zr	0.0000	±	0.0012
Mo	0.0000	±	0.0021
Pd	0.0026	±	0.0058
Ag	0.0013	±	0.0066
Cd	0.0000	±	0.0069
In	0.0000	±	0.0083
Sn	0.0000	±	0.0103
Sb	0.0011	±	0.0121
Ba	0.0124	±	0.0460
La	0.0049	±	0.0606
Au	0.0000	±	0.0022
Hg	0.0000	±	0.0019
Tl	0.0000	±	0.0018
Pb	0.0010	±	0.0018
U	0.0000	±	0.0019
Sum	1.3501	±	0.1332

Comments:

Table 3

Ambient and Source Field Sampling Data Validation Flags[a]

Validation Flag	Sub Flag	Description
A		Sampler adjustment or maintenance.
	A1	Sampler audit during sample period.
	A2	Sampler cleaned prior to sample period.
	A3	Particle size cut device regreased or replaced prior to sample period.
B		Field Blank.
D		Sample dropped.
	D1	Sample dropped after sampling.
	D2	Filter dropped during unloading.
F		Filter damaged or ripped.
	F1	Filter damaged in the field.
	F2	Filter damaged when removed from holder.
	F3	Filter wrinkled.
	F4	Filter torn due to over-tightened filter holder.
	F5	Teflon membrane separated from support ring.
	F6	Pinholes in filter.
G		Filter deposit damaged.
	G1	Deposit scratched or scraped, causing a thin line in the deposit.
	G2	Deposit smudged, causing a large area of deposit to be displaced.
	G3	Filter returned to lab with deposit side down in PetriSlide.
	G4	Part of deposit appears to have fallen off; particles on inside of PetriSlide.
	G5	Finger touched filter in the field (without gloves).
	G6	Finger touched filter in the lab (with gloves).
H		Filter holder assembly problem.
	H1	Filter misaligned in holder - possible air leak.
	H2	Filter holder loose in sampler - possible air leak.
	H3	Filter holder not tightened sufficiently - possible air leak.
	H4	Filter support grid upside down.
	H5	Two substrates loaded in place of one.
I		Inhomogeneous sample deposit.
	I1	Evidence of impaction - deposit heavier in center of filter.
	I2	Random areas of darker or lighter deposit on filter.
	I3	Light colored deposit with dark specks.
	I4	Non-uniform deposit near edge - possible air leak.
L		Sample loading error.
	L1	Teflon and quartz filters were loaded reversely in SFS.
	L2	$PM_{2.5}$ and PM_{10} filter pack switched.

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Table 3 (continued)

Ambient and Source Field Sampling Data Validation Flags[a]

Validation Flag	Sub Flag	Description
	L3	Fine and Coarse filters were loaded reversely in dichotomous sampler.
	L4	Filter loaded in wrong port.
M		Sampler malfunction.
N		Foreign substance on sample.
	N1	Insects on deposit, removed before analysis.
	N2	Insects on deposit, not all removed.
	N3	Metallic particles observed on deposit.
	N4	Many particles on deposit much larger than cut point of inlet.
	N5	Fibers or fuzz on filter.
	N6	Oily-looking droplets on filter.
	N7	Shiny substance on filter.
	N8	Particles on back of filter.
	N9	Discoloration on deposit.
O		Sampler operation error.
	O1	Pump was not switched on after changing samples.
	O2	Timer set incorrectly.
	O3	Dichotomous sampler assembled with virtual impactor 180° out of phase; only PM_{10} data reported.
P		Power failure during sampling.
Q		Flow rate error.
	Q1	Initial or final flow rate differed from nominal by > ±10%.
	Q2	Initial or final flow rate differed from nominal by > ±15%.
	Q3	Final flow rate differed from initial by > ±15%.
	Q4	Initial or final flow rate not recorded, used estimated flow rate.
	Q5	Nominal flow rate assumed.
R		Replacement filter used.
	R1	Filter that failed flow rate or QC checks replaced with spare.
	R2	Filter sampling sequence changed from order designated on field data sheet.
S		Sample validity is suspect.
T		Sampling time error.
	T1	Sampling duration error of > ±10%.
	T2	Sample start time error of > ±10% of sample duration.
	T3	Elapsed time meter reading not recorded or recorded incorrectly. Sample duration estimated based on readings from previous or subsequent sample.

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Table 3 (continued)

Ambient and Source Field Sampling Data Validation Flags[a]

Validation Flag	Sub Flag	Description
	T4	Nominal sample duration assumed.
	T5	Sample ran during prescribed period, plus part of next period.
	T6	More than one sample was run to account for the prescribed period.
U		Unusual local particulate sources during sample period.
	U1	Local construction activity.
	U2	Forest fire or slash or field burning.
V		Invalid sample (Void).
W		Wet Sample.
	W1	Deposit spotted from water drops.
	W2	Filter damp when unloaded.
	W3	Filter holder contained water when unloaded.
X		No sample was taken this period, sample run was skipped.

[a] Samples are categorized as valid, suspect, or invalid. Unflagged samples, or samples with any flag except 'S' or 'V' indicate valid results. The 'S' flag indicates samples of suspect validity. The 'V' flag indicates invalid samples. Field data validation flags are all upper case.

Table 4
Chemical Analysis Data Validation Flags[a]

Validation Flag	Sub Flag	Description
b		Blank.
	b1	Field/dynamic blank.
	b2	Laboratory blank.
	b3	Distilled-deionized water blank.
	b4	Method blank.
	b5	Extract/solution blank.
	b6	Transport blank.
c		Analysis result reprocessed or recalculated.
	c1	XRF spectrum reprocessed using manually adjusted background.
d		Sample dropped.
f		Filter damaged or ripped.
	f1	Filter damaged, outside of analysis area.
	f2	Filter damaged, within analysis area.
	f3	Filter wrinkled.
	f4	Filter stuck to PetriSlide.
	f5	Teflon membrane separated from support ring.
	f6	Pinholes in filter.
g		Filter deposit damaged.
	g1	Deposit scratched or scraped, causing a thin line in the deposit.
	g2	Deposit smudged, causing a large area of deposit to be displaced.
	g3	Filter deposit side down in PetriSlide.
	g4	Part of deposit appears to have fallen off; particles on inside of PetriSlide.
	g5	Ungloved finger touched filter.
	g6	Gloved finger touched filter.
h		Filter holder assembly problem.
	h1	Deposit not centered.
	h2	Sampled on wrong side of filter.
	h4	Filter support grid upside down- deposit has widely spaced stripes or grid pattern.
	h5	Two filters in PetriSlide- analyzed separately.
i		Inhomogeneous sample deposit.
	i1	Evidence of impaction - deposit heavier in center of filter.
	i2	Random areas of darker or lighter deposit on filter.
	i3	Light colored deposit with dark specks.
	i4	Non-uniform deposit near edge - possible air leak.

Table 4 (continued)
Chemical Analysis Data Validation Flags[a]

Validation Flag	Sub Flag	Description
m		Analysis results affected by matrix effect.
	m1	Organic/elemental carbon split undetermined due to an apparent color change of non-carbon particles during analysis; all measured carbon reported as organic.
	m2	Non-white carbon punch after carbon analysis, indicative of mineral particles in deposit.
	m3	A non-typical, but valid, laser response was observed during TOR analysis. This phenomena may result in increased uncertainty of the organic/elemental carbon split. Total carbon measurements are likely unaffected.
n		Foreign substance on sample.
	n1	Insects on deposit, removed before analysis.
	n2	Insects on deposit, not all removed.
	n3	Metallic particles observed on deposit.
	n4	Many particles on deposit much larger than cut point of inlet.
	n5	Fibers or fuzz on filter.
	n6	Oily-looking droplets on filter.
	n7	Shiny substance on filter.
	n8	Particles on back of filter.
	n9	Discoloration on deposit.
q		Standard.
	q1	Quality control standard.
	q2	Externally prepared quality control standard.
	q3	Second type of externally prepared quality control standard.
	q4	Calibration standard.
r		Replicate analysis.
	r1	First replicate analysis on the same analyzer.
	r2	Second replicate analysis on the same analyzer.
	r3	Third replicate analysis on the same analyzer.
	r4	Sample re-analysis.
	r5	Replicate on different analyzer.
	r6	Sample re-extraction and re-analysis.
	r7	Sample re-analyzed with same result, original value used.
s		Suspect analysis result.
v		Invalid (void) analysis result.
	v1	Quality control standard check exceeded ± 10% of specified concentration range.
	v2	Replicate analysis failed acceptable limit specified in SOP.
	v3	Potential contamination.
	v4	Concentration out of expected range.

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Table 4 (continued)
Chemical Analysis Data Validation Flags[a]

Validation Flag	Sub Flag	Description
w		Wet Sample.
	w1	Deposit spotted from water drops.

[a] Analysis results are categorized as valid, suspect, or invalid. Unflagged samples, or samples with any flag except 's' or 'v' indicate valid results. The 's' flag indicates results of suspect validity. The 'v' flag indicates invalid analysis results. Chemical analysis data validation flags are all lower case.

Table 5
Cairo Receptor Model Study Source Code Descriptions

Source Code	Source Mnemonic	Source Description
1	AgriSoil	Agricultural Dirt
2	DsrtSoil	Desert Soil
3	PavedRd	Paved Road Dust
4	UnpavdRd	Unpaved Road Dust
5	Auto1	Automotive - Petrol Run 1
6	Auto2	Automotive - Petrol Run 2
7	CementD3	Cement, Dry, Bypass, K7 Run 3
8	CementW2	Cement, Wetk1 Run 2
9	CementW3	Cement, Wetk1 Run 3
10	Diesel3	Heavy Duty Diesel Exhaust Run 3
11	OilComb3	Heavy Oil (Mazut) Combustion Run 3
12	Lead2	Lead Smelter Run 2
13	Lead3	Lead Smelter Run 3
14	OilLt2	Light Oil, Solaar Run 2
15	LimeK1	Lime Kiln Run 1
16	Sinter1	Sintering, Iron and Steel Run 1
17	Steel2	Steel Converter, Iron and Steel Run 2
18	Burn3	Vegative/Trash Burning Run 3

Cairo, Egypt 10 Year Meteorological Data Summary by Month for 1981 - 1990

Cairo Wind Speed Percentage by Interval

	Speed Interval in km/hr								
	Calm	01-03	04-06	07-10	11 16	17-21	22-27	28 33	34-40
January	3.6	24.7	29.9	26.9	13.6	1.2	0.0	0.0	0.0
February	2.0	24.1	30.5	27.1	14.3	1.7	0.4	0.0	0.0
March	1.6	19.6	30.0	31.4	15.3	1.9	0.2	0.0	0.0
April	1.6	16.5	28.6	32.6	18.1	2.1	0.4	0.1	0.0
May	1.2	14.3	27.7	34.3	20.5	1.8	0.1	0.0	0.0
June	0.8	14.4	29.7	37.5	16.9	0.7	0.0	0.0	0.0
July	1.0	15.9	36.5	37.4	9.0	0.1	0.0	0.0	0.0
August	1.1	18.9	35.2	35.4	9.3	0.1	0.0	0.0	0.0
September	1.6	21.0	31.4	33.2	12.7	0.2	0.0	0.0	0.0
October	3.0	24.9	33.4	29.0	9.4	0.3	0.0	0.0	0.0
November	5.4	30.2	33.0	23.1	8.1	0.3	0.0	0.0	0.0
December	4.9	29.8	32.6	22.9	8.8	0.8	0.1	0.0	0.0
10 yr means	2.32	21.19	31.54	30.90	13.00	0.93	0.10	0.01	0.00

Cairo Wind Direction Percentage by 60 Degree Sectors

	Direction in Degrees						
	345-044	045-104	105-164	165-224	225 284	285-344	Calm
January	22.2	11.4	7.5	25.3	20.3	9.8	3.6
February	22.4	13.7	6.5	22.1	21.9	11.6	2.0
March	38.0	14.0	4.8	9.3	18.3	13.9	1.6
April	48.2	13.0	4.3	5.9	9.7	17.3	1.6
May	54.9	14.6	2.7	2.2	6.1	18.4	1.2
June	56.5	8.4	1.3	1.2	5.0	26.8	0.8
July	48.0	3.8	0.5	0.1	5.9	40.6	1.0
August	57.0	5.4	0.7	0.3	3.5	32.0	1.1
September	65.5	10.3	1.3	0.8	3.4	17.2	1.6
October	53.9	13.1	4.3	3.5	7.3	15.0	3.0
November	33.3	13.1	9.6	12.9	11.2	14.6	5.4
December	25.8	13.7	9.6	21.1	14.2	10.7	4.9
10 yr means	43.8	11.2	4.4	8.7	10.6	19.0	2.3

University and Community
College System of Nevada

Desert Research Institute

Energy and Environmental
Engineering Center

March 8, 1996

Dr. Charles Rodes
Research Triangle Institute
Center for Aerosol Technology
P.O. Box 12194
Research Triangle Park, NC 27709

Dear Charles:

Enclosed are the analysis results for the second batch of ambient dichotomous samples, and the point source samples you submitted for the Cairo Receptor Modeling Study. A total of 32 ambient filters plus 30 source filters including blanks were analyzed for 38 elements by x-ray fluorescence (XRF).

The dichotomous Teflon filter XRF analysis results are shown in Table 1. Concentrations are in $\mu g/m^3$, assuming a deposit area of 6.4 cm^2 and using the sample volumes you provided. PM_{10} concentrations are calculated as the sum of the fine and coarse measurements. Note that no sample start and stop times or durations were provided. Sampling date was not indicated for one sample pair (Site T, filters 31120 and 31121).

Many of the source samples required special analysis procedures because of their heavy loadings (samples from the cement kiln, lead smelter, iron sintering, lime kiln and steel converter sources). These samples were analyzed using reduced x-ray beam power, and the data were processed using special self-absorption corrections to accommodate the heavy loadings. Some elements (Pd, Ag, Cd, In, Sn, Sb, Ba and La) could not be determined on the lead smelter samples because of the high loadings. The filters from the iron and steel arc furnace could not be analyzed. Their deposits of 80 and 116 mg were not sufficiently adhered to the filter surface and a significant fraction of the deposit had fallen off the filters. Concentrations in mass percent are given in Table 2.

No ambient or source field blanks were available; laboratory blanks (unexposed filters) were used for subtracting XRF spectral backgrounds. Uncertainties reflect a one standard deviation error estimate based on XRF measurement precision from counting statistics as verified by replicate analyses, and an assumed volume uncertainty of 5%.

Field and analysis flags applied to ambient and source samples are defined in Tables 3 and 4.

P.O. Box 60220
Reno, NV 89506-0220
702-677-3108
Fax 702-677-3157

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Coarse particle Al, Si, P, S, Cl, K, and Ca values for both ambient and source data determined by XRF have been adjusted for large particle self-absorption using the theoretical formulation developed by Tom Dzubay (Dzubay and Nelson, "Self Absorption Corrections for X-Ray Fluorescence Analysis of Aerosols," Advances in X-Ray Analysis,18,619). This adjustment is a function of particle size distribution and composition. Since the actual particle size distribution and composition is unknown, the uncertainty of these adjustments is up to ± 25%, and is reflected in the reported uncertainty.

Data are provided in xbase and CMB 7.0 file formats on the enclosed diskette as listed below. For completeness, data from the first batch of samples (reported 5/1/95) are included as well. Source identification code descriptions as used in the CMB source file are listed in Table 5.

ADCAIRO.TXT	CMB 7.0 ambient data file for batch 1 and 2 samples
PRCAIRO.TXT	CMB 7.0 source data file for resuspension and point source samples
CRCON01D.DBF	Xbase file format of batch 1 ambient samples
CRCON01D.DBT	Xbase memo file for CRCON01D.DBF
CRCON02D.DBF	Xbase file format of batch 2 ambient samples
CRCON02D.DBT	Xbase memo file for CRCON02D.DBF
CRPER01R.DBF	Xbase file format of batch 1 resuspension samples
CRPER01R.DBT	Xbase memo file for CRPER01R.DBF
CRPER03X.DBF	Xbase file format of batch 2 point source samples
CRPER03X.DBT	Xbase memo file for CRPER03X.DBF

Sincerely,

Clifton A. Frazier

Clifton A. Frazier

c: J. Bowen
J. Chow
D. Egami
B. Hinsvark
J. Watson
C. Whitaker

enclosures

Cairo Agricultural Dust by Species Percentage

Sorted by FINE %

	% FINE	Std. Dev.	% COARSE	Std. Dev.	% PM10
SI	13.4805	1.0317	22.1825	7.2712	35.6630
FE	6.1304	0.4683	6.2855	0.5971	12.4159
CA	5.9843	0.4704	8.2871	1.5591	14.2714
AL	4.9470	0.3908	8.6960	2.6955	13.6430
OC	2.5691	5.9994	4.6098	2.2344	7.1789
K	0.8846	0.0788	1.1751	0.2547	2.0597
TI	0.7178	0.1770	0.8380	0.1082	1.5558
LA	0.5901	0.0450	0.2684	0.0209	0.8585
S	0.5363	0.0507	0.5171	0.1869	1.0534
CL	0.2104	0.0465	0.2312	0.0796	0.4416
SB	0.1420	0.0000	0.0659	0.0301	0.2079
MN	0.1375	0.0156	0.1278	0.0141	0.2653
P	0.0804	0.0247	0.1959	0.0866	0.2763
ZN	0.0518	0.0082	0.0376	0.0049	0.0894
PB	0.0450	0.0211	0.0209	0.0094	0.0659
SR	0.0395	0.0081	0.0433	0.0053	0.0828
AG	0.0261	0.0936	0.0010	0.0436	0.0271
CU	0.0228	0.0072	0.0186	0.0036	0.0414
V	0.0214	0.0971	0.0375	0.0583	0.0589
CR	0.0183	0.0152	0.0105	0.0088	0.0288
ZR	0.0179	0.0107	0.0184	0.0050	0.0363
SN	0.0179	0.1420	0.0291	0.0659	0.0470
CD	0.0147	0.1001	0.0042	0.0467	0.0189
PD	0.0128	0.0829	0.0000	0.0387	0.0128
MO	0.0123	0.0251	0.0012	0.0115	0.0135
RB	0.0109	0.0395	0.0039	0.0433	0.0148
HG	0.0079	0.0232	0.0000	0.0105	0.0079
NI	0.0078	0.0066	0.0044	0.0031	0.0122
IN	0.0053	0.1140	0.0092	0.0529	0.0145
U	0.0032	0.0216	0.0009	0.0100	0.0041
SE	0.0016	0.0103	0.0000	0.0047	0.0016
BR	0.0014	0.0109	0.0048	0.0039	0.0062
CO	0.0000	0.0918	0.0000	0.1229	0.0000
GA	0.0000	0.0167	0.0034	0.0078	0.0034
AS	0.0000	0.0212	0.0000	0.0111	0.0000
Y	0.0000	0.0120	0.0027	0.0056	0.0027
BA	0.0000	0.5901	0.0301	0.2684	0.0301
AU	0.0000	0.0275	0.0018	0.0128	0.0018
TL	0.0000	0.0218	0.0000	0.0101	0.0000
EC	0.0000	1.4848	0.0000	0.7092	0.0000

Sum Fine: 36.7490 Sum Coarse: 53.7638 Sum PM10: 90.5128

Note: Bold analytes indicate those with either PM10/error or Fine/erro
greater than a factor of 2

File: cairagr.xls

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Cairo Desert Dust by Species Percentage						
	Sorted by FINE %					
	%		%		%	
	FINE	Std. Dev.	COARSE	Std. Dev.	PM10	Std. Dev.
CA	13.5972	0.9631	14.8162	2.7941	28.4134	2.9554
SI	11.7541	0.8329	16.7233	5.5082	28.4774	5.5708
FE	5.8267	0.4126	4.9021	0.4891	10.7288	0.6399
AL	3.8290	0.1452	6.0311	0.9466	9.8601	0.9577
OC	2.5691	5.9994	4.6098	2.2344	7.1789	6.4020
S	1.4627	0.1043	1.6297	0.5850	3.0924	0.5942
K	1.0557	0.0819	1.0273	0.2294	2.0830	0.2436
CL	0.5943	0.0514	0.5282	0.1680	1.1225	0.1757
TI	0.5741	0.0554	0.5554	0.0579	1.1295	0.0801
MN	0.0851	0.0072	0.0734	0.0083	0.1585	0.0110
BA	0.0806	0.1327	0.0141	0.0893	0.0947	0.1599
SR	0.0690	0.0052	0.0700	0.0069	0.1390	0.0086
LA	0.0586	0.1749	0.0000	0.1150	0.0586	0.2093
ZN	0.0463	0.0037	0.0343	0.0036	0.0806	0.0052
P	0.0402	0.0110	0.0523	0.0279	0.0925	0.0300
PB	0.0287	0.0051	0.0213	0.0033	0.0500	0.0061
ZR	0.0178	0.0028	0.0171	0.0024	0.0349	0.0037
V	0.0162	0.0364	0.0335	0.0166	0.0497	0.0400
CR	0.0155	0.0049	0.0142	0.0041	0.0297	0.0064
CU	0.0153	0.0019	0.0116	0.0015	0.0269	0.0024
SN	0.0048	0.0388	0.0086	0.0237	0.0134	0.0455
NI	0.0047	0.0016	0.0047	0.0012	0.0094	0.0020
Y	0.0045	0.0020	0.0037	0.0011	0.0082	0.0023
BR	0.0038	0.0016	0.0023	0.0009	0.0061	0.0018
RB	0.0036	0.0015	0.0039	0.0009	0.0075	0.0017
SB	0.0035	0.0383	0.0099	0.0265	0.0134	0.0466
AS	0.0018	0.0068	0.0012	0.0064	0.0030	0.0093
GA	0.0017	0.0039	0.0017	0.0017	0.0034	0.0043
U	0.0014	0.0050	0.0017	0.0035	0.0031	0.0061
HG	0.0010	0.0052	0.0013	0.0035	0.0023	0.0063
TL	0.0007	0.0051	0.0025	0.0036	0.0032	0.0062
AU	0.0006	0.0065	0.0007	0.0046	0.0013	0.0080
SE	0.0005	0.0023	0.0005	0.0016	0.0010	0.0028
CO	0.0000	0.0853	0.0000	0.1040	0.0000	0.1345
MO	0.0000	0.0057	0.0000	0.0038	0.0000	0.0069
PD	0.0000	0.0203	0.0012	0.0150	0.0012	0.0252
AG	0.0000	0.0232	0.0016	0.0169	0.0016	0.0287
CD	0.0000	0.0245	0.0000	0.0177	0.0000	0.0302
IN	0.0000	0.0271	0.0059	0.0195	0.0059	0.0334
Sum Fine:	41.7688	Sum Coarse:	51.2163	Sum PM10:	92.9851	
	Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios				
		greater than a factor of 2				
File:	cairdsdt.xls					

Cairo Paved Road Dust by Species Percentage

Sorted by FINE %

	% FINE	Std. Dev.	% COARSE	Std. Dev.	% PM10	Std. Dev.
CA	16.1851	1.1590	20.4331	3.7076	36.6182	3.8845
SI	7.2351	0.5190	10.8112	3.5095	18.0463	3.5477
FE	3.7156	0.2661	3.2230	0.2769	6.9386	0.3840
OC	2.5691	5.9994	4.6098	2.2344	7.1789	6.4020
AL	1.9563	0.1452	3.0885	0.9466	5.0448	0.9577
S	1.6603	0.1201	1.6409	0.5283	3.3012	0.5418
EC	1.3918	0.4750	3.1930	0.4496	4.5848	0.6540
K	0.8238	0.0711	0.8375	0.1860	1.6613	0.1991
CL	0.8055	0.0679	0.8297	0.2534	1.6352	0.2623
TI	0.2964	0.0558	0.2870	0.0304	0.5834	0.0635
PB	0.2328	0.0182	0.1874	0.0165	0.4202	0.0246
BA	0.2287	0.1302	0.1791	0.0418	0.4078	0.1367
ZN	0.1897	0.0139	0.1423	0.0125	0.3320	0.0187
P	0.0996	0.0144	0.0821	0.0375	0.1817	0.0402
SR	0.0789	0.0062	0.0798	0.0068	0.1587	0.0092
MN	0.0662	0.0062	0.0566	0.0055	0.1228	0.0083
BR	0.0451	0.0040	0.0369	0.0034	0.0820	0.0052
CU	0.0352	0.0034	0.0253	0.0024	0.0605	0.0042
CR	0.0169	0.0050	0.0114	0.0026	0.0283	0.0056
SN	0.0139	0.0451	0.0020	0.0197	0.0159	0.0492
SB	0.0110	0.0517	0.0102	0.0224	0.0212	0.0563
V	0.0100	0.0336	0.0092	0.0209	0.0192	0.0396
ZR	0.0083	0.0034	0.0095	0.0017	0.0178	0.0038
NI	0.0076	0.0021	0.0068	0.0010	0.0144	0.0023
MO	0.0024	0.0078	0.0000	0.0032	0.0024	0.0084
RB	0.0023	0.0034	0.0028	0.0010	0.0051	0.0035
Y	0.0023	0.0044	0.0015	0.0026	0.0038	0.0051
AU	0.0023	0.0112	0.0002	0.0076	0.0025	0.0135
U	0.0010	0.0069	0.0000	0.0031	0.0010	0.0076
CO	0.0000	0.0548	0.0000	0.0578	0.0000	0.0796
GA	0.0000	0.0061	0.0018	0.0036	0.0018	0.0071
AS	0.0000	0.0378	0.0000	0.0370	0.0000	0.0529
SE	0.0000	0.0035	0.0000	0.0018	0.0000	0.0039
PD	0.0000	0.0269	0.0000	0.0124	0.0000	0.0296
AG	0.0000	0.0311	0.0025	0.0140	0.0025	0.0341
CD	0.0000	0.0332	0.0014	0.0147	0.0014	0.0363
IN	0.0000	0.0370	0.0080	0.0165	0.0080	0.0405
LA	0.0000	0.2405	0.0000	0.0972	0.0000	0.2594
HG	0.0000	0.0072	0.0021	0.0033	0.0021	0.0079
TL	0.0000	0.0098	0.0000	0.0072	0.0000	0.0122

Sum Fine: 37.6932 Sum Coarse: 49.8126 Sum PM10: 87.5058

Note: Bold analytes indicate those with either PM10/error or Fine/erro
greater than a factor of 2

File: cairrddt.xls

Cairo Unpaved Road Dust by Species Percentage						
		Sorted by FINE %				
	%		%		%	
	FINE	Std. Dev.	COARSE	Std. Dev.	PM10	Std. Dev.
CA	15.2515	1.0879	24.3322	4.5849	39.5837	4.7122
SI	6.2036	0.4434	13.3464	3.4174	19.5500	3.4460
FE	3.5118	0.2505	3.5719	0.3648	7.0837	0.4425
OC	2.5691	5.9994	4.6098	2.2344	7.1789	6.4020
AL	2.0877	0.1526	3.5253	1.1053	5.6130	1.1158
S	1.3130	0.0946	1.7104	0.6155	3.0234	0.6227
CL	1.1669	0.0897	1.6172	0.4962	2.7841	0.5042
K	0.9672	0.0783	1.1297	0.2590	2.0969	0.2706
TI	0.3186	0.0467	0.3084	0.0414	0.6270	0.0624
ZN	0.2252	0.0162	0.2106	0.0219	0.4358	0.0272
P	0.1967	0.0179	0.1851	0.0817	0.3818	0.0836
BA	0.1315	0.1031	0.1842	0.0636	0.3157	0.1211
SR	0.0975	0.0073	0.1173	0.0118	0.2148	0.0139
PB	0.0927	0.0085	0.0968	0.0105	0.1895	0.0135
CU	0.0865	0.0065	0.0817	0.0086	0.1682	0.0108
MN	0.0657	0.0058	0.0622	0.0072	0.1279	0.0092
SB	0.0245	0.0399	0.0000	0.0298	0.0245	0.0498
SN	0.0231	0.0351	0.0108	0.0265	0.0339	0.0440
CR	0.0207	0.0042	0.0192	0.0004	0.0399	0.0042
V	0.0153	0.0264	0.0102	0.0264	0.0255	0.0373
ZR	0.0095	0.0029	0.0074	0.0027	0.0169	0.0040
BR	0.0082	0.0019	0.0094	0.0015	0.0176	0.0024
NI	0.0051	0.0017	0.0076	0.0014	0.0127	0.0022
RB	0.0027	0.0016	0.0031	0.0010	0.0058	0.0019
HG	0.0026	0.0055	0.0015	0.0043	0.0041	0.0070
Y	0.0023	0.0021	0.0014	0.0013	0.0037	0.0025
GA	0.0020	0.0042	0.0000	0.0035	0.0020	0.0055
AS	0.0018	0.0160	0.0000	0.0225	0.0018	0.0276
AU	0.0009	0.0105	0.0036	0.0123	0.0045	0.0162
U	0.0006	0.0051	0.0000	0.0040	0.0006	0.0065
SE	0.0003	0.0024	0.0000	0.0021	0.0003	0.0032
CO	0.0000	0.0517	0.0000	0.0751	0.0000	0.0912
MO	0.0000	0.0058	0.0000	0.0044	0.0000	0.0073
PD	0.0000	0.0210	0.0000	0.0167	0.0000	0.0268
AG	0.0000	0.0241	0.0000	0.0186	0.0000	0.0304
CD	0.0000	0.0259	0.0049	0.0198	0.0049	0.0326
IN	0.0000	0.0282	0.0051	0.0217	0.0051	0.0356
LA	0.0000	0.1821	0.0017	0.1309	0.0017	0.2243
TL	0.0000	0.0059	0.0000	0.0056	0.0000	0.0081
EC	0.0000	1.4848	0.0000	0.7092	0.0000	1.6455
Sum Fine:	34.4048	Sum Coarse:	55.1751	Sum PM10:	89.5799	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	greater than a factor of 2					
File:	cairurdd.xls					

Cairo Source Signature: Automobiles - Petrol Fueled (sample 1)						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
OC	15.5314	0.7829	na	0.0000	15.5314	0.7829
Pb	8.7233	0.6275	1.0916	1.2334	9.1968	0.9785
Br	5.0320	0.3625	0.6636	0.7217	5.3789	0.5711
EC	2.4529	0.1289	na	0.0000	2.4529	0.1289
Al	0.8570	0.1544	0.0000	0.6754	0.6585	0.4899
Ca	0.2842	0.0208	0.1395	0.0998	0.5259	0.0721
Zn	0.1987	0.0143	0.0000	0.0267	0.1975	0.0214
Fe	0.1513	0.0110	0.0600	0.0329	0.2489	0.0245
S	0.0970	0.7114	0.0000	2.1039	0.0000	1.5704
P	0.0744	0.0130	0.0148	0.0444	0.0904	0.0327
K	0.0277	0.0033	0.0000	0.0075	0.0105	0.0058
Cu	0.0065	0.0006	0.0000	0.0008	0.0023	0.0007
Ti	0.0046	0.0203	0.0028	0.0360	0.0096	0.0292
Sn	0.0026	0.0204	0.0000	0.0372	0.0023	0.0300
Sb	0.0024	0.0198	0.0000	0.0353	0.0000	0.0286
V	0.0019	0.0084	0.0006	0.0149	0.0029	0.0121
Mn	0.0018	0.0006	0.0006	0.0010	0.0027	0.0008
Ni	0.0015	0.0004	0.0005	0.0006	0.0022	0.0005
Co	0.0014	0.0026	0.0000	0.0066	0.0012	0.0050
Cr	0.0013	0.0020	0.0004	0.0037	0.0019	0.0030
Ga	0.0005	0.0927	0.0014	0.1791	0.0034	0.1426
Si	0.0000	0.1025	0.0000	0.4009	0.0000	0.2926
Cl	0.0000	0.1049	0.0000	0.2839	0.0000	0.2140
As	0.0000	1.3399	0.0000	2.5881	0.0000	2.0608
Se	0.0000	0.0370	0.0000	0.0715	0.0000	0.0569
Rb	0.0000	0.1725	0.0000	0.3360	0.0000	0.2671
Sr	0.0000	0.0067	0.0000	0.0129	0.0000	0.0103
Y	0.0000	0.0759	0.0000	0.1467	0.0000	0.1168
Zr	0.0000	0.0061	0.0000	0.0117	0.0000	0.0093
Mo	0.0000	0.0032	0.0000	0.0060	0.0000	0.0048
Pd	0.0000	0.0419	0.0000	0.0891	0.0000	0.0696
Ag	0.0000	0.0140	0.0000	0.0254	0.0000	0.0205
Cd	0.0000	0.0159	0.0000	0.0293	0.0000	0.0236
In	0.0000	0.0177	0.0000	0.0327	0.0000	0.0263
Ba	0.0000	0.0598	0.0078	0.1057	0.0169	0.0859
La	0.0000	0.0749	0.0089	0.1325	0.0194	0.1076
Au	0.0000	0.0206	0.0000	0.0398	0.0000	0.0317
Hg	0.0000	0.0323	0.0000	0.0624	0.0000	0.0497
Tl	0.0000	0.2354	0.0000	0.4546	0.0000	0.3620
U	0.0000	0.0780	0.0000	0.1518	0.0000	0.1207
Sum Fine:	33.4544	Sum Coarse:	1.9925	Sum PM10:	34.3565	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source1						

Cairo Source Signature: Automobiles - Petrol Fueled (sample 2)						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Pb	14.0748	0.9981	2.4089	2.1816	15.6657	1.6964
Br	6.9819	0.4963	1.3393	1.1108	7.9812	0.8603
OC	4.8314	2.0010	na	0.0000	4.8314	2.0010
EC	2.4272	0.1309	na	0.0000	2.4272	0.1309
Fe	0.8636	0.0613	0.2118	0.1457	1.0543	0.1118
Al	0.8132	0.2035	0.0000	2.3877	0.6273	1.6945
Ca	0.3070	0.0221	0.0429	0.0528	0.3276	0.0405
Zn	0.2197	0.0156	0.0335	0.0335	0.2386	0.0261
P	0.0825	0.0174	0.0000	0.0583	0.0737	0.0430
Sn	0.0178	0.0239	0.0000	0.0602	0.0000	0.0458
Mn	0.0057	0.0008	0.0009	0.0015	0.0062	0.0012
Ti	0.0043	0.0173	0.0000	0.0331	0.0042	0.0264
Cu	0.0028	0.0003	0.0007	0.0006	0.0035	0.0005
Cr	0.0025	0.0007	0.0006	0.0014	0.0031	0.0011
Ni	0.0021	0.0003	0.0003	0.0006	0.0022	0.0005
V	0.0020	0.0072	0.0000	0.0138	0.0015	0.0110
Co	0.0018	0.0132	0.0000	0.0293	0.0008	0.0227
Si	0.0000	0.1534	0.0000	0.6459	0.0000	0.4694
S	0.0000	1.1469	0.0000	3.6489	0.0000	2.7046
Cl	0.0000	0.1675	0.0000	0.4890	0.0000	0.3655
K	0.0000	0.0076	0.0000	0.0186	0.0000	0.0142
Ga	0.0000	0.1493	0.0000	0.3141	0.0000	0.2459
As	0.0000	2.1599	0.0000	4.5445	0.0000	3.5579
Se	0.0000	0.0593	0.0000	0.1248	0.0000	0.0977
Rb	0.0000	0.2394	0.0000	0.5114	0.0000	0.3993
Sr	0.0000	0.0105	0.0000	0.0221	0.0000	0.0173
Y	0.0000	0.1205	0.0000	0.2539	0.0000	0.1987
Zr	0.0000	0.0095	0.0000	0.0199	0.0000	0.0156
Mo	0.0000	0.0038	0.0000	0.0076	0.0000	0.0060
Pd	0.0000	0.1632	0.0000	0.4083	0.0000	0.3109
Ag	0.0000	0.0160	0.0000	0.0331	0.0000	0.0260
Cd	0.0000	0.0231	0.0000	0.0447	0.0000	0.0356
In	0.0000	0.0217	0.0000	0.0456	0.0000	0.0357
Sb	0.0000	0.0193	0.0000	0.0386	0.0000	0.0305
Ba	0.0000	0.0492	0.0000	0.0924	0.0000	0.0740
La	0.0000	0.0599	0.0000	0.1133	0.0000	0.0906
Au	0.0000	0.0310	0.0000	0.0653	0.0000	0.0511
Hg	0.0000	0.0513	0.0000	0.1079	0.0000	0.0845
Tl	0.0000	0.3793	0.0000	0.7979	0.0000	0.6247
U	0.0000	0.1083	0.0045	0.2313	0.0066	0.1806
Sum Fine:	30.6403	Sum Coarse:	4.0435	Sum PM10:	33.2551	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source2						

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Cairo Source Signature: Cement Production - Dry Bypass						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Cl	36.4618	2.5973	na	6.8777	31.9588	5.1985
K	36.2404	2.5788	na	4.4227	29.1239	3.6201
S	3.2876	0.2351	0.6834	1.5154	4.4985	1.0844
Ca	1.2023	0.1988	2.7626	3.0066	12.3136	2.1306
OC	0.8042	0.0795	na	0.0000	0.8042	0.0795
Rb	0.3499	0.0249	0.0000	0.0253	0.2801	0.0251
Br	0.0806	0.0058	0.0000	0.0062	0.0669	0.0060
Fe	0.0636	0.0046	0.0754	0.0389	0.3509	0.0277
Zn	0.0433	0.0031	0.0000	0.0033	0.0364	0.0032
P	0.0401	0.0720	0.0000	0.1785	0.0000	0.1361
Pb	0.0378	0.0028	0.0000	0.0032	0.0328	0.0030
Mn	0.0277	0.0020	0.0034	0.0027	0.0278	0.0024
Ti	0.0183	0.0037	0.0087	0.0064	0.0457	0.0052
Sr	0.0147	0.0011	0.0168	0.0087	0.0785	0.0062
Cu	0.0126	0.0009	0.0000	0.0011	0.0107	0.0010
U	0.0112	0.0412	0.0000	0.0451	0.0085	0.0432
V	0.0104	0.0016	0.0021	0.0023	0.0141	0.0020
Cr	0.0085	0.0007	0.0012	0.0011	0.0093	0.0009
Cd	0.0075	0.0021	0.0000	0.0063	0.0020	0.0047
Zr	0.0014	0.0003	0.0004	0.0042	0.0024	0.0030
Ni	0.0013	0.0002	0.0010	0.0005	0.0048	0.0004
Hg	0.0011	0.0013	0.0000	0.0015	0.0010	0.0014
Y	0.0009	0.0151	0.0000	0.0165	0.0008	0.0158
Ag	0.0009	0.0060	0.0000	0.0062	0.0003	0.0061
Se	0.0003	0.0006	0.0000	0.0008	0.0000	0.0007
Al	0.0000	0.1481	0.0000	0.5812	0.0000	0.4241
Si	0.0000	0.3025	0.0000	1.0412	0.0000	0.7667
Co	0.0000	0.0059	0.0000	0.0199	0.0000	0.0147
Ga	0.0000	0.0009	0.0000	0.0011	0.0000	0.0010
As	0.0000	0.0068	0.0000	0.0083	0.0000	0.0076
Mo	0.0000	0.0010	0.0000	0.0012	0.0000	0.0011
Pd	0.0000	0.0055	0.0000	0.0057	0.0000	0.0056
In	0.0000	0.0064	0.0001	0.0066	0.0004	0.0065
Sn	0.0000	0.0074	0.0007	0.0076	0.0030	0.0075
Sb	0.0000	0.0084	0.0000	0.0084	0.0001	0.0084
Ba	0.0000	0.0236	0.0025	0.0254	0.0107	0.0245
La	0.0000	0.0293	0.0005	0.0315	0.0021	0.0304
Au	0.0000	0.0021	0.0000	0.0025	0.0000	0.0023
Tl	0.0000	0.0017	0.0000	0.0021	0.0000	0.0019
EC	0.0000	0.0388	0.0000	0.0000	0.0000	0.0388
Sum Fine:	78.7284	Sum Coarse:	3.5588	Sum PM10:	79.6883	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source3						

Cairo Source Signature: Cement Production - Wet Kiln; Sample 1						
	Sorted by PM10 concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Ca	2.2430	0.1637	46.4747	5.9428	24.1741	4.2038
K	8.2604	0.5858	19.9060	3.3133	15.6374	2.3792
Cl	9.0745	0.6449	12.2204	2.9372	12.4974	2.1264
S	2.7043	0.1927	6.7225	1.7266	5.2192	1.2285
Si	0.0000	0.1860	8.0466	1.8505	3.9044	1.3151
Fe	0.2666	0.0189	2.9204	0.2006	1.6100	0.1425
Al	0.0088	0.0987	3.2874	0.7503	1.6015	0.5351
OC	0.8740	0.0742	na	0.0000	0.8740	0.0742
Sr	0.0238	0.0017	0.2582	0.0177	0.1425	0.0126
Rb	0.2109	0.0150	0.0000	0.0169	0.1313	0.0160
Ti	0.0158	0.0032	0.2408	0.0171	0.1283	0.0123
Pb	0.0580	0.0042	0.0000	0.0057	0.0438	0.0050
Zn	0.0228	0.0016	0.0396	0.0045	0.0357	0.0034
Br	0.0562	0.0040	0.0000	0.0044	0.0327	0.0042
Mn	0.0074	0.0006	0.0541	0.0042	0.0316	0.0030
Co	0.0023	0.0041	0.0260	0.0344	0.0143	0.0245
Cr	0.0036	0.0007	0.0214	0.0022	0.0130	0.0016
Cu	0.0109	0.0008	0.0000	0.0013	0.0108	0.0011
V	0.0009	0.0054	0.0164	0.0067	0.0086	0.0061
Sb	0.0000	0.0065	0.0105	0.0127	0.0051	0.0101
La	0.0177	0.0277	0.0000	0.0509	0.0050	0.0410
Cd	0.0061	0.0015	0.0000	0.0076	0.0045	0.0055
Zr	0.0014	0.0004	0.0068	0.0076	0.0043	0.0054
U	0.0068	0.0252	0.0000	0.0352	0.0035	0.0306
Ag	0.0000	0.0043	0.0037	0.0088	0.0018	0.0069
EC	0.0015	0.0303	0.0000	0.0000	0.0015	0.0303
Y	0.0003	0.0092	0.0018	0.0129	0.0011	0.0112
Sn	0.0010	0.0058	0.0000	0.0112	0.0003	0.0089
Se	0.0000	0.0006	0.0004	0.0010	0.0002	0.0008
P	0.0000	0.0457	0.0000	0.1524	0.0000	0.1125
Ni	0.0009	0.0001	0.0000	0.0168	0.0000	0.0119
Ga	0.0000	0.0010	0.0000	0.0017	0.0000	0.0014
As	0.0000	0.0096	0.0000	0.0147	0.0000	0.0124
Mo	0.0000	0.0010	0.0000	0.0022	0.0000	0.0017
Pd	0.0000	0.0039	0.0000	0.0080	0.0000	0.0063
In	0.0003	0.0048	0.0000	0.0095	0.0000	0.0075
Ba	0.0073	0.0218	0.0000	0.0408	0.0000	0.0327
Au	0.0000	0.0015	0.0000	0.0032	0.0000	0.0025
Hg	0.0002	0.0012	0.0000	0.0021	0.0000	0.0017
Tl	0.0000	0.0020	0.0000	0.0033	0.0000	0.0027
Sum Fine:	23.8877	Sum Coarse:	100.2577	Sum PM10:	66.1379	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source4						

Cairo Source Signature: Cement Production - Wet Kiln; Sample 2						
	Sorted by PM10 concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Ca	3.3670	0.2511	14.3935	5.0179	21.1607	3.5526
Cl	22.3714	1.5844	na	1.6281	12.6429	1.6064
K	16.7620	1.1862	na	1.5457	11.8023	1.3777
S	2.7055	0.1927	2.1655	1.5143	4.3703	1.0794
Si	0.0000	0.2279	3.0356	1.9099	4.0796	1.3601
Al	0.0448	0.1260	1.3646	0.8344	1.8581	0.5967
Fe	0.2953	0.0209	0.8497	0.1476	1.3013	0.1054
OC	0.9619	0.0741	na	0.0000	0.9619	0.0741
Rb	0.2369	0.0168	0.0000	0.0158	0.1685	0.0163
Zn	0.1763	0.0125	0.0000	0.0117	0.1245	0.0121
Sr	0.0192	0.0014	0.0844	0.0141	0.1238	0.0100
Ti	0.0263	0.0036	0.0685	0.0129	0.1063	0.0095
Pb	0.0646	0.0047	0.0000	0.0043	0.0450	0.0045
Br	0.0609	0.0043	0.0000	0.0041	0.0431	0.0042
Mn	0.0171	0.0013	0.0131	0.0031	0.0269	0.0024
EC	0.0204	0.0268	0.0000	0.0000	0.0204	0.0268
Co	0.0038	0.0045	0.0081	0.0275	0.0130	0.0197
La	0.0240	0.0265	0.0000	0.0330	0.0117	0.0299
Cr	0.0055	0.0008	0.0060	0.0017	0.0110	0.0013
Cu	0.0074	0.0006	0.0000	0.0008	0.0069	0.0007
V	0.0031	0.0057	0.0037	0.0037	0.0066	0.0048
Cd	0.0098	0.0018	0.0000	0.0020	0.0063	0.0019
U	0.0072	0.0281	0.0000	0.0305	0.0061	0.0293
Zr	0.0015	0.0003	0.0022	0.0066	0.0038	0.0047
Ag	0.0019	0.0048	0.0000	0.0059	0.0017	0.0054
Sb	0.0011	0.0070	0.0000	0.0085	0.0011	0.0078
Y	0.0008	0.0103	0.0000	0.0111	0.0008	0.0107
Sn	0.0000	0.0061	0.0004	0.0076	0.0005	0.0069
Se	0.0001	0.0006	0.0001	0.0008	0.0002	0.0007
P	0.0000	0.0575	0.0000	0.1485	0.0000	0.1126
Ni	0.0012	0.0002	0.0000	0.0154	0.0000	0.0109
Ga	0.0000	0.0011	0.0000	0.0013	0.0000	0.0012
As	0.0000	0.0106	0.0000	0.0114	0.0000	0.0110
Mo	0.0000	0.0010	0.0000	0.0019	0.0000	0.0015
Pd	0.0000	0.0044	0.0000	0.0055	0.0000	0.0050
In	0.0000	0.0052	0.0000	0.0065	0.0000	0.0059
Ba	0.0000	0.0208	0.0000	0.0259	0.0000	0.0235
Au	0.0000	0.0059	0.0000	0.0063	0.0000	0.0061
Hg	0.0000	0.0012	0.0000	0.0016	0.0000	0.0014
Tl	0.0000	0.0022	0.0000	0.0024	0.0000	0.0023
Sum Fine:	47.1970	Sum Coarse:	21.9955	Sum PM10:	58.9053	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source5						

Cairo Source Signature: Heavy Duty Diesel Exhaust						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
OC	38.7889	2.4466	na	0.0000	38.7889	2.4466
EC	12.5898	1.1468	na	0.0000	12.5898	1.1468
S	1.9567	0.1645	5.0735	0.5132	2.1215	0.3811
Fe	0.9131	0.0758	18.8352	0.4953	3.5170	0.3543
Zn	0.8462	0.0701	0.0000	0.1059	0.7965	0.0898
Pb	0.7712	0.0646	0.0000	0.1010	0.7499	0.0848
K	0.7244	0.0620	4.0685	0.2399	1.1215	0.1752
Ca	0.5698	0.0492	53.7602	2.2375	8.6407	1.5825
Cl	0.5189	0.0494	7.7735	0.5367	1.5490	0.3811
Si	0.4505	0.0428	35.7388	2.5646	5.7934	1.8137
Ba	0.1163	0.2612	0.3518	0.3675	0.1338	0.3188
Sb	0.0921	0.0250	0.0000	0.0805	0.0450	0.0596
Br	0.0778	0.0071	0.0000	0.0097	0.0648	0.0085
Al	0.0685	0.0701	9.1259	0.6465	1.4474	0.4598
Cu	0.0307	0.0031	0.1403	0.0065	0.0426	0.0051
Mn	0.0245	0.0035	0.5538	0.0154	0.1018	0.0112
Cd	0.0079	0.0394	0.0207	0.0582	0.0086	0.0497
In	0.0075	0.0475	0.0000	0.0689	0.0058	0.0592
Sn	0.0070	0.0600	0.1134	0.0871	0.0222	0.0748
Ag	0.0068	0.0403	0.0543	0.0579	0.0130	0.0499
Ni	0.0058	0.0016	0.0516	0.0030	0.0119	0.0024
Cr	0.0042	0.0093	0.1793	0.0108	0.0304	0.0101
Ti	0.0024	0.0896	1.0411	0.0928	0.1614	0.0912
Sr	0.0023	0.0046	0.3944	0.0100	0.0621	0.0078
Ga	0.0013	0.0121	0.0000	0.0188	0.0000	0.0158
Pd	0.0009	0.0349	0.0761	0.0495	0.0123	0.0428
P	0.0000	0.0410	0.2880	0.1209	0.0442	0.0903
V	0.0000	0.0370	0.0626	0.0540	0.0096	0.0463
Co	0.0000	0.0153	0.0072	0.0776	0.0011	0.0559
As	0.0000	0.1201	0.0000	0.1994	0.0000	0.1646
Se	0.0000	0.0056	0.0000	0.0085	0.0000	0.0072
Rb	0.0000	0.0052	0.0209	0.0078	0.0032	0.0066
Y	0.0000	0.0086	0.0046	0.0135	0.0007	0.0113
Zr	0.0000	0.0061	0.0319	0.0097	0.0049	0.0081
Mo	0.0000	0.0110	0.0117	0.0156	0.0018	0.0135
La	0.0000	0.3409	0.0000	0.4765	0.0000	0.4143
Au	0.0000	0.0331	0.0202	0.0583	0.0031	0.0474
Hg	0.0000	0.0109	0.0000	0.0164	0.0000	0.0139
Tl	0.0000	0.0242	0.0000	0.0391	0.0000	0.0325
U	0.0000	0.0097	0.0000	0.0141	0.0000	0.0121
Sum Fine:	58.5855	Sum Coarse:	137.7994	Sum PM10:	77.8999	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source6						

Cairo Source Signature: Heavy Oil (Mazut) Combustion						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
EC	143.6924	7.3267	na	0.0000	143.6924	7.3267
OC	2.5419	0.2706	na	0.0000	2.5419	0.2706
S	2.0961	0.1515	0.4327	0.8191	3.0549	0.5890
Si	0.1163	0.0101	0.0657	0.1069	0.3050	0.0759
Zn	0.1144	0.0083	0.0000	0.0118	0.0833	0.0102
Sn	0.1056	0.0090	0.0077	0.0170	0.1080	0.0136
Fe	0.0919	0.0067	0.1513	0.0741	0.5642	0.0526
V	0.0764	0.0061	0.0069	0.0128	0.0826	0.0100
Ni	0.0396	0.0029	0.0104	0.0087	0.0651	0.0065
Pb	0.0387	0.0031	0.0073	0.0076	0.0543	0.0058
Ca	0.0316	0.0029	0.0384	0.0350	0.1497	0.0248
Al	0.0231	0.0063	0.0210	0.0422	0.0866	0.0302
K	0.0184	0.0021	0.0036	0.0062	0.0261	0.0046
Cu	0.0180	0.0014	0.0036	0.0036	0.0259	0.0027
Sb	0.0107	0.0128	0.0000	0.0231	0.0034	0.0187
Ag	0.0047	0.0069	0.0000	0.0127	0.0038	0.0102
As	0.0019	0.0065	0.0003	0.0148	0.0026	0.0114
Pd	0.0016	0.0059	0.0000	0.0105	0.0000	0.0085
In	0.0016	0.0087	0.0000	0.0152	0.0000	0.0124
Ti	0.0007	0.0160	0.0000	0.0314	0.0000	0.0249
Cd	0.0006	0.0071	0.0004	0.0127	0.0017	0.0103
Cr	0.0005	0.0033	0.0000	0.0078	0.0000	0.0060
Br	0.0005	0.0009	0.0002	0.0013	0.0010	0.0011
Sr	0.0005	0.0009	0.0006	0.0013	0.0025	0.0011
La	0.0003	0.0623	0.0112	0.1128	0.0365	0.0911
Ga	0.0002	0.0016	0.0000	0.0030	0.0000	0.0024
Mn	0.0001	0.0013	0.0006	0.0020	0.0019	0.0017
P	0.0000	0.0136	0.0000	0.0435	0.0000	0.0322
Cl	0.0000	0.0405	0.0000	0.1162	0.0000	0.0870
Co	0.0000	0.0017	0.0000	0.0125	0.0000	0.0089
Se	0.0000	0.0009	0.0000	0.0016	0.0000	0.0013
Rb	0.0000	0.0008	0.0000	0.0013	0.0000	0.0011
Y	0.0000	0.0011	0.0000	0.0021	0.0000	0.0017
Zr	0.0000	0.0012	0.0000	0.0022	0.0000	0.0018
Mo	0.0000	0.0022	0.0000	0.0041	0.0000	0.0033
Ba	0.0000	0.0473	0.0129	0.0858	0.0420	0.0693
Au	0.0000	0.0048	0.0000	0.0085	0.0000	0.0069
Hg	0.0000	0.0020	0.0000	0.0039	0.0000	0.0031
Tl	0.0000	0.0023	0.0000	0.0047	0.0000	0.0037
U	0.0000	0.0019	0.0000	0.0035	0.0000	0.0028
Sum Fine:	149.0283	Sum Coarse:	0.7748	Sum PM10:	150.9354	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source7						

Cairo Source Signature: Iron and Steel - Sintering						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Cl	26.2174	1.8576	na	4.4984	25.2909	3.4414
K	16.1016	1.1404	na	2.6425	15.9531	2.0351
Fe	6.4186	0.4545	0.7214	1.0025	6.9841	0.7783
OC	6.0337	0.3879	na	0.0000	6.0337	0.3879
Zn	4.2399	0.3002	0.0000	0.5525	3.7377	0.4446
Pb	1.1129	0.0789	0.0000	0.1485	1.0060	0.1189
Ca	0.6298	0.0873	0.1197	0.2463	0.9542	0.1848
Mn	0.5052	0.0360	0.0000	0.0721	0.4916	0.0570
Tl	0.2739	0.0220	0.0000	0.0432	0.2610	0.0343
Al	0.1778	0.0369	0.1034	0.3017	0.6518	0.2149
Rb	0.1512	0.0107	0.0000	0.0207	0.1411	0.0165
EC	0.1293	0.0905	na	0.0000	0.1293	0.0905
As	0.0920	0.1704	0.0109	0.3322	0.1034	0.2640
Ba	0.0864	0.0123	0.0000	0.0971	0.0564	0.0692
P	0.0744	0.0192	0.0218	0.0963	0.1546	0.0694
Cd	0.0510	0.0047	0.0000	0.0104	0.0405	0.0081
Si	0.0498	0.1299	0.1006	0.4506	0.5760	0.3316
Cu	0.0367	0.0027	0.0036	0.0056	0.0369	0.0044
Se	0.0346	0.0030	0.0041	0.0064	0.0388	0.0050
Au	0.0219	0.1374	0.0000	0.2720	0.0146	0.2155
Br	0.0170	0.0037	0.0000	0.0073	0.0151	0.0058
Sn	0.0161	0.0037	0.0000	0.0279	0.0063	0.0199
Ti	0.0140	0.0165	0.0035	0.0272	0.0257	0.0225
Mo	0.0134	0.0011	0.0000	0.0023	0.0122	0.0018
Sb	0.0083	0.0119	0.0017	0.0355	0.0131	0.0265
Sr	0.0071	0.0011	0.0011	0.0025	0.0093	0.0019
V	0.0041	0.0092	0.0008	0.0225	0.0063	0.0172
Y	0.0034	0.0113	0.0000	0.0222	0.0014	0.0176
U	0.0026	0.0181	0.0000	0.0360	0.0020	0.0285
Zr	0.0019	0.0004	0.0002	0.0011	0.0021	0.0008
Co	0.0014	0.0966	0.0000	0.2052	0.0000	0.1604
Cr	0.0006	0.0089	0.0000	0.0189	0.0005	0.0148
S	0.0000	0.4742	0.0000	1.3319	0.0000	0.9997
Ni	0.0000	0.0031	0.0004	0.0067	0.0022	0.0052
Ga	0.0000	0.0136	0.0000	0.0269	0.0000	0.0213
Pd	0.0000	0.0074	0.0010	0.0212	0.0053	0.0159
Ag	0.0000	0.0079	0.0000	0.0230	0.0000	0.0172
In	0.0000	0.0089	0.0000	0.0264	0.0000	0.0197
La	0.0000	0.0377	0.0000	0.1309	0.0000	0.0963
Hg	0.0000	0.0146	0.0000	0.0292	0.0000	0.0231
Sum Fine:	62.5280	Sum Coarse:	1.0941	Sum PM10:	62.7572	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source8						

Cairo Source Signature: Iron and Steel - Converter						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Fe	32.1945	2.4660	na	2.9789	28.1857	2.7345
Cl	2.0462	0.1598	0.0000	0.3418	1.7549	0.2668
K	1.9697	0.1525	0.0000	0.2006	1.4550	0.1782
Mn	1.5715	0.1217	0.0000	0.1585	1.4586	0.1413
Ca	1.4052	0.1092	0.5232	0.6265	3.0053	0.4497
S	0.9236	0.0728	0.0000	0.1612	0.6835	0.1251
Zn	0.5185	0.0399	0.0887	0.0762	0.6634	0.0608
Si	0.3535	0.0313	0.1895	0.3841	1.0031	0.2725
Pb	0.3210	0.0253	0.3309	0.1932	1.5889	0.1378
P	0.0546	0.0110	0.0000	0.0656	0.0158	0.0470
La	0.0511	0.2432	0.0000	0.2452	0.0000	0.2442
Ba	0.0474	0.1834	0.0143	0.1903	0.0873	0.1869
Sn	0.0411	0.0520	0.0081	0.0301	0.0571	0.0425
EC	0.0378	0.3778	na	0.0000	0.0378	0.3778
Sb	0.0295	0.0571	0.0095	0.0329	0.0566	0.0466
Ti	0.0292	0.0672	0.0000	0.0733	0.0000	0.0703
In	0.0194	0.0414	0.0000	0.0442	0.0047	0.0428
Sr	0.0145	0.0016	0.0019	0.0023	0.0160	0.0020
Cu	0.0080	0.0013	0.0000	0.0015	0.0074	0.0014
Rb	0.0074	0.0012	0.0000	0.0016	0.0057	0.0014
Au	0.0069	0.0207	0.0000	0.0445	0.0007	0.0347
Hg	0.0067	0.0078	0.0000	0.0121	0.0020	0.0102
Mo	0.0066	0.0075	0.0000	0.0075	0.0019	0.0075
Ga	0.0059	0.0070	0.0000	0.0254	0.0023	0.0186
As	0.0047	0.0508	0.0000	0.3456	0.0000	0.2470
U	0.0039	0.0069	0.0000	0.0075	0.0000	0.0072
Al	0.0030	0.0523	0.0838	0.1891	0.3593	0.1387
Y	0.0006	0.0047	0.0000	0.0191	0.0000	0.0139
Zr	0.0006	0.0042	0.0001	0.0046	0.0009	0.0044
Se	0.0004	0.0038	0.0006	0.0102	0.0027	0.0077
V	0.0000	0.0403	0.0000	0.0489	0.0000	0.0448
Cr	0.0000	0.0394	0.0000	0.0516	0.0000	0.0459
Co	0.0000	0.4873	0.0000	0.6457	0.0000	0.5720
Ni	0.0000	0.0107	0.0000	0.0139	0.0000	0.0124
Br	0.0000	0.0046	0.0000	0.0169	0.0000	0.0124
Pd	0.0000	0.0322	0.0000	0.0351	0.0000	0.0337
Ag	0.0000	0.0364	0.0000	0.0382	0.0000	0.0373
Cd	0.0000	0.0364	0.0014	0.0397	0.0060	0.0381
Tl	0.0000	0.0119	0.0000	0.0619	0.0000	0.0446
OC	na	na	na	na	na	na
Sum Fine:	41.6830	Sum Coarse:	1.2519	Sum PM10:	40.4626	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source9						

Cairo Source Signature: Lead (Pb) Smelter - sample 1						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Pb	57.3435	4.0806	13.3960	8.9574	59.8155	6.9601
Cl	5.5777	0.4919	0.9845	1.3404	5.6553	1.0096
Fe	0.6653	0.0474	0.6550	0.1368	0.9494	0.1024
Zn	0.1647	0.0117	0.0461	0.0262	0.1757	0.0203
OC	0.0827	0.0084	na	na	0.0827	0.0084
Cu	0.0390	0.0028	0.0095	0.0062	0.0409	0.0048
Co	0.0316	0.0917	0.0344	0.2347	0.0468	0.1782
Mn	0.0260	0.0020	0.0201	0.0051	0.0343	0.0039
Ti	0.0039	0.0045	0.0000	0.0098	0.0021	0.0076
Ni	0.0023	0.0003	0.0035	0.0008	0.0039	0.0006
V	0.0019	0.0029	0.0000	0.0063	0.0017	0.0049
Se	0.0007	0.1706	0.0003	0.3677	0.0008	0.2866
Al	0.0000	1.0221	0.0000	5.0308	0.0000	3.6300
Si	0.0000	2.3312	0.0000	9.8743	0.0000	7.1741
P	0.0000	0.6636	0.0000	2.3499	0.0000	1.7266
S	0.0000	15.3766	0.0000	49.7298	0.0000	36.8069
K	0.0000	0.2439	0.0000	0.6376	0.0000	0.4827
Ca	0.0000	0.4651	0.0000	1.2570	0.0000	0.9477
Cr	0.0000	0.0022	0.0000	0.0049	0.0000	0.0038
Ga	0.0000	0.4347	0.0000	0.9369	0.0000	0.7303
As	0.0000	6.2718	0.0000	13.5160	0.0000	10.5361
Br	0.0000	0.2967	0.0000	0.6394	0.0000	0.4984
Rb	0.0000	0.0517	0.0000	0.1115	0.0000	0.0869
Sr	0.0000	0.0280	0.0000	0.0604	0.0000	0.0471
Y	0.0000	0.3348	0.0000	0.7215	0.0000	0.5624
Zr	0.0000	0.0272	0.0000	0.0585	0.0000	0.0456
Mo	0.0000	0.0082	0.0000	0.0176	0.0000	0.0137
Au	0.0000	0.0800	0.0000	0.1724	0.0000	0.1344
Hg	0.0000	0.1457	0.0000	0.3139	0.0000	0.2447
Tl	0.0000	1.1035	0.0000	2.3783	0.0000	1.8539
U	0.0000	0.0451	0.0000	0.0972	0.0000	0.0758
EC	0.0000	0.0043	na	na	0.0000	0.0043
Pd	na	na	na	na	na	na
Ag	na	na	na	na	na	na
Cd	na	na	na	na	na	na
In	na	na	na	na	na	na
Sn	na	na	na	na	na	na
Sb	na	na	na	na	na	na
Ba	na	na	na	na	na	na
La	na	na	na	na	na	na
Sum Fine:	63.9393	Sum Coarse:	15.1495	Sum PM10:	66.8091	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source10						

Cairo Source Signature: Lead (Pb) Smelter - sample 2						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Pb	64.3421	4.5501	11.8413	10.1018	68.7229	7.8342
Cl	6.3481	0.5428	0.6495	1.4592	6.3550	1.1009
Fe	0.8258	0.0584	0.5496	0.1718	1.2080	0.1283
Al	0.4144	1.0019	0.0000	4.9860	0.0453	3.5961
Zn	0.1760	0.0125	0.0447	0.0290	0.1981	0.0223
OC	0.1043	0.0106	na	na	0.1043	0.0106
Cu	0.0591	0.0042	0.0107	0.0093	0.0630	0.0072
Co	0.0320	0.1146	0.0273	0.2943	0.0517	0.2233
Mn	0.0290	0.0022	0.0128	0.0057	0.0371	0.0043
EC	0.0128	0.0060	na	na	0.0128	0.0060
V	0.0044	0.0011	0.0000	0.0054	0.0006	0.0039
Ti	0.0027	0.0049	0.0000	0.0108	0.0000	0.0084
Ni	0.0022	0.0003	0.0027	0.0008	0.0042	0.0006
Si	0.0000	2.2888	0.0000	9.7937	0.0000	7.1118
P	0.0000	0.6570	0.0000	2.3481	0.0000	1.7241
S	0.0000	15.2521	0.0000	49.7983	0.0000	36.8273
K	0.0000	0.2532	0.0000	0.6761	0.0000	0.5105
Ca	0.0000	0.4861	0.0000	1.2775	0.0000	0.9665
Cr	0.0000	0.0025	0.0000	0.0057	0.0000	0.0044
Ga	0.0000	0.5051	0.0000	1.0790	0.0000	0.8424
As	0.0000	7.2871	0.0000	15.5666	0.0000	12.1536
Se	0.0000	0.1981	0.0000	0.4232	0.0000	0.3304
Br	0.0000	0.3445	0.0000	0.7360	0.0000	0.5746
Rb	0.0000	0.0601	0.0000	0.1285	0.0000	0.1003
Sr	0.0000	0.0327	0.0000	0.0698	0.0000	0.0545
Y	0.0000	0.3890	0.0000	0.8310	0.0000	0.6488
Zr	0.0000	0.0316	0.0000	0.0675	0.0000	0.0527
Mo	0.0000	0.0095	0.0000	0.0202	0.0000	0.0158
Au	0.0000	0.0929	0.0000	0.1985	0.0000	0.1550
Hg	0.0000	0.1692	0.0000	0.3614	0.0000	0.2822
Tl	0.0000	1.2819	0.0000	2.7384	0.0000	2.1380
U	0.0000	0.0524	0.0000	0.1119	0.0000	0.0874
Pd	na	na	na	na	na	na
Ag	na	na	na	na	na	na
Cd	na	na	na	na	na	na
In	na	na	na	na	na	na
Sn	na	na	na	na	na	na
Sb	na	na	na	na	na	na
Ba	na	na	na	na	na	na
La	na	na	na	na	na	na
Sum Fine:	72.3529	Sum Coarse:	13.1386	Sum PM10:	76.8030	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source11						

Cairo Source Signature: Light Oil (Solaar) Combustion						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
S	8.8626	0.6301	0.0000	3.1876	6.7344	2.2976
OC	0.1434	0.0121	0.0000	0.0000	0.1434	0.0121
EC	0.0856	0.0091	0.0000	0.0000	0.0856	0.0091
Si	0.0800	0.0098	0.0000	0.0494	0.1313	0.0356
Sn	0.0415	0.0041	0.0000	0.0087	0.0205	0.0068
La	0.0289	0.0381	0.0000	0.0987	0.0153	0.0748
Ca	0.0259	0.0022	na	0.0356	0.1476	0.0252
Al	0.0171	0.0277	0.0000	0.1223	0.0654	0.0887
Fe	0.0123	0.0009	na	0.0165	0.1061	0.0117
K	0.0073	0.0011	na	0.0055	0.0179	0.0040
Pb	0.0072	0.0008	na	0.0026	0.0129	0.0019
Zn	0.0055	0.0004	0.0000	0.0029	0.0184	0.0021
Sb	0.0036	0.0080	0.0000	0.0213	0.0029	0.0161
Pd	0.0021	0.0042	0.0010	0.0111	0.0023	0.0084
Cd	0.0017	0.0047	0.0000	0.0126	0.0000	0.0095
Se	0.0010	0.0002	0.0000	0.0005	0.0018	0.0004
Ag	0.0007	0.0047	na	0.0123	0.0022	0.0093
Cu	0.0003	0.0004	0.0000	0.0009	0.0013	0.0007
Br	0.0003	0.0005	na	0.0010	0.0019	0.0008
Tl	0.0002	0.0011	0.0000	0.0031	0.0000	0.0023
Sr	0.0001	0.0005	0.0000	0.0012	0.0018	0.0009
Y	0.0001	0.0006	0.0000	0.0016	0.0001	0.0012
P	0.0000	0.0213	0.0000	0.0821	0.0000	0.0600
Cl	0.0000	0.1792	0.0000	0.5520	0.0000	0.4104
Ti	0.0000	0.0109	0.0000	0.0287	0.0000	0.0217
V	0.0000	0.0069	0.0000	0.0178	0.0000	0.0135
Cr	0.0000	0.0022	na	0.0058	0.0002	0.0044
Mn	0.0000	0.0009	na	0.0025	0.0009	0.0019
Co	0.0000	0.0005	0.0000	0.0026	0.0000	0.0019
Ni	0.0000	0.0004	0.0000	0.0011	0.0008	0.0008
Ga	0.0000	0.0008	0.0000	0.0021	0.0003	0.0016
As	0.0000	0.0016	0.0000	0.0050	0.0006	0.0037
Rb	0.0000	0.0004	0.0000	0.0012	0.0000	0.0009
Zr	0.0000	0.0007	na	0.0015	0.0010	0.0012
Mo	0.0000	0.0012	na	0.0032	0.0004	0.0024
In	0.0000	0.0057	na	0.0151	0.0025	0.0114
Ba	0.0000	0.0290	0.0000	0.0752	0.0000	0.0570
Au	0.0000	0.0013	na	0.0037	0.0006	0.0028
Hg	0.0000	0.0011	0.0000	0.0028	0.0000	0.0021
U	0.0000	0.0011	0.0000	0.0028	0.0000	0.0021
Sum Fine:	9.3274	Sum Coarse:	0.0010	Sum PM10:	7.5204	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source12						

Cairo Source Signature: Lime Kiln						
	Sorted by PM10 concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
Cl	37.0656	2.6592	na	na	11.2100	1.4377
Ca	12.5551	0.9019	2.8978	9.6859	41.7914	6.8786
K	10.0061	0.7188	na	na	2.7800	0.3702
OC	1.2717	0.1372	na	na	1.2717	0.1372
Fe	0.5686	0.0408	0.0000	0.0321	0.4575	0.0367
EC	0.1163	0.0358	na	na	0.1163	0.0358
Al	0.0836	0.1268	0.0200	0.1708	0.2870	0.1504
P	0.0779	0.0233	0.0000	0.0911	0.0105	0.0665
Rb	0.0559	0.0040	0.0000	0.0000	0.0163	0.0018
Pb	0.0542	0.0040	0.0000	0.0000	0.0098	0.0016
Zn	0.0242	0.0018	0.0000	0.0000	0.0099	0.0009
Mn	0.0206	0.0016	0.0000	0.0009	0.0146	0.0013
Sr	0.0196	0.0014	0.0052	0.0078	0.0741	0.0056
La	0.0158	0.0445	0.0014	0.0182	0.0234	0.0340
Ti	0.0140	0.0148	0.0012	0.0000	0.0205	0.0074
Cd	0.0123	0.0029	0.0000	0.0060	0.0023	0.0047
Cu	0.0110	0.0008	0.0000	0.0000	0.0056	0.0005
Br	0.0110	0.0009	0.0000	0.0000	0.0033	0.0004
Cr	0.0085	0.0012	0.0000	0.0004	0.0048	0.0009
Ba	0.0068	0.0354	0.0006	0.0114	0.0101	0.0263
In	0.0065	0.0092	0.0000	0.0000	0.0000	0.0061
Ni	0.0031	0.0003	0.0000	0.0706	0.0000	0.0499
Co	0.0024	0.0087	0.0000	0.0087	0.0000	0.0087
V	0.0023	0.0089	0.0000	0.0049	0.0023	0.0072
Pd	0.0012	0.0075	0.0000	0.0014	0.0000	0.0054
Ag	0.0011	0.0082	0.0000	0.0015	0.0000	0.0059
U	0.0010	0.0069	0.0000	0.0000	0.0008	0.0038
Zr	0.0008	0.0011	0.0002	0.0041	0.0029	0.0030
Y	0.0002	0.0026	0.0000	0.0000	0.0005	0.0015
S	0.0000	0.0650	0.0016	0.0578	0.0213	0.0615
As	0.0000	0.0087	0.0000	0.0000	0.0003	0.0042
Si	0.0000	0.0921	0.0000	0.2840	0.0000	0.2111
Ga	0.0000	0.0012	0.0000	0.0004	0.0000	0.0009
Se	0.0000	0.0007	0.0000	0.0005	0.0000	0.0006
Mo	0.0000	0.0015	0.0000	0.0013	0.0000	0.0014
Sn	0.0000	0.0108	0.0000	0.0000	0.0000	0.0073
Sb	0.0000	0.0121	0.0000	0.0000	0.0000	0.0084
Au	0.0000	0.0019	0.0000	0.0012	0.0000	0.0016
Hg	0.0000	0.0014	0.0000	0.0012	0.0000	0.0013
Tl	0.0000	0.0022	0.0000	0.0000	0.0000	0.0015
Sum Fine:	62.0174	Sum Coarse:	2.9281	Sum PM10:	58.1472	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source13						

Cairo Source Signature: Vegative/Trash Burning						
	Sorted by Fine concentration					
	Conc. %	2.5	Conc. %	2.5-10	Conc. %	PM10
Analyte	2.5	error	2.5-10	error	PM10	error
OC	7.2893	0.3710	na	na	7.2893	0.3710
Cl	0.9197	0.0657	0.0000	0.1159	0.7140	0.0942
S	0.1822	0.0132	0.0000	0.0311	0.1618	0.0239
Ca	0.0841	0.0062	0.0421	0.0440	0.2113	0.0314
K	0.0528	0.0041	0.0000	0.0071	0.0419	0.0058
Fe	0.0497	0.0036	0.0114	0.0095	0.0762	0.0072
Si	0.0406	0.0040	0.0121	0.0238	0.0721	0.0171
La	0.0235	0.0470	0.0000	0.0717	0.0049	0.0606
EC	0.0196	0.0075	na	na	0.0196	0.0075
Ba	0.0151	0.0355	0.0000	0.0545	0.0124	0.0460
Al	0.0098	0.0033	0.0056	0.0151	0.0271	0.0109
Br	0.0096	0.0007	0.0000	0.0012	0.0094	0.0010
Pb	0.0076	0.0009	0.0000	0.0024	0.0010	0.0018
Zn	0.0034	0.0003	0.0009	0.0008	0.0056	0.0006
Sn	0.0012	0.0081	0.0000	0.0121	0.0000	0.0103
Sr	0.0008	0.0002	0.0001	0.0004	0.0010	0.0003
Ni	0.0007	0.0002	0.0000	0.0007	0.0001	0.0005
In	0.0001	0.0064	0.0000	0.0098	0.0000	0.0083
P	0.0000	0.0064	0.0012	0.0169	0.0045	0.0128
Ti	0.0000	0.0134	0.0002	0.0194	0.0007	0.0167
V	0.0000	0.0084	0.0000	0.0103	0.0000	0.0094
Cr	0.0000	0.0028	0.0000	0.0030	0.0001	0.0029
Mn	0.0000	0.0012	0.0001	0.0017	0.0004	0.0015
Co	0.0000	0.0010	0.0000	0.0022	0.0000	0.0017
Cu	0.0000	0.0005	0.0000	0.0009	0.0001	0.0007
Ga	0.0000	0.0011	0.0000	0.0016	0.0000	0.0014
As	0.0000	0.0019	0.0002	0.0025	0.0006	0.0022
Se	0.0000	0.0006	0.0000	0.0010	0.0000	0.0008
Rb	0.0000	0.0007	0.0000	0.0011	0.0000	0.0009
Y	0.0000	0.0008	0.0000	0.0012	0.0000	0.0010
Zr	0.0000	0.0009	0.0000	0.0014	0.0000	0.0012
Mo	0.0000	0.0016	0.0000	0.0025	0.0000	0.0021
Pd	0.0000	0.0045	0.0007	0.0069	0.0026	0.0058
Ag	0.0000	0.0051	0.0004	0.0078	0.0013	0.0066
Cd	0.0000	0.0054	0.0000	0.0081	0.0000	0.0069
Sb	0.0000	0.0093	0.0003	0.0144	0.0011	0.0121
Au	0.0000	0.0017	0.0000	0.0026	0.0000	0.0022
Hg	0.0000	0.0014	0.0000	0.0023	0.0000	0.0019
Tl	0.0000	0.0014	0.0000	0.0021	0.0000	0.0018
U	0.0000	0.0014	0.0000	0.0023	0.0000	0.0019
Sum Fine:	8.7099	Sum Coarse:	0.0754	Sum PM10:	8.6592	
Note:	Bold analytes indicate those with either PM10/error or Fine/error ratios					
	that are greater than a factor of 2.					
File: source14						

Contact List of Key Personnel

Bowen, John L., PhD	Desert Research Institute P. O. Box 60220 Reno, NV ph. 702-677-3164	FAX 702-677-3316
Borrazzo, John E., PhD	USAID G/PHN/HN/EH SA-18, Rm 1221 Washington, DC 20523-1817 ph 703-875-4500	FAX 703-875-4686
Cary, Robert, PhD	Sunset Laboratories, Inc. 2017 19th Avenue Forest Grove, OR 97116 ph. 503-357-5151	FAX 503-357-3168
Chow, Judy, PhD	Desert Research Institute P. O. Box 60220 Reno, NV ph. 702-677-3173	FAX 702-677-3316
Ewida, Kamal Tolba, PhD	18 El Mansour Mohammed Street Zamalek Cairo, Egypt ph 011-202-340-5489	FAX 011-202-340-5489
Fernandez, David	Environmental Health Project 1611 N. Kent St., Suite 300 Arlington, VA 22209 ph. 703-247-8758	FAX: 703-243-9004
Goggin, James	USAID Cairo Mission 106 Kasr El-Aini St. Cairo, Garden City, Egypt ph. 011-202-355-7371	FAX 011-202-356-2932
Hardison, Eva, PhD	Research Triangle Institute	

P. O. Box 12194
Cornwallis Road
Research Triangle Park, NC 27709
ph 919-541-5926 FAX 919-541-8778

Kapolanu, Ramesh
Radian Corporation
900 Perimeter Park
Morrisville, NC 27560
W 919-481-0202 FAX 919-460-1631

Lanasa, Sam
Graseby-Andersen Samplers
4801 Fulton Industrial Blvd.
Atlanta, GA 30336
ph. 800-241-6898 FAX 404-319-0336

Lawless, Philip A., PhD
Research Triangle Institute
P. O. Box 12194
Cornwallis Road
Research Triangle Park, NC 27709
ph 919-541-6782 FAX 919-541-6936

Nasralla, Mahmoud M., PhD
National Research Center
Tahrir Street
Giza
Cairo, Egypt
Home: 011-202-353-7299 FAX 202-337-0931

Rodes, Charles E., PhD
Research Triangle Institute
P. O. Box 12194
Cornwallis Road
Research Triangle Park, NC 27709
ph 919-541-6749 FAX 919-541-6936

Shenoi, Nikhil
Radian Corporation
P. O. Box 201088
Austin, TX 78720-1088
W 512-454-4797 FAX 512-345-9684

Sherif, Yasser
Cabinet of Ministers
Egyptian Environmental Affairs Agency
Technical Cooperation Office for the Environment
16 Lebnan St.
Cairo, Mohandessin, Egypt
ph. 011-202-302-9102 FAX 011-202-302-9081

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Stone, Charles	University Research Glassware (URG) P. O. Box 368 Carrboro, NC 27510 ph. 919-942-2753 FAX 919-942-3522
Susan Diamond	Express Transport by Air 467 Mundet Place Hillside, NJ 07205 ph. 908-688-7888
Varley, Robert C. G.	Environmental Health Project 1611 N. Kent St., Suite 300 Arlington, VA 22209 ph. 703-247-8758 FAX: 703-243-9004

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