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Network Design and Optimum Site Exposure Criteria for Particulate Matter

by

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SECTION 1

INTRODUCTION

The primary purpose of this document is to assist in planning a network of monitoring sites for measuring particulate matter. The measurements will conform to the new PM_{10} standard, which replaces the former TSP standard.[1] As a secondary objective, this document will aid in understanding the relationship between PM_{10} measurements and the quality of air that is sampled. The information contained here will prove useful to both air quality surveillance personnel and the users of air quality monitoring data. In this document, the siting process is viewed dynamically.

Information received from monitoring sites can be used to feed back into the siting process in order to improve the site selections. The information can also be used to improve air quality simulation models or other analytical tools used in the siting process; however, the process of improving air quality models is not covered in this report.

Monitoring is undertaken to collect needed data. In planning a monitoring network, these data needs must be well defined and understood. This document provides suggestions for helping to identify what these data needs may be. The data needs may change with time as the monitoring results help characterize the local situation and as health effects research clarifies the significant characteristics of air quality exposure. These considerations apply especially to particulate matter, which is made up of highly variable components in space and time.

The major sections of this report treat the following topics:

- Characteristics of PM_{10}.
- Monitoring objectives
- Elements of site selection
- Methodology for siting PM_{10} monitors
- Examples of siting studies.

[1] TSP refers to total suspended particulate matter, and PM_{10} refers to particulate matter that includes particles in the nominal size range of 10 μm and smaller aerodynamic diameter.

The principal steps in the siting methodology described in Section 5 include the following:

1. Determine needs for monitoring data
2. Assemble and analyze available particulate matter data
3. Model levels of PM_{10}
4. Determine PM_{10} monitoring network requirements
5. Select location and placement of PM_{10} monitors
6. Document and review site selection.

The appendixes include descriptions of sources of data that may be useful in the site selection process.

SECTION 2

CHARACTERISTICS OF PM_{10}

PM_{10} is the indicator for the National Ambient Air Quality Standard (NAAQS) particulate matter, which replaces total suspended particulate matter (TSP). "PM_{10}" means particulate matter with an aerodynamic diameter less than or equal to a nominal 10 μm, as measured by the reference method described in Appendix J, 40 CFR 50, and in accordance with 40 CFR 53, or as measured by an equivalent method designated in accordance with 40 CFR 53. In siting monitors for measuring PM_{10}, it is desirable to understand the general principles that govern the generation, transformation, and removal of particulate matter; the basic workings of available instrumentation; and the significant factors that control the spatial and temporal patterns of PM_{10}.

GENERAL PRINCIPLES

Particulate matter as an air pollutant includes a broad class of airborne liquid or solid substances that vary greatly in chemical and physical properties. One important characteristic is size, because larger particles are not collected in the human respiratory tract and are therefore not a health hazard. Because of irregularities in shape, density, composition, and structure of atmospheric aerosols, individual particles are conveniently characterized by their aerodynamic equivalent diameters (AED). Particles with the same fall velocity are defined as having the same AED, which for convenience is specified as the diameter of a uniform sphere with unit density that obtains the fall velocity (e.g., see Corn 1976).

Throughout this document, most references to particle size refer to AED. When the effects of particles on visibility and light scattering are considered, the use of a different definition of particle size more closely related to actual physical size may be necessary. The primary health hazards from particulate matter are due to its depositon in the human respiratory tract. The impact of particle size and chemical composition on the deposition process is discussed in the EPA staff review of the NAAQS for particulate matter (EPA 1981a).

The atmospheric aerosols that make up PM_{10} measurements will vary both in size distribution and in chemical composition. Generally, three distinct size modes are present, although the smallest size mode is often difficult to detect. This is shown by the data in Figure 1, which were collected in the California ACHEX study (Whitby 1980). The smallest size mode (<0.1 μm) is short-lived and most often observed as a distinct class near combustion sources. The small nuclei (Aitken) mode particles grow rapidly by coagulation into the next largest size mode. The middle size (accumulation) mode particles (0.1-2.5 μm) are formed mainly by coagulation of and vapor condensation on the nuclei mode particles.

The largest coarse size mode particles (>2.5 μm) generally make up most of the mass and include particles formed by anthropogenic processes and reentrained surface dust. The two smaller size modes make up what is generally referred to as fine particulate, and the largest size mode is coarse particulate.

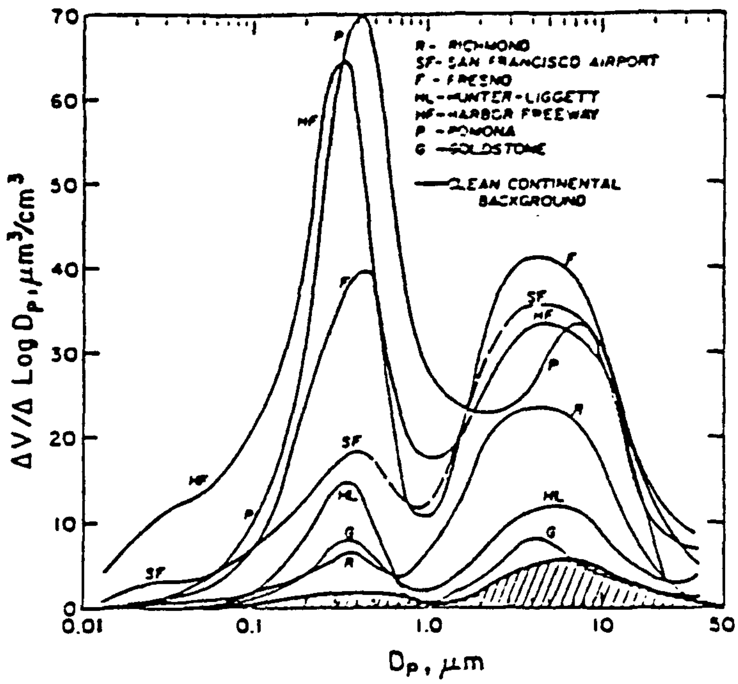


Figure 1. Average volume size distribution for seven sites in the California ACHEX study in 1972 (Whitby 1980).

These two classes, fine and coarse particulates, have different sources and behave independently in the atmosphere. Fine particles mainly result from combustion processes, including the condensation and atmospheric transformation of exhaust gases to form PM. Mechanical processes and wind erosion produce coarse particles. Figure 2 summarizes the principal differences in size and composition of the two types of particles. Fine particles typically consist of sulfates, nitrates, carbonaceous organics, ammonium, and lead. Coarse particles typically consist of oxides of silicon, iron, aluminum, sea salt, tire particles, and plant particles.

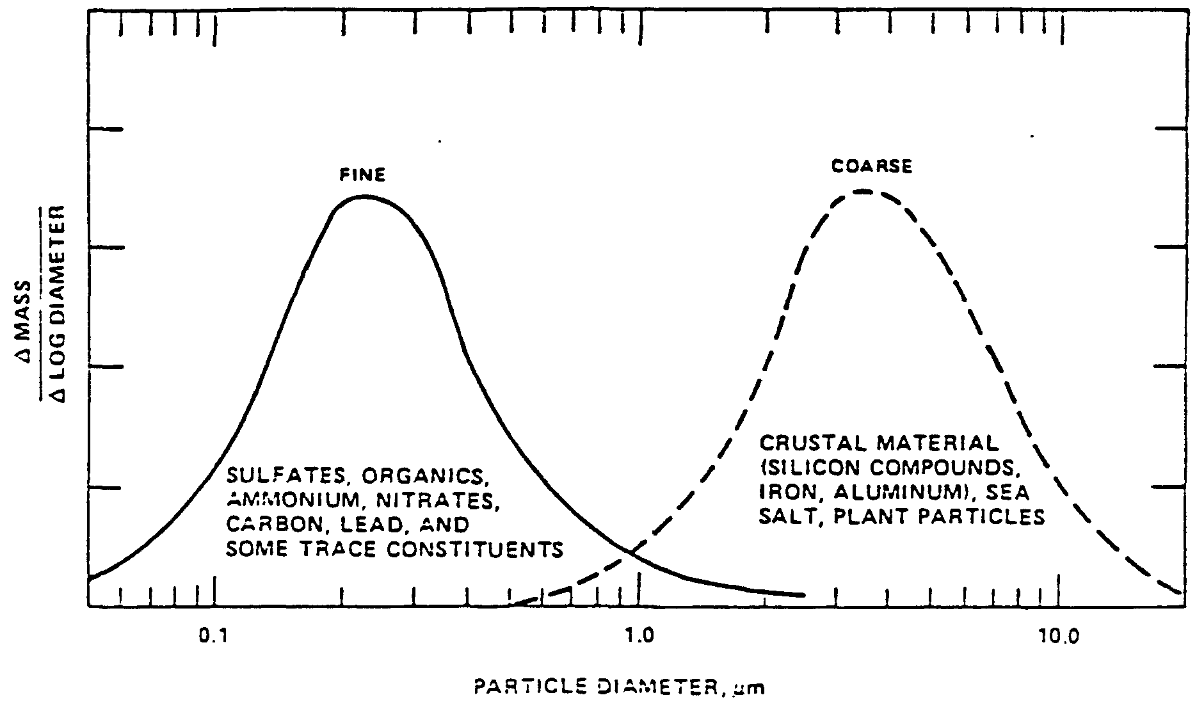


Figure 2. Idealized time and coarse particle mass and chemical composition (U.S. Environmental Protection Agency 1981b).

Both manmade and natural sources emit atmospheric PM. Natural sources in the United States emit about 84 million metric tons annually, while manmade sources emit 125 to 383 million metric tons annually. Dust, sea spray, wild fires, biogenic emanations, and volcanoes are the principal natural sources. Most of the manmade emissions are fugitives from roads (unpaved and paved), construction activities, agricultural tilling, mining activities, and industrial processes. The emissions are estimated using approximations. Reliable estimates of particle emissions from the combustion of fuel and well-defined sources are also available (see Table 1), but these are estimated to include only about 10 percent of the total manmade emissions. However, almost all of these manmade emissions are fine particles, while the natural and fugitive emissions are coarse particles, of which 50 percent or less are smaller than 10 µm. Most of the sources of coarse particles exist in rural areas where population densities are low.

TABLE 1. NATIONAL ESTIMATES OF PARTICULATE EMISSIONS (10^6 metric tons per year) (EPA 1981b)

Source category	1940	1950	1960	1970	1975	1978
Stationary fuel combustion	8.7	8.1	6.7	7.2	5.1	3.8
Industrial processes	9.9	12.6	14.1	12.8	7.4	6.2
Solid waste disposal	0.5	0.7	0.9	1.1	0.5	0.5
Transportation	0.5	1.1	0.6	1.1	1.0	1.3
Miscellaneous	5.2	3.7	3.3	1.0	0.6	0.7
TOTAL	24.8	26.2	25.6	23.2	14.6	12.5

The height of release of emissions can have an important bearing on human health. For example, emissions from motor vehicles and home heating in densely populated areas may be as important as emissions from large stationary sources in remote areas. Both types of sources must be taken into account in assessing monitoring sites.

INSTRUMENTATION

Until a sufficient data base is developed for PM_{10} measurements, most of the information that is available to indicate the nature of particulate matter concentrations will be based on TSP measurements made with high-volume (hi-vol) monitors. Therefore, it is important to understand what hi-vols measure and how this differs from what PM_{10} monitors measure. In addition, the advantages and limitations of instruments that use optical reflectance and beta attenuation need to be understood.

Hi-Vol TSP Monitors

The hi-vol sampler collects particles on a glass-fiber filter. Air is drawn through the filter at a relatively high flow rate (approximately 1.5 m^3/min). Although the collection efficiency for larger (>10 μm) particles is sensitive to wind speed, hi-vols collect essentially all particles less than 25 μm under most conditions. The AED of particles with a 50 percent collection efficiency varies from 25 to 30 μm. However, day-to-day variations in wind speed account for no more than a 10 percent variability in measured concentrations (EPA 1981b). Under identical meteorological conditions, a typical coefficient of variation is 3 to 5 percent. A more significant problem is the formation of artifact mass caused by the reaction of acid gases with material collected on the glass-fiber filter during a 24-hour sample collection. An estimated 6 to 7 $\mu g/m^3$ can be added to a 24-hour concentration measurement by artifacts. Errors may also occur due to loss of volatile particles, deposition on filters before and after sampling, gas reactions after sampling, and filter handling.

Potential Reference Method for PM_{10}

The reference method for PM_{10} is designed to measure that portion of suspended particulate matter in the atmosphere that is likely to be deposited in the thoracic region of the human respiratory tract. The PM_{10} reference method has a collection efficiency of 50 percent for particles with 10 μm AED (i.e., D_{50} = 10 μm).[1] The measurement consists of drawing air at a constant rate through a specially shaped inlet that inertially separates particles larger than 10 μm from the sampling stream. The effectiveness of the size discrimination for the 10 μm separation must match the prescribed limits defined by the reference method, or not differ by more than 10 percent in the expected mass concentration measured by a sampler with the ideal size cut efficiencies. The particles contained in each sampling stream are collected on a filter that is weighed (after moisture equilibration) before and after sampling. As with hi-vol sampling, the volume of air sampled is also measured and corrected to EPA reference conditions (i.e., 25° C and 760 mm Hg).

Although the median particle size collection efficiency is the principal characteristic of a PM_{10} reference method sampler, a sampler must also meet the following criteria to be a reference method:

- The particle size above which the collection efficiency is less than 50 percent must be within 1 μm of 10 μm.
- The concentration measurements must be reproducible with 15 percent precision.
- The flow rate must be stable to within 10 percent of the initial flow rate over a 24-hour period.

The specific requirements of a PM_{10} reference method are given in Appendix J of 40 CFR 50.

[1] The particle size cut, D_{50}, of a PM sampler is defined as the particle diameter at which the collection efficiency is less than 50 percent for all larger particles.

PM_{10} samplers are subject to errors due to loss of volatile particles, artifact PM, nonsampled PM deposition, humidity, filter handling, flow rate variations, and air volume determinations. However, the uncertainties associated with gravimetric measures of particulate matter are less than those associated with particulate measurements based on other principles.

Other Particulate Matter Measurements

The gravimetric method of measuring PM is limited by the need to (1) accumulate an adequate mass for detection by use of an analytical balance, (2) condition the filter for moisture content, (3) separate the collection time from the mass assessment time, and (4) handle the sample between collection and assessment. To eliminate these disadvantages, optical sensing and beta attenuation measurement principles can be used. However, measurements based on these principles do not measure mass directly and may produce variable concentration estimates when certain properties of the particles vary (e.g., particle size distribution or carbon content).

A commonly used instrument based on optical sensing is the tape sampler. Particles are collected to form a stain on a paper tape filter, which is periodically advanced. The transmittance of light through the stain is measured to determine the optical density or coefficient of haze (COHS). The COHS units at a given site may be calibrated to mass measurements made with a colocated gravimetric device. The tape sample is capable of finer time resolution and faster readout time than gravimetric sensing methods. For certain purposes, including response to severe pollution buildups that require a rapid update of information, optical sensing may be a necessary alternative to gravimetric sensing.

It is also possible to measure specific properties of collected samples. Such properties may include sulfate and nitrate components, visibility reduction, and specific elemental components. The need for information other than mass concentration of PM should be defined when monitoring operations are planned and factored into siting considerations. Samples taken for mass concentration measurements usually can be used for other purposes, because the mass measurement techniques preserve the samples.

USE OF AVAILABLE DATA TO DRAW INFERENCES ABOUT PM_{10} LEVELS

Because of the abundance of TSP data and the limited quantity of PM_{10} data available, it may be necessary to use TSP or other available measures of PM to determine expected patterns of PM_{10}. EPA has published a document examining relations of PM_{10} to other particulate matter (Procedure for Estimating Probability of Nonattainment of PM_{10} NAAQS Using TSP or PM_{10} Data). The details of this procedure are beyond the scope of this document; however, a few conclusions from this report are provided.

The ratio of PM_{10}/TSP was examined at sites consisting of collocated PM_{10}/TSP sites operating in 1982 and 1983 for the purpose of establishing a simple ratio which would permit the direct adjustment of TSP to PM_{10}. However, upon scrutinizi the data base, it was clear that a substantial degree of variability existed amongst individual ratios. (The IP/TSP ratios were also examined, only to establish that they confirmed the PM_{10}/TSP analyses.) This variability includes inter- as well as intrasite differences in the ratios. As described elsewhere in the document, the PM_{10}/TSP ratio was also found to be somewhat sensitive to TSP concentrations. This sensitivity is diminished by focusing on site-days observing TSP $\geq$ 100 ug/m^3 or, in the case of annual analyses, site-years with TSP $\geq$ 55 ug/m^3.

Several attempts were also made to find an explanatory site descriptor which could account for the disparity in the ratios among sites (i.e., inter-site variability). In the first attempt, such site descriptors as urban versus suburban were compared; however, no statistically significant difference was found. Geographic area (East, Southwest, West Coast, etc.) and site type (industrial, commercial or residential) likewise revealed insignificant differences in the ratios. In a more recent and more extensive investigation of geographic differences performed on the entire 1982 and 1983 data base, statistically significant differences were found among individual sites as well as among larger groupings of sites. However, the differences among larger groupings of sites are smaller and are difficult to explain on a physical basis. These investigations conclude that unless sufficient data to calculate a site specific PM_{10}/TSP ratio are available, the existing data base does not justify use of different distributions of ratios for different parts of the country.

The previously described investigations of geographic, climatological, concentration range, or site type classifiers were attempts to reduce or account for part of the variability in PM_{10} to TSP ratios. No doubt, a part of the overall variance in ratios results from intra-site variation in ratios arising from differences in the sources impacting the monitor site. As discussed in other sections of the document, there are several issues associated with the precision of the TSP and PM_{10} measurements which affect intra-site variance. These factors include windspeed dependence, weighing problems, artifact formation and sampler wall losses. Thus, the inter-site variance can potentially be eliminated by the use of site specific data, but the intra-site variance can only be partially reduced by careful operating procedures.

The variance among PM_{10}/TSP ratios suggests the need to examine the frequency distribution of ratios rather than relying on a single value for the ratio. The cumulative frequency distribution for PM_{10}/TSP is presented in Figure 3 for site average (arithmetic mean) ratios. Figure 4 contains a similar distribution for 24-hour ratios.

SPATIAL/TEMPORAL PATTERNS

National spatial and temporal patterns of PM_{10} have been deduced from a variety of available PM observations. Sections 3 and 4 of this document contain guidelines for estimating these patterns in local areas. Important factors that influence the patterns are the sources of emissions, topography and other physiographic factors, and meteorology. Figure 5 shows an indication of the variation in concentrations that can be expected with season of the year and with rural, suburban, and urban location. These graphs are based on monitoring data from a small number of sites.

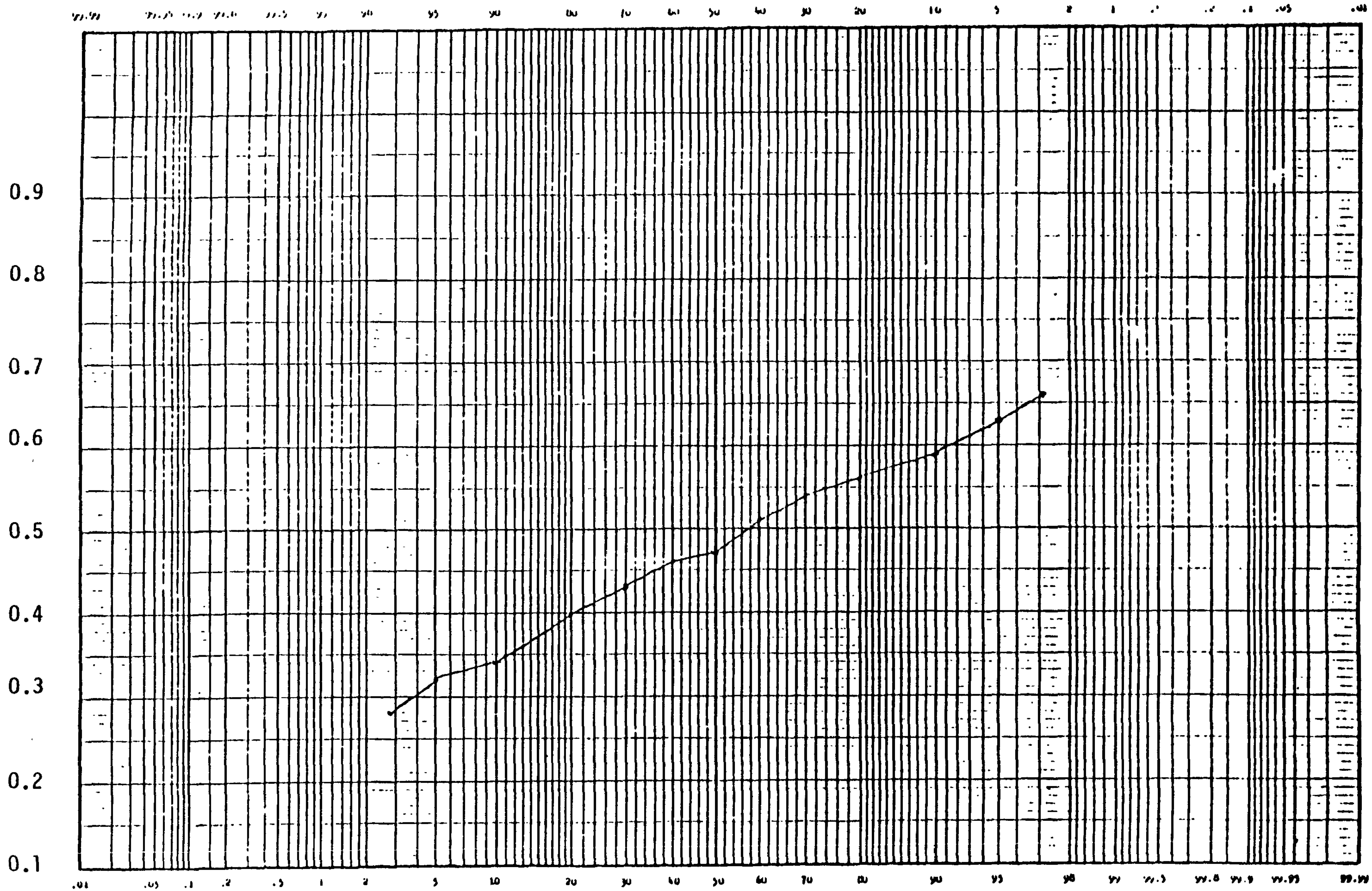


Figure 3. Distribution of Annual PM_{10}/TSP Ratios

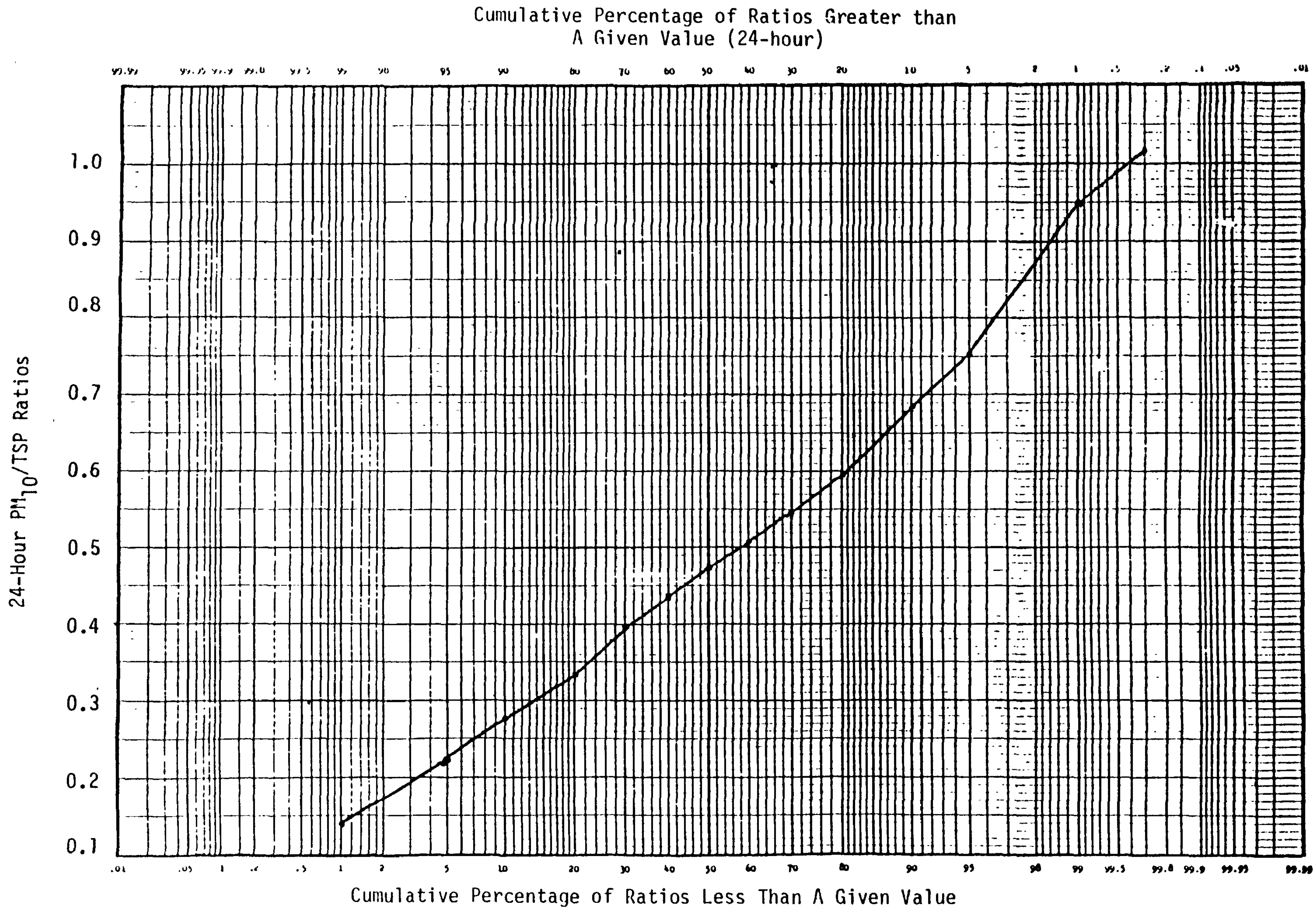


Figure 4. Distribution of 24-hour PM_{10}/TSP Ratios

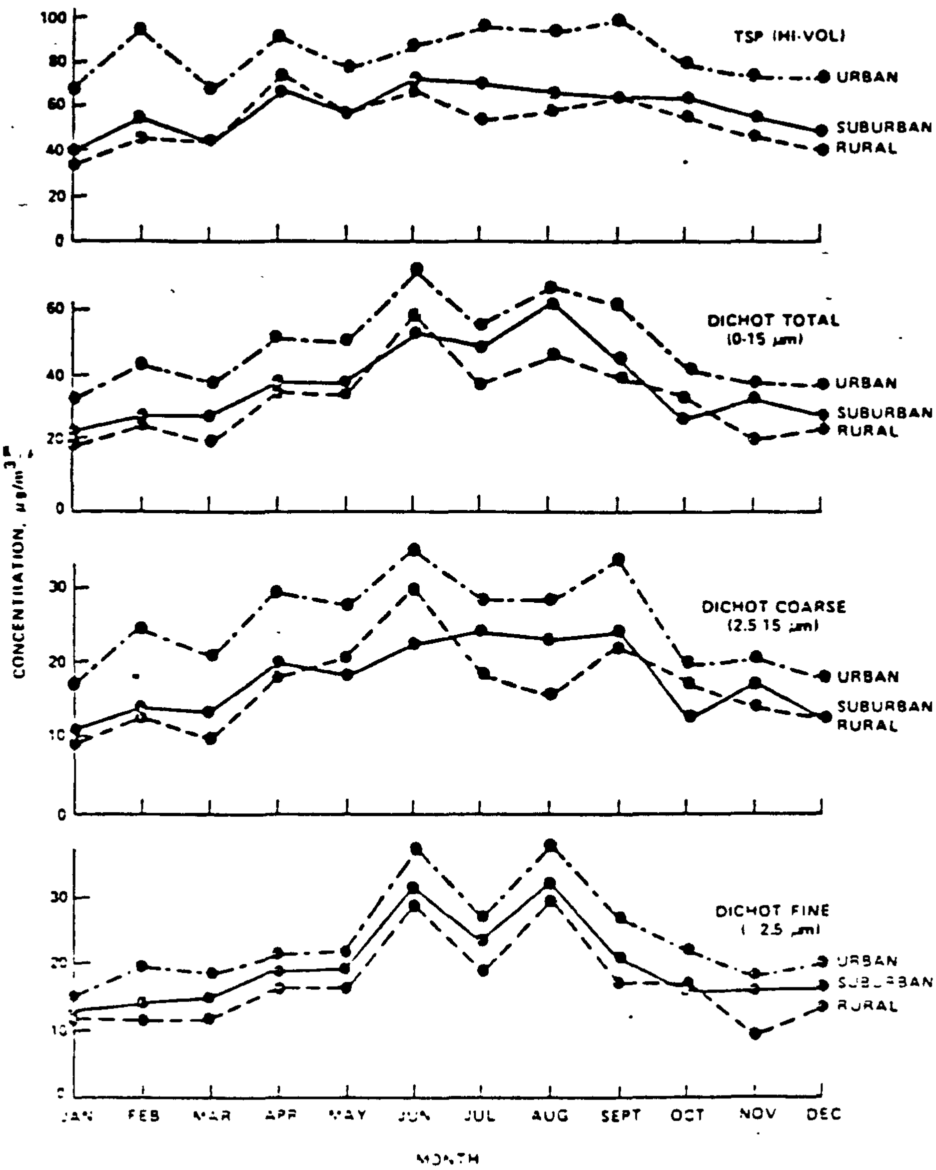


Figure 5. Seasonal variations in urban, suburban, and rural areas for four size ranges of particles.

Source: After Trijonis et al. (1980).

Influence of Sources

The highest TSP values are found in dusty arid regions and in industrialized cities. Table 2 shows a breakdown of the principal categories of sources that comprise the EPA national inventory of particulate emissions. The much larger fugitive emissions from nonindustrial anthropogenic activities, such as travel on unpaved roads and wind-eroded farmland, are not included in these figures. These indirect fugitive emissions are coarse particles, and less than 50 percent of their mass will be less than 10 um in diameter. Furthermore, the sources are widely dispersed and not concentrated near populated areas.

Most of the interest in controlling and monitoring particulate emissions focuses on the stationary sources listed in Table 2. These emissions are believed to contain more toxic elements and to consist primarily of fine particles. Fugitive dust emissions from stationary sources are of particular concern, because they exceed stack emissions, are emitted near ground level, and contain more toxic materials than soils from farmlands and unpaved roads away from industrial sources.

Influence of Atmospheric Processes

PM emitted into the atmosphere is transported by the wind and diluted by various atmospheric turbulence and mixing processes. In addition, particles are removed by dry and wet deposition processes. Particles remaining airborne may grow by condensation, coagulation, and chemical reactions; these growth processes are enhanced by the accumulation of moisture. Figure 6 summarizes and graphically illustrates many of these various atmospheric processes.

Secondary pollutants, which form and grow due to these atmospheric processes, are a major component of PM concentrations. Sulfates, formed primarily by atmospheric reactions, often account for 40 percent of the fine particles. Because fine particles typically contribute about one-third of TSP mass and because PM_{10} is expected to equal about 50 percent of the TSP levels, it is reasonable to expect the sulfate contribution to equal about 25 percent of PM_{10} measurements. But on many occasions the total contribution of secondary PM to PM_{10} measurements may be considerably higher than 25 percent. Because the formation of secondary PM requires time, the principal sources are likely to be remote from the point where they are measured. This makes it important to measure PM_{10} concentrations upwind of urban areas, as well as within and downwind of the areas of concern. The formation of sulfates and nitrates is sufficiently active in both summer and winter to produce high contributions to PM_{10} measurements. The formation of organic aerosols is also important; observed 24-hour concentrations have reached as high as 100 $\mu g/m^3$.

TABLE 2. SUMARY OF NATIONAL 1985 PARTICULATE MATTER EMISSIONS BY SOURCE CATEGORY (EPA 1987)

Source Category	1985 Emissions (10^3 tons)
Coal-fired electric utility boilers	627
Coal-fired industrial boilers	132
Integrated iron and steel plants and coke ovens*	187
Portland cement plants	286
Primary nonferrous smelters#	44
Solid waste disposal plants	110
Kraft Pulp and paper mills	110
Asphalt batching plants	132
Concrete lime and gypsum	99
Iron and steel foundries	44
Subtotal for selected source categories	1771
Stationary sources§	6600
Mobile sources	1430
All sources	8030

* Includes emissions from materials handling and storage piles.

Includes fugitive process emissions and emissions from ore crushing and materials handling.

§ By difference between all sources and mobile sources.

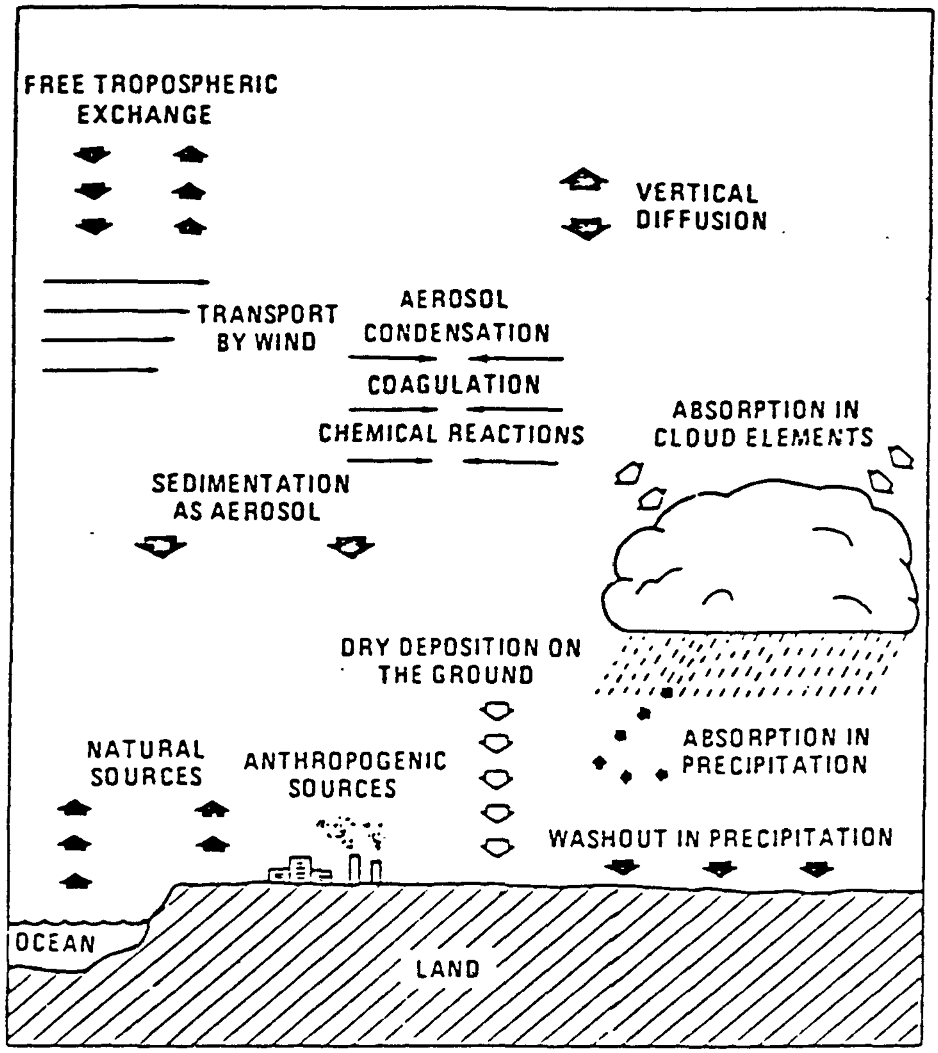


Figure 6. Complex processes affecting transport and transformation of airborne particulate matter.

Source: Adapted from Drake and Barrager (1979).

SECTION 3

MONITORING OBJECTIVES FOR PM_{10}

Two pressing questions arise in planning a monitoring program. How many monitors are required? And where should they be located? The answers affect the allocation of resources that, particularly in operational settings, ultimately shape the final program.

Due to a wide diversity of topography, population distribution, source locations, and climates, ambient air quality monitoring regulations and policies rarely specify the number and location of monitors. But regardless of the influence of physical factors, the specifications for a monitoring network strongly depend upon the monitoring objectives.

A monitoring objective relates the monitoring mandate to spatial/temporal variations in sources of pollution, meteorology, and receptors of pollution. The monitoring mandate arises from specific needs and uses for data. A monitoring objective is the link between the goals of the mandate and appropriate siting opportunities in the monitoring scene. Monitoring objectives relate program objectives that concentrate upon end uses for the collected data and physical objectives that concentrate on the temporal and spatial character of representative sampling.

One obvious use of PM_{10} data lies in establishing environmental regulations and policies. Such regulatory mandates are rooted in the Clean Air Act (CAA) and other Federal, state, and local regulations that specify air quality requirements.

Other data uses satisfy research needs and support public services. A variety of data uses for the criteria pollutants have been summarized in other EPA monitoring guidelines (Ball and Anderson 1977; Ludwig and Kealoha 1975; Ludwig, Kealoha, and Shelar 1977; Ludwig and Shelar 1978) and elsewhere (e.g., EPA 1977a). Table 3 summarizes these varied data uses:

- Evaluation of ambient air quality
- Enforcement of source-specific regulations
- Evaluation/development of control plans
- Air quality maintenance planning
- Protection of public health
- Development and testing of models
- Research.

TABLE 3. PRINCIPAL DATA USES FOR PM_{10}

1. Evaluation of Ambient Air Quality

   - Judging Attainment of NAAQS
   - Establishing Progress in Achieving/Maintaining NAAQS
   - Establishing Long-Term Trends

2. Enforcement of Source-Specific Regulations

   - Categorical Sources (ESECA, SCS, PSD)
   - Individual Sources
   - Enforcement Actions

3. Evaluation/Development of Control Plans

   - SIP Provisions
   - Evaluation/Development/Revision of Local Control Strategies

4. Air Quality Maintenance Planning

   - Establishing Baseline Conditions
   - Project Future Air Quality

5. Protection of Public Health

   - Air Quality Indices
   - Documentation of Population Exposures
   - Response to Unique Citizen Complaints
   - Development/Revision of Standards

6. Development and Testing of Models

   - Input for Receptor Models
   - Validation and Refinement
   - Assessing Representativeness of Monitoring Networks

7. Research

   - Effects on Humans, Plants, Animals and Environment
   - Characterization of Source, Transport, Transformation, and Fate for Anthropogenic and Natural Emissions
   - Development/Testing of New Instrumentation

The order of the listed uses does not represent any sense of priority. The uses are a composite of diverse program objectives that would require extended discussion to develop in detail.

In all areas except research, a straightforward relationship exists between mandate and program objectives or data uses. Thus these representative data uses provide a range of example situations, so that physical objectives for specific cases not covered here can be developed by analogy.

EVALUATION OF AMBIENT AIR QUALITY

The National Ambient Air Quality Standard for PM_{10} stipulates acceptable air quality in terms of a 24-hour criteria level (not to be exceeded more than the specified number of times a year) and an annual criteria level (the 12-month arithmetic mean). Although the NAAQS is the principal standard that must be met, other local and state agencies may set standards that must be met.

Compliance with the NAAQS is a fundamental goal of ambient air quality control strategies (particularly for State Implementation Plans (SIPs)) and forms the basis for air quality maintenance planning, policy development, and additional regulation. Data are needed to evaluate ambient air quality and detect compliance with the NAAQS. Attainment status is conferred upon an area, based on the expectation that the NAAQS criteria levels are not violated. Therefore, the monitoring objectives are geared to acquiring measurements that represent conditions throughout the area in question, the underlying context being that air quality levels elsewhere in the area are no worse than those indicated by the measurements.

The data are also used to demonstrate reasonable progress toward attainment for areas in violation of the NAAQS, document baseline conditions for environmentally sound expansion and development, and depict long-term trends.

ENFORCEMENT OF SOURCE-SPECIFIC REGULATIONS

Under some circumstances, major air pollution sources are allowed to operate under demonstration that their emissions do not cause ground-level concentrations that exceed a specified criteria level. The criteria level is ordinarily tied to NAAQS, but may be tied to other criteria. These situations may prevail for power plants, coking facilities, and other categorical sources under a variety of regulations. Source-specific regulations may consist of tailored or negotiated agreements that are integrated to implementation plans on a source-by-source basis. Although the responsibility to monitor may fall upon a regulatory agency or upon the source management, the objective is to measure the impact of a known source.

Indications of compliance/noncompliance are often used in enforcement proceedings and frequently form the basis for litigation and negotiation. A corollary monitoring situation entails isolating an offending source or family of sources when an adverse impact is measured.

Many applications require a long-term, continuing monitoring program. However, in some enforcement situations, a relatively short sampling program or a periodic survey approach is applicable.

EVALUATION/DEVELOPMENT OF CONTROL PLANS

Government monitoring agencies and pollution source operators are actively concerned with gaining/retaining NAAQS attainment status. Procedures for pursuing this goal are stated in the SIP, which is expanded and modified as needed.

Monitoring data are needed for the following purposes:

- Define nonattainment areas
- Develop control policies and strategies
- Define nondeterioration areas
- Develop air pollution emergency episode plans.

The monitoring data are used to demonstrate and characterize the need for controls. The demonstration may identify categorical sources or specific sources. Nondeterioration areas and areas subject to growth or economic rejuvenation require monitoring to define the baseline conditions.

Monitoring data are needed in areas subject to extremely high concentrations to identify the onset and abatement of episodes. A separate guidance document on the timely reporting of PM_{10} concentrations during emergency episodes is available (EPA 1983).

AIR QUALITY MAINTENANCE PLANNING

Planning agencies and developers from the private sector require monitoring data to determine baseline air quality levels in locations of projected growth and expansion. These data may be critical in determining whether such activity will meet Prevention of Significant Deterioration (PSD) requirements in attainment areas or interfere with progress toward attainment of NAAQS in nonattainment areas. Siting considerations need to consider whether special sites are needed to meet these data needs or whether the nearest available monitoring will be adequate.

PROTECTION OF PUBLIC HEALTH

It can be argued that all air quality monitoring is ultimately oriented to public health. Air quality indices keep the public appraised of current levels of air pollutants. The siting requirements to meet the data use need to be coordinated with needs for emergency episode data and for ambient air quality evaluations. A second category of public health oriented data use involves documentation of population exposures. This may require a specially sited network designed to estimate personal exposures in connection with epidemiological studies. Special monitoring sites may also be required to respond to unique citizen complaints. These frequently involve sources and impacts that are not part of operational coverage.

DEVELOPMENT AND TESTING OF MODELS

Monitoring requirements to support model development or testing are generally unique for each project. This is particularly true for model development support where the objective is to describe and understand the ongoing processes or to develop parameter values representative of a specific terrain, meteorological condition, or source configuration. As a general rule, monitoring for model development must be intensive and flexible to provide the maximum benefit. Measurements are desired that are as tightly spaced and as frequently recorded as are compatible with economic restraints. However, the monitoring equipment should be mobile enough so that it can be moved as conditions change or as analyzed information indicates a need for information from different locations.

The primary emphasis is on demonstrating that the model being tested adequately estimates the highest concentrations. This means that monitoring data needs to be taken at locations downwind of major sources during critical meteorological conditions. The data record needs to be sufficiently long to truly characterize the data site--usually a minimum of 1 year--if the model is to demonstrate validity at the test site. Test data, preferably from a different locality, must be independent of data used to develop the model. The placement and number of monitors will depend on meteorological conditions, topography, source characteristics, and purpose of the model. Sections 4 and 5 of this report provide further suggestions with respect to these influences.

RESEARCH

Monitoring data is needed to support research allied to PM_{10} questions in order to improve the scientific tools for measurement, interpretation, and prediction. Monitoring sites selected to support research may coincide or supplement other monitoring requirements. Research needs in the following areas may be considered when selecting sites:

1. Effects on humans, plants, animals, and environment

2. Characterization of source, transport, transformation, and fate for natural and anthropogenic emissions

3. Development and testing of new instrumentation.

SECTION 4

ELEMENTS OF SITE SELECTION

The site selection procedures offered in Section 5 rely primarily on inferred and demonstrated associations among PM_{10} sources, meteorology, and a number of physical factors such as topography and land use. Important outcomes (i.e., ambient concentrations) can vary tremendously from place to place within a monitoring scene and from time to time at a given place. From a useful perspective, any area to be monitored is going to be too complex to bring all structures into focus at once. The concept of representative scale is a useful way to characterize these variations on a physical basis that can be related to comprehensible patterns.

REPRESENTATIVE SCALES

The concept of representative spatial scale is used to define a characteristic distance over which pollutant concentrations are uniform or nearly so. As a corollary, we can define homogeneous areas in which measurements performed in the relatively small air volume near a sampler (nominal horizontal extent of 1 meter) can represent conditions prevailing over some much larger area.

Representative spatial scales illustrated in Figure 7 have been previously identified (EPA 1979) and are compatible with spatial scales of source areas. We shall be concerned with the following spatial scales:

- Microscale--ambient air volumes ranging in horizontal extent from a few meters to as much as 100 m. The microscale encompasses the immediate vicinity of the monitor. In the immediate presence of PM_{10} sources, exposure may in reality be only representative of the microscale. For this reason, the microscale is the final judgmental factor in site selection (see Section 5) and requires a site visit to make this appraisal, because maps rarely portray confounding influences in sufficient detail.

- Middle scale--ambient air volumes covering areas larger than microscale but generally no more than 0.5 km in extent. In settled areas, this may amount to several city blocks. As will be shown later, this is essentially the lower limit of resolution for most models.

- Neighborhood scale--ambient air volumes whose horizontal extent is generally between 0.5 and 4 km. The neighborhood scale is aptly named. It is useful in defining extended areas of homogeneous land use.

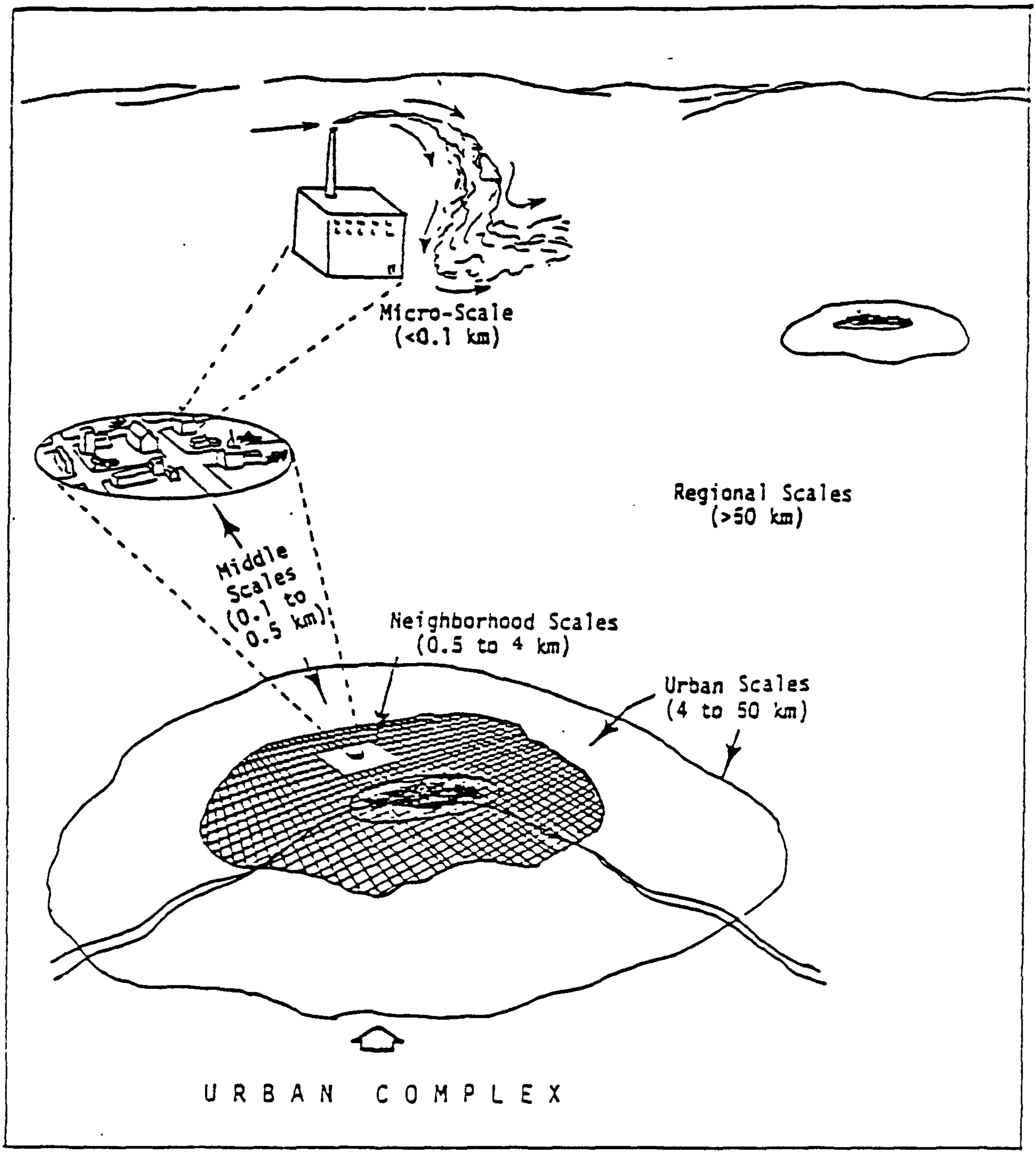


Figure 7. Illustration of various spatial scales of representativeness (Ball and Andersen 1977).

- Urban scale--ambient air volumes whose horizontal extent may range between 4 and 50 km. This is frequently the most desirable representative spatial scale, because it captures an entire urban area. However, the diversity of sources that prevail within such areas argue against homogeneity at this scale.

- Regional scale--ambient air volumes whose horizontal extent ranges from tens of kilometers to hundreds of kilometers. Monitors that are unaffected by specific sources or by localized groups of sources can be representative at this scale.

- National and global scales--seek to characterize air quality from a national perspective (thousands of kilometers) or from a global perspective (tens of thousands of kilometers).

Although all of the above scale intervals may be needed to subdivide a monitoring scene, the neighborhood scale in urban settings and the regional scale in substantially unsettled areas are particularly practical scales for spatial coverage by a single monitor. In many circumstances, the representativ ness of the small scales must be estimated by networks composed of a limited number of sites.

ANALYSIS OF THE AREA TO BE MONITORED

The primary intent of the analytical process that supports site selection is to characterize pollutant levels within the area to be monitored. This requires information regarding the location of important sources of PM_{10}, a description of atmospheric trajectories to trace the movement of PM_{10}, and estimates of dispersion accompanying such movement. These reflect a complex interplay among topography and climatology that must be cast into time frames that are compatible with the NAAQS. Three components for analysis are as follows:

- Regional dispersion climatology--to assemble the basis for transport/dispersion patterns that may be applied to the area to be monitored as a whole

- Physical differentiation--to assemble the basis for identifying distortions of simple source/receptor relationships due to local alterations of trajectory and dispersion

- Emissions configuration--to assemble the basis for identifying relevant PM_{10} sources and recognizing useful patterns.

An area of interest with respect to air quality is usually defined by political boundaries, such as state, county, city, or air quality control region lines. A method of systematically characterizing the area to be monitored into homogeneous areas of air quality levels that are potential locations of air pollution monitoring sites requires that sources of particulate emissions, patterns of terrain and physiography, and climatology be taken into account. A method and data sources for performing such a classification analysis for ambient concentrations of PM have been developed in this study beginning with a description of the three categories of influencing factors. The methodology is presented in Section 5.

Emissions Configuration

The emissions configuration is simply the spatial/temporal distribution of sources throughout the monitoring scene; in concept, it will consist of one or more maps delineating areas of similar source characteristics. Depending on the mix of sources and local/regional climate, such maps will depict relevant seasonal and diurnal emissions patterns in terms of relative intensities and release heights.

In concept, the most straightforward approach to generating maps would be to selectively allocate the elements of a formal emissions inventory to a suitably detailed grid. In practice, this is not a trivial task; even an automated approach carries a substantial burden in data management and manipulation. Though difficult, this approach has merit because it develops highly usable data for subsequent computerized modeling.

An alternative approach is to proxy these source areas by patterns of land use. In most urban areas, planning agencies have compiled information that can form the basis for categories of near-surface emission. In the absence of such information, relatively unsophisticated interpretation of aerial photographs can be helpful. Table 4 offers a land use classification that is amenable to this approach. Emission factors can be assigned to each land use classification based on consideration of local heating fuels, climate, and census data in housing and population densities. In addition, large point sources (e.g., 1000 tons per year) should be separately identified.

The first use of an emissions configuration is in a semiquantitative or subjective mode. The orientation of key impact zones can be surmised with the aid of appropriate wind roses. Areas likely to be inundated by several sources can be identified.

An emissions inventory provides important information to the site selection process by identifying significant point and area sources and cataloging emissions in terms of location, source strength, operating characteristics, etc. The National Emissions Data System (NEDS), for instance, identifies individual point sources that release 100 tons per year or more

TABLE 4. IDENTIFICATION AND CLASSIFICATION OF LAND USE TYPES (AFTER AUER 1978)

Type	Use and structures	Vegetation
I1	Heavy Industrial	
	Major chemical, steel, and fabrication industries; generally 3- to 5-story buildings, flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	Light-Moderate Industrial	
	Rail yards, truck depots, warehouses, industrial parks, minor fabrications; generally 1- to 3-story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	Commercial	
	Office and apartment buildings, hotels; >10-story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	Common Residential	
	Single-family dwelling with normal easements; generally single-story, pitched-roof structures; frequent driveways	Abundant grass lawns and light to moderately wooded; >70% vegetation
R2	Compact Residential	
	Single- and some multiple-family dwellings with close spacing; generally <2-story, pitched-roof structures; garages (via alley), no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3	Compact Residential	
	Old multifamily dwellings with close (<2 m) lateral separation; generally 2-story, flat-roof structures; garages (via alley) and ashpits; no driveways	Limited lawn sizes, old established shade trees; <35% vegetation
R4	Estate Residential	
	Expansive family dwelling on multiacre tracts	Abundant grass lawns and lightly wooded; >95% vegetation
A1	Metropolitan Natural	
	Major municipal, state, or Federal parks, golf courses, cemeteries, campuses; occasional single-story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	Agricultural Rural	Local crops (e.g., corn, soybeans); >95% vegetation
A3	Undeveloped	
	Uncultivated; wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation

of five criteria emissions (particulate matter, SO_x, NO_x, CO, hydrocarbons) as well as area sources aggregated at the county level (i.e., all other stationary sources that individually emit less than 100 tons per year and all mobile sources). More detailed approaches (e.g., Pace 1979) develop microinventories that add perspective and structure to the area source category.

It is beyond the intended scope of this report to promote methodologies for constructing emission inventories. For the purposes at hand, an emissions inventory for particulate matter emissions is assumed to be available and ready for use. Such an inventory may be composed of NEDS-based data (EPA 1984) or may have been specially constructed for the monitor siting analysis.

During the last few years EPA has had PM_{10} emission factors developed for a large number of source categories. The development of PM_{10} emission factors for additional source categories including some fugitive and open sources is still in progress at this time. The user is referred to EPA's Compilation of Air Pollution Emission Factors AP-42 for specific emissions by source category and specific methodology for their use in developing emission estimates. The compilation provides specific factors not only by general source category but also for each processing step within a category. Tables 5 and 6 present example emission factors for some selected source categories. These examples have been taken from EPA's report.

Terrain and Physiography

The patterns of ambient concentrations that occur due to the transport and diffusion of pollutants over open and flat terrain are significantly distorted by irregularities in the terrain and other features of physiography. Two major factors in this regard are as follows:

- Aerodynamic diversion--flow around and over obstacles. Distortion of the flow field may be severe during moderate to strong synoptic winds.

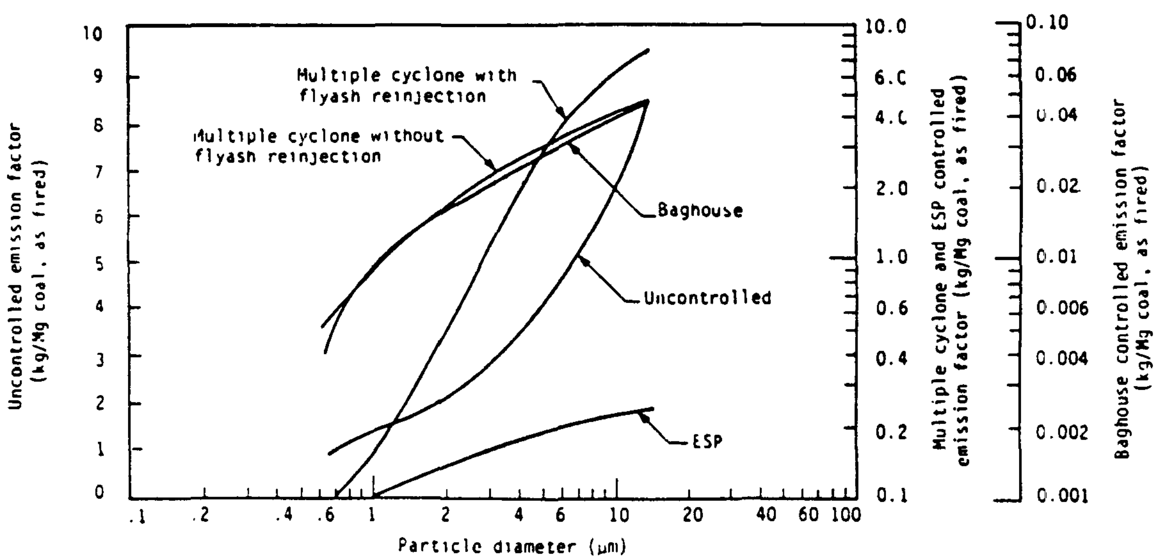
- Local circulations--mountain-valley winds, land-sea breezes, and the like that may prevail when synoptic influences are sufficiently weak. Under these conditions, flow patterns within the scene may "wall off" subareas. Transport and dispersion estimates at one place are unlikely to reflect air motions elsewhere.

TABLE 5. **CUMULATIVE PARTICLE SIZE DISTRIBUTION AND SIZE SPECIFIC EMISSION FACTORS FOR SPREADER STOKERS BURNING BITUMINOUS COAL[a]**

EMISSION FACTOR RATING: C (uncontrolled and controlled for multiple cyclone without flyash reinjection, and with baghouse)
E (multiple cyclone controlled with flyash reinjection, and ESP controlled)

Particle size[b] (µm)	Cumulative mass % ≤ stated size					Cumulative emission factor [kg/Mg (lb/ton) coal, as fired]				
	Uncontrolled	Controlled				Uncontrolled	Controlled			
		Multiple cyclone[c]	Multiple cyclone[d]	ESP	Baghouse		Multiple cyclone[c]	Multiple cyclone[d]	ESP	Baghouse
15	28	86	74	97	72	8.4 (16.8)	7.3 (14.6)	4.4 (8.8)	0.23 (0.46)	0.043 (0.086)
10	20	73	65	90	60	6.0 (12.0)	6.2 (12.4)	3.9 (7.8)	0.22 (0.44)	0.036 (0.072)
6	14	51	52	82	46	4.2 (8.4)	4.3 (8.6)	3.1 (6.2)	0.20 (0.40)	0.028 (0.056)
2.5	7	8	27	61	26	2.1 (4.2)	0.7 (1.4)	1.6 (3.2)	0.15 (0.30)	0.016 (0.032)
1.25	5	2	16	46	18	1.5 (3.0)	0.2 (0.4)	1.0 (2.0)	0.11 (0.22)	0.011 (0.022)
1.00	5	2	14	41	15	1.5 (3.0)	0.2 (0.4)	0.8 (1.6)	0.10 (0.20)	0.009 (0.018)
0.625	4	1	9	e	7	1.2 (2.4)	0.1 (0.2)	0.5 (1.0)	e	0.004 (0.008)
TOTAL	100	100	100	100	100	30.0 (60.0)	8.5 (17.0)	6.0 (12.0)	0.24 (0.48)	0.06 (0.12)

[a]Reference 61. ESP = electrostatic precipitator.
[b]Expressed as aerodynamic equivalent diameter.
[c]With flyash reinjection.
[d]Without flyash reinjection.
[e]Insufficient data.
[f]Estimated control efficiency for ESP, 99.2%; baghouse, 99.8%.



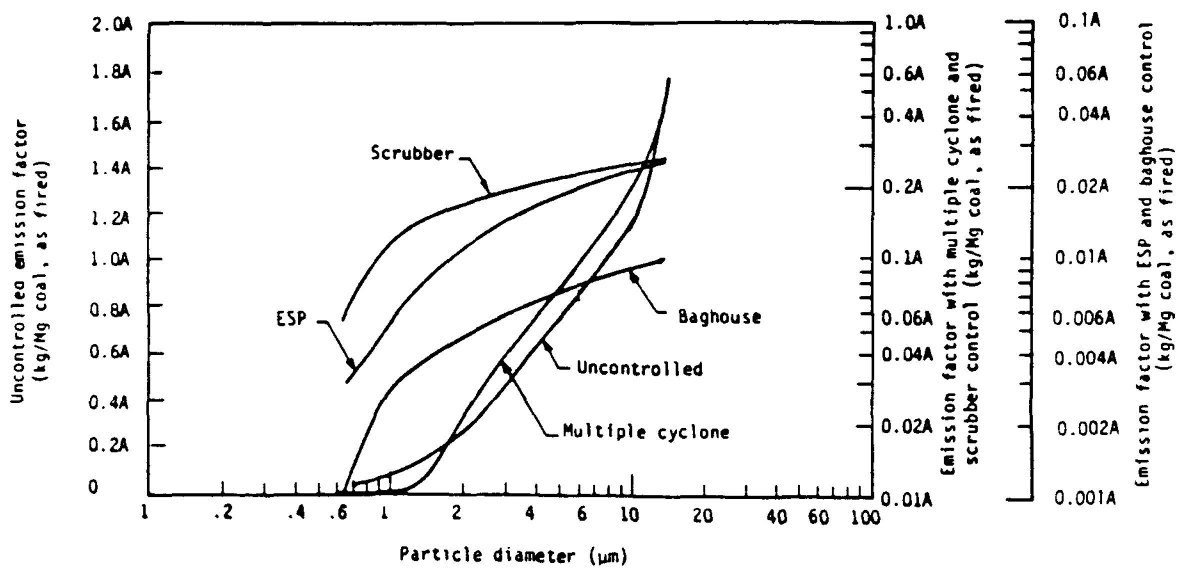
Cumulative size specific emission factors for spreader stokers burning bituminous coal

TABLE 5 (continued): CUMULATIVE PARTICLE SIZE DISTRIBUTION AND SIZE SPECIFIC EMISSION FACTORS FOR DRY BOTTOM BOILERS BURNING PULVERIZED BITUMINOUS COAL[a]

EMISSION FACTOR RATING: C (uncontrolled)
D (scrubber and ESP controlled)
E (multiple cyclone and baghouse)

Particle size[b] (μm)	Cumulative mass % ≤ stated size					Cumulative emission factor[c] [kg/Mg (lb/ton) coal, as fired]				
	Uncontrolled	Controlled				Uncontrolled	Controlled[d]			
		Multiple cyclone	Scrubber	ESP	Baghouse		Multiple cyclone	Scrubber	ESP	Baghouse
15	32	54	81	79	97	1.6A (3.2A)	0.54A (1.08A)	0.24A (0.48A)	0.032A (0.06A)	0.010A (0.02A)
10	23	29	71	67	92	1.15A (2.3A)	0.29A (0.58A)	0.21A (0.42A)	0.027A (0.05A)	0.009A (0.02A)
6	17	14	62	50	77	0.85A (1.7A)	0.14A (0.28A)	0.19A (0.38A)	0.020A (0.04A)	0.008A (0.02A)
2.5	6	3	51	29	53	0.30A (0.6A)	0.03A (0.06A)	0.15A (0.3A)	0.012A (0.02A)	0.005A (0.01A)
1.25	2	1	35	17	31	0.10A (0.2A)	0.01A (0.02A)	0.11A (0.22A)	0.007A (0.01A)	0.003A (0.006A)
1.00	2	1	31	14	25	0.10A (0.2A)	0.01A (0.02A)	0.09A (0.18A)	0.006A (0.01A)	0.003A (0.006A)
0.625	1	1	20	12	14	0.05A (0.10)	0.01A (0.02A)	0.06A (0.12A)	0.005A (0.01A)	0.001A (0.002A)
TOTAL	100	100	100	100	100	5A (10A)	1A (2A)	0.3A (0.6A)	0.04A (0.08A)	0.01A (0.02A)

[a] Reference 61. ESP = electrostatic precipitator.
[b] Expressed as aerodynamic equivalent diameter.
[c] A = coal ash weight %, as fired.
[d] Estimated control efficiency for multiple cyclone, 80%; scrubber, 94%; ESP, 99.2%; baghouse, 99.8%.



Cumulative size specific emission factors for dry bottom boilers burning pulverized bituminous coal.

TABLE 6. SIZE SPECIFIC EMISSION FACTORS FOR COKE MANUFACTURING

Process	Particulate emission factor rating	Particle size (μm)	Cumulative mass % ≤ stated size	Cumulative mass emission factors	
				kg/Mg	lb/ton
Coal preheating Uncontrolled	D	0.5	44	0.8	1.5
		1.0	48.5	0.8	1.7
		2.0	55	1.0	1.9
		2.5	59.5	1.0	2.1
		5.0	79.5	1.4	2.8
		10.0	97.5	1.7	3.4
		15.0	99.9	1.7	3.5
			100	1.7	3.5
Controlled with venturi scrubber	D	0.5	78	0.10	0.20
		1.0	80	0.10	0.20
		2.0	83	0.10	0.21
		2.5	84	0.11	0.21
		5.0	88	0.11	0.22
		10.0	94	0.12	0.24
		15.0	96.5	0.12	0.24
			100	0.12	0.25
Coal charging Sequential or stage	E	0.5	13.5	0.001	0.002
		1.0	25.2	0.002	0.004
		2.0	33.6	0.003	0.005
		2.5	39.1	0.003	0.006
		5.0	45.8	0.004	0.007
		10.0	48.9	0.004	0.008
		15.0	49.0	0.004	0.008
			100	0.008	0.016
Coke pushing Uncontrolled	D	0.5	3.1	0.02	0.04
		1.0	7.7	0.04	0.09
		2.0	14.8	0.09	0.17
		2.5	16.7	0.10	0.19
		5.0	26.6	0.15	0.30
		10.0	43.3	0.25	0.50
		15.0	50.0	0.29	0.58
			100	0.58	1.15
Controlled with Venturi scrubber	D	0.5	24	0.02	0.04
		1.0	47	0.04	0.08
		2.0	66.5	0.06	0.12
		2.5	73.5	0.07	0.13
		5.0	75	0.07	0.13
		10.0	87	0.08	0.16
		15.0	92	0.08	0.17
			100	0.09	0.18

(continued)

TABLE 6 (Continued)

Process	Particulate emission factor rating	Particle size (µm)	Cumulative mass % ≤ stated size	Cumulative mass emission factors kg/Mg	lb/ton
Mobile scrubber car	D	1.0	28.0	0.010	0.020
		2.0	29.5	0.011	0.021
		2.5	30.0	0.011	0.022
		5.0	30.0	0.011	0.022
		10.0	32.0	0.012	0.024
		15.0	35.0	0.013	0.023
			100	0.036	0.072
Quenching Uncontrolled (dirty water)	D	1.0	13.8	0.36	0.72
		2.5	19.3	0.51	1.01
		5.0	21.4	0.56	1.12
		10.0	22.8	0.60	1.19
		15.0	26.4	0.69	1.38
			100	2.62	5.24
Uncontrolled (clean water)	B	1.0	4.0	0.02	0.05
		2.5	11.1	0.06	0.13
		5.0	19.1	0.11	0.22
		10.0	30.1	0.17	0.34
		15.0	37.4	0.21	0.42
			100	0.57	1.13
With baffles (dirty water)	D	1.0	8.5	0.06	0.11
		2.5	20.4	0.13	0.27
		5.0	24.8	0.16	0.32
		10.0	32.3	0.21	0.42
		15.0	49.8	0.32	0.65
			100	0.65	1.30
With baffles (clean water)	D	1.0	1.2	0.003	0.006
		2.5	6.0	0.02	0.03
		5.0	7.0	0.02	0.04
		10.0	9.8	0.03	0.05
		15.0	15.1	0.04	0.08
			100	0.27	0.54
Combustion stack Uncontrolled	D	1.0	77.4	0.18	0.36
		2.0	85.7	0.20	0.40
		2.5	93.5	0.22	0.44
		5.0	95.8	0.22	0.45
		10.0	95.9	0.22	0.45
		15.0	96	0.22	0.45
			100	0.23	0.47

In many instances these factors are of minor influence to site selection, particularly when viewed from the perspective of the 24-hour averaging period that defines most operational PM_{10} monitoring. More often, however, these influences are severe enough to warrant attention, particularly in source-oriented applications. There are many circumstances where an area may experienc aerodynamic diversion problems under moderate to strong synoptic influences while exhibiting local circulations when synoptic conditions are weak. Because of this, discussion of these two factors is structured around the physical aspects of the monitoring scene that should alert the monitoring designer to the situation. Four primary areas for discussion have been identified: topographic influences, coastal settings, small-scale obstacles, and urban effects.

These factors are expressed in varying intensity from area to area. A detailed discussion of resulting patterns is clearly beyond the intended scope of this document. Therefore, each topical area will be treated in summary fashion, and the description will rely heavily upon illustrations.

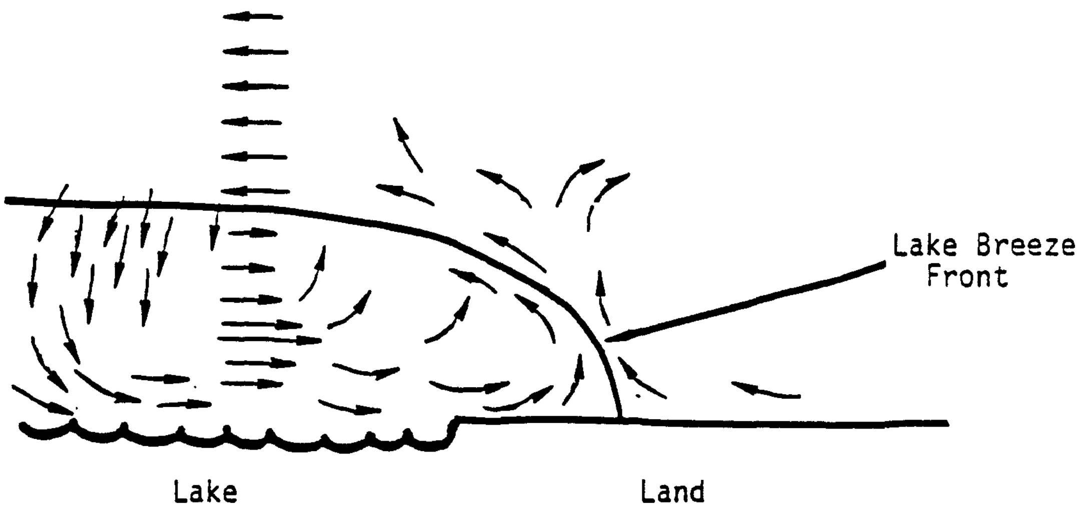
Topographic Influences--

Topographic elements become a factor when their influences extend into the neighborhood scale (horizontal size order of kilometers). Because the ratio of downstream aerodynamic effect to obstacle height is on the size order of 10 to 1, obstacles on the order of 100 m will influence horizontal sizes of the order of 1 km. The central problem that terrain introduces is the added detail impressed upon the advection/dispersion field. That is, a simple pattern that may be replicated consistently throughout a scene of level terrain becomes an inconstant three-dimensional perturbation in the presence of substantial terrain relief. The principal types of flow distortion that occur include separation flow on the downwind side of ridges when the flow is perpendicular to the ridge, channeling of air flow by valleys, and local circulations caused by differential heating of adjacent terrain slopes.

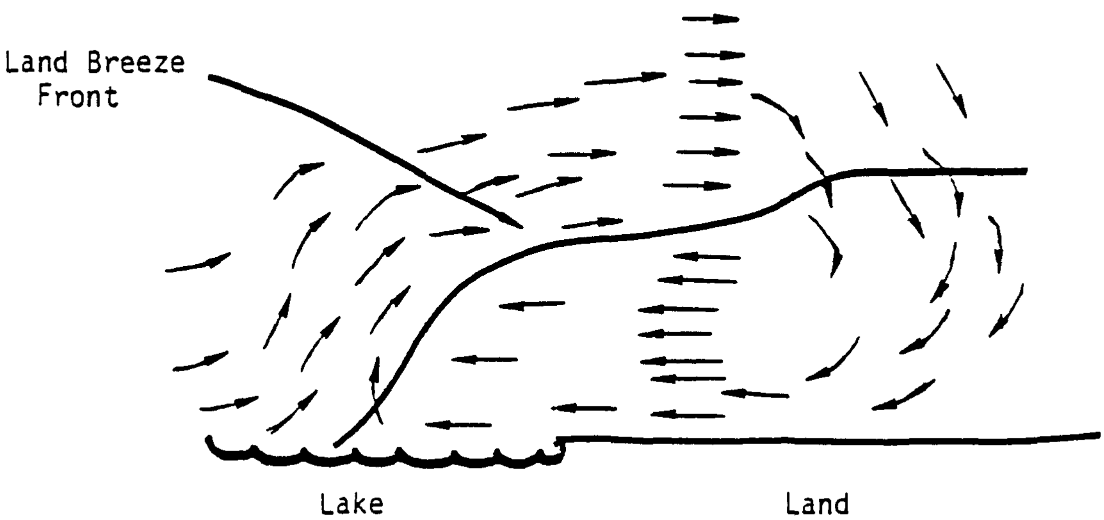
Coastal Settings--

In coastal settings, during periods of light synoptic winds accompanied by a sufficiently strong thermal contrast between water temperatures and land temperatures, a land/sea breeze circulation (or conversely, land/lake breeze) will control air motions in the vicinity of the shoreline.

Figure 8 displays the characteristic circulation patterns associated with a lake (or sea) breeze (8a) and a land breeze (8b). This circulation system is not static. As shown in Figure 9, the convergence zone migrates inland as the land surface heats up. The intensity of the sea breeze may increase through midafternoon, but dies out after sunset as the land surface rapidly cools. At night, the land breeze sets up, but is generally less vigorous because thermal contrasts are smaller.



A. Lake Breeze



B. Land Breeze

Figure 8. Characteristics of lake coast air flow.

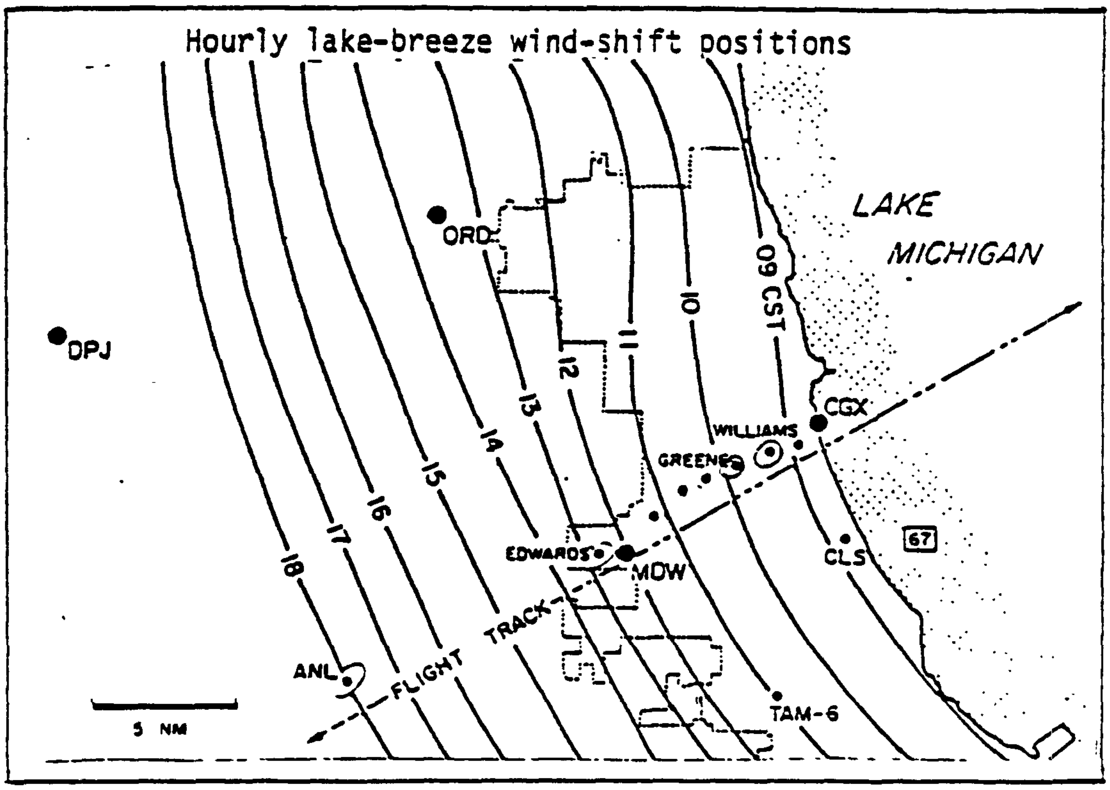


Figure 9. Hourly positions of lake breeze front of August 13, 1967, with the ground track of the NACR Queen air plotted. Hygrothermograph traces at several distances from the shoreline are included. Surface water temperature is 67° F. One full wind barb equals 5 knots. From Lyons and Olsson 1972.

The primary impact of this system is to recompose a coastal monitoring scene into at least two siting domains: one area subject to the land/sea breeze effects, another outside of this influence. The size and extent of the land/sea breeze-affected subarea can be assessed in a number of ways. An obvious factor of contrast is the horizontal distribution of wind directions on appropriate days; however, few areas have sufficiently detailed meteorologica networks to define the horizontal extent of the area and the change in size of the affected area with time. A more reasonable approach is to use air temperatu and relative humidity patterns to characterize this effect. Figure 9 displays distinctive signatures in hygrothermograph recordings and suggests a method of analysis that may be helpful.

Small Scale Obstacles--

Wind deflection around and over obstacles is a concern in selecting specific sites in an urban area, because the effects occur on the microscale. As shown in Figure 10, air does not simply slip past an isolated structure. There are three distinguishable zones of air around a building:

1. Displacement zone--where streamlines are deflected upwind and outward, remaining so for some distance

2. Wake zone--where streamlines gradually recover original configuration

3. Cavity zone--return flow in the immediate vicinity of the downwind side.

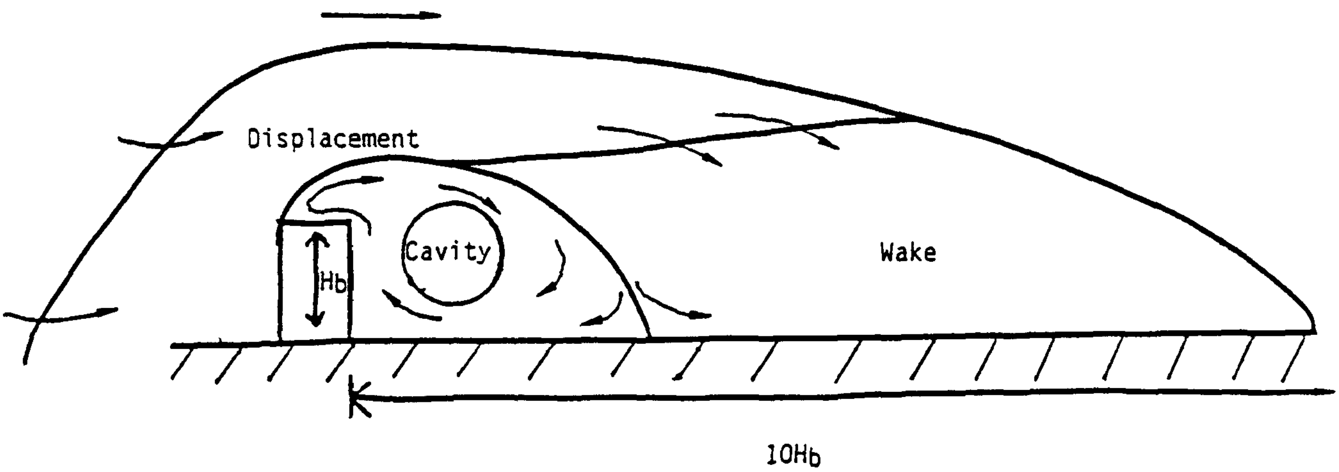


Figure 10. Flow zones around a building

In terms of site selection, this effect is of obvious importance if an intervening obstacle contains a strong enough source to generate a ground-level impact that would be assigned to a source further upstream--particularly if monitoring were to unwittingly take place in the cavity zone. This effect is further complicated when many such obstacles are placed together, as shown in Figure 11.

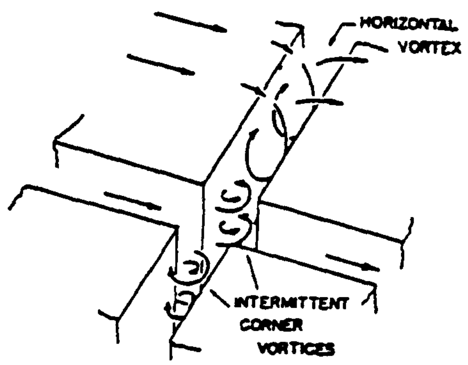


Figure 11. Flow characteristics among multiple buildings.

Urban Effects--

In addition to the effects of individual buildings, a city induces large-scale modifications to the local wind field. These modifications have a bearing on site selection, due to the heat island circulation.

When a heat island circulation exists, there is a convergence zone over the center of the city and a return flow into outlying areas, as illustrated in Figure 12. This circulation pattern is most pronounced at night when differential radiative cooling rates favor higher temperatures in the urban center. The circulation pattern is generally weaker during the day when urban/rural thermal contrasts are not as strong. Table 7 summarizes the general magnitude of key heat island circulation elements.

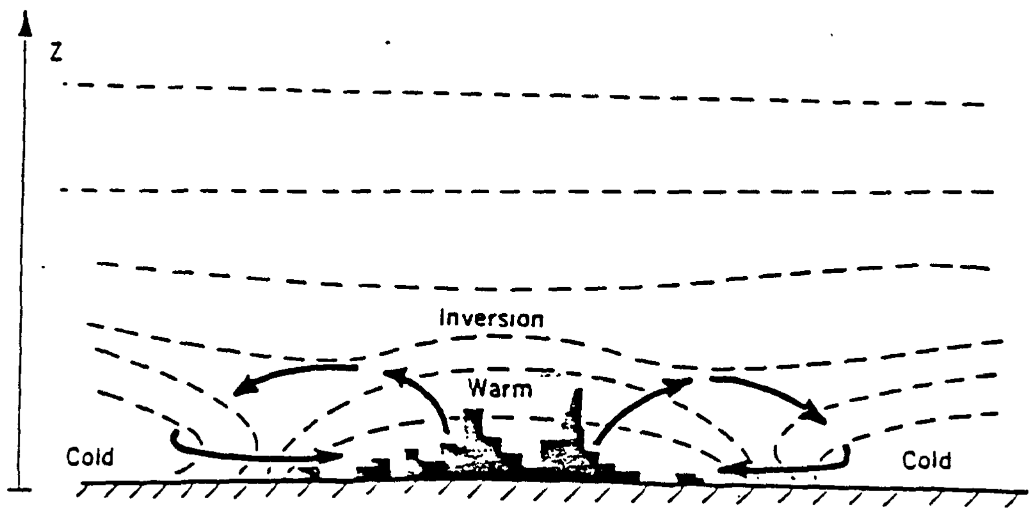


Figure 12. Idealized urban heat island air flow (After Landsberg 1975).

TABLE 7. ESTIMATES OF THE ST. LOUIS, MISSOURI, HEAT ISLAND CIRCULATION

Element	General magnitude
Urban/rural temperature difference	$\geq 2°C$
Gradient wind (900 mb)	≥ 5 m/sec
Average surface wind	2 m/sec
Average vertical velocity	0.3 m/sec
Diameter of surface inflow	30 km
Diameter of updraft	7 km
Depth of circulation	1 km

Source: Landsberg.

Under sufficiently strong winds, the heat island circulation is overwhelmed. Oke and Hannel (1970) have developed a simple relationship between the threshold wind speed to prohibit the circulation and relative city size. Oke and Hannel's empirical formulation is as follows:

$$U_{lim} = 3.4 \text{ Log}P - 11.6$$

where P is the population number. Thus, a large urban area whose population is counted in the millions can exhibit a heat island circulation even if regional winds are quite strong. Although this relationship showed a high correlation (94 percent variance explained) for the cities studied, it should not be treated as an absolute measure. Each urban setting will have its own idiosyncracies due to local terrain, presence of water bodies, or other factors.

Climatology

Regional dispersion climatology encompasses those atmospheric parameters of regional scale influence that affect the distribution of ambient concentration. The parameters of primary concern are advection, dispersion, and vertical mixing. With the exception of advection (i.e., surface winds), the instrumentation to acquire direct measures of these parameters are generally not found in most settings. Even when relevant measurements are available, the important fine structure needed to characterize significant air pollution transport is generally not observed (e.g, Hewson 1976; Holzworth 1974; and McCormick and Holzworth 1976). Nevertheless, it is important to consider what regular data are available to estimate advection, dispersion, and vertical mixing. Additional parameters needed for air quality simulations are also considered.

Advection--

For most monitoring objectives, advection is adequately defined by the near-surface wind (speed and direction) measured at (or adjusted to) a reference height of 10 meters above the ground. Useful observations may consist of short-term averages taken hourly or every 3 hours, as well as true algebraic or vectorial averages over these time intervals. Nearly continuous recordings are sometimes available.

Directional air flow is an intuitively appealing siting tool. One of the most useful summary depictions is the wind use that expresses advection in terms of relative frequency of occurrence by direction, usually with a breakdown of wind speed by classes within each directional interval. By convention, a wind direction denotes the sector from which wind is blowing. Wind roses may be compared on an 8-point basis, a 16-point basis, or a 36-point basis.

The most common summary wind roses are compared for annual, seasonal, or monthly distributions (see Figure 13). Under some circumstances, wind roses are devised to study winds under critical conditions. For example, STAR[1] summaries offer a joint frequency distribution of winds and atmospheric stability. These are available from the National Climatic Center and may be compared for various time periods. Additional categories of wind roses include winds under important pollutant index levels, distribution of persistent 24-hour winds, and distributions within key parts of the day (i.e., morning versus afternoon).

Dispersion--

Dispersion is the summary effect of atmospheric turbulence in actively diluting source material. Direct measurements of the three-dimensional wind fluctuations that manifest turbulence are rarely made. Instead, various methods of characterizing turbulence based on theoretical and empirical relationships are employed. The most common system is based upon associations among wind speed, solar insolation, and cloud cover, as shown in Table 8. Many operational models accept this type of data directly, and manual techniques have evolved to treat these as well (see Turner 1970).

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[1] STability ARray, a broad-based algorithm for determining stability in the lower atmosphere using estimates based on winds and cloudiness. See Doty, Wallace, and Holzworth 1976.

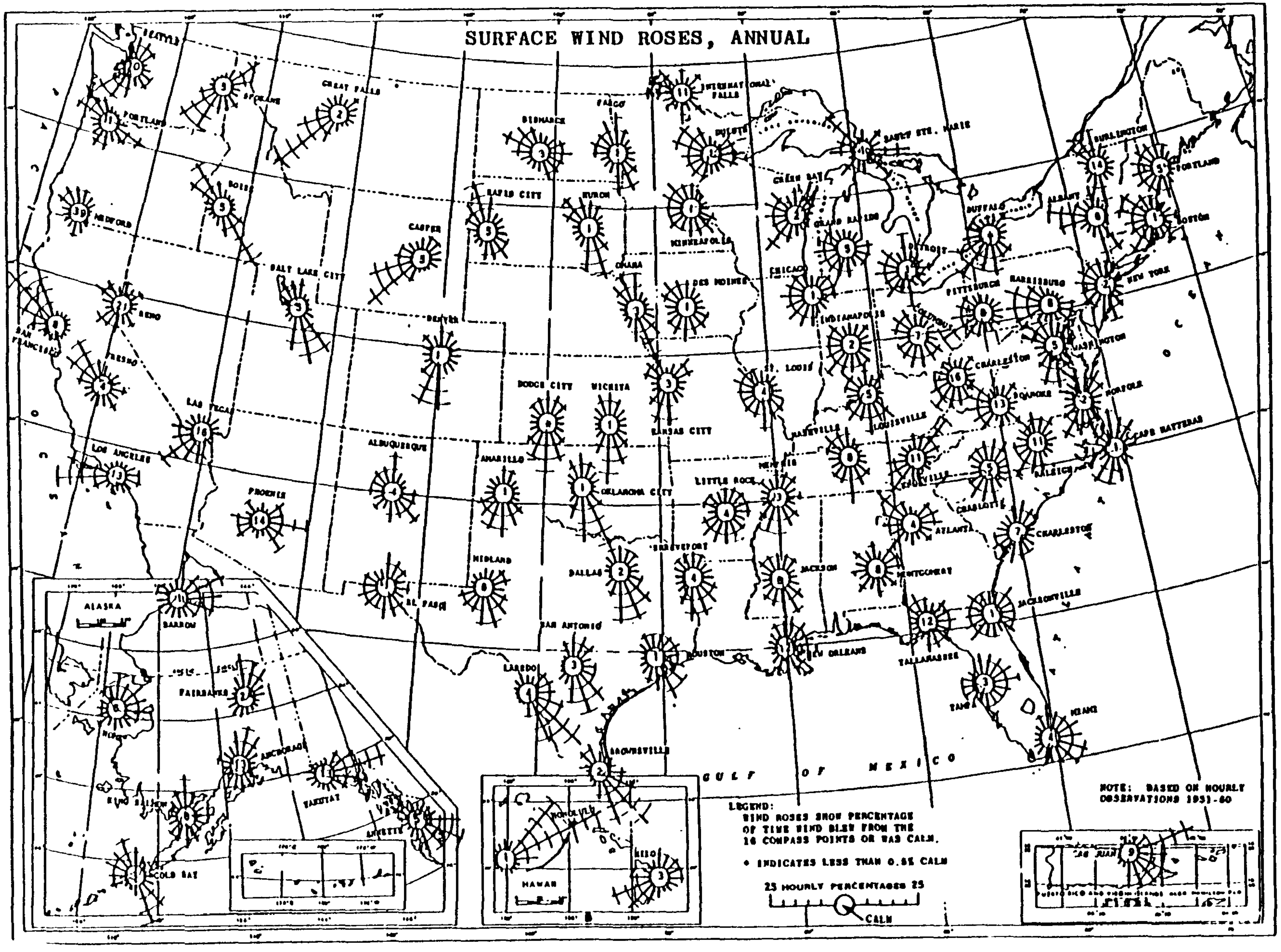

Figure 13. Annual wind roses for U.S. locations.

TABLE 8. DISPERSION CLASSIFICATIONS (PASQUILL 1961)

Surface wind speed at 10 m (m sec^{-1})	Insolation			Night	
	Strong	Moderate	Slight	Thinly overcast or $\geq 4/8$ low cloud	$\leq 3/8$ cloud
2	A	A-B	B	-	-
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
>6	C	C	D	D	D

Mixing Height--

Mixing height defines the vertical extent of mixing. Ground-based and low-level inversions are the principal limiting factors. Mixing height is determined from a thermodynamic analysis of vertical temperature soundings. These soundings are routinely performed at 0000 GMT and 1200 GMT each day at a number of stations. Contact National Climactic Center (see Appendix A) for a list. Additionally, climatological summaries are also available (see Holzworth 1972).

Other Parameters--

Additional parameters that may be useful are listed below. Routine data sources are summarized in Appendix B.

- Solar radiation--for estimates of formation rates of secondary aerosols
- Visibility--as a proxy for regional scale impacts
- Precipitation--to relate to scavenging processes
- Air temperature--to be applied to plume rise estimates, or as a fine adjustment to residential space heating demand as a proxy for some combustion sources.

TAXONOMY OF REPRESENTATIVE SITES

By classifying monitoring objectives and monitoring sites, it is possible to categorize all monitoring requirements into discrete groupings. Siting methods that are appropriate to each group or to several groups can be more easily identified. Furthermore, some groupings may be of little interest and need not receive further attention.

In the preceding section, spatial scales of areas were defined within which air quality levels are reasonably homogeneous for typical organizations of human structures and activities that characterize each scale. These definitions were very general. The physical characteristics that primarily contribute to variations in air quality include sources of emissions, types of terrain, and types of meteorological influences. Each of these characteristics and the nature of the variations that affect air quality levels have been previously discussed.

For the purpose of classifying representative siting situations with respect to PM_{10}, the following three categories of sources of emissions are of interest:

- Background or general region
- General urban or industrial area
  - Homogeneous
  - Complex
- Major source within an urban area
- Isolated source.

With respect to terrain influences the following categories of topographical features are of interest:

- Plains
- Coast
- Ridge and valley
- Irregular terrain
  - Extremely rough
  - Moderately rough
- Urban.

Although mixtures of the above terrain influences are possible, it is unrealisti to attempt to characterize such complex influences within the scope of present modeling and analysis methods. For monitoring planning purposes, it may be best to incorporate the single most important influence into the analysis.

With respect to meteorological influences on air quality levels, there are two important categories of features that have been frequently cited as being important in creating poor air quality levels. These categories are (1) stagnation situations with limited vertical mixing and little advection for prolonged periods and (2) persistent winds in which pollution from a source is consistently transported to the same location for a prolonged period. The following categories of meteorological influences are of interest:

- Frequent air stagnation conditions
- Frequent persistent winds
- Normally variable meteorological conditions.

For PM_{10} air quality levels, there are two averaging times of interest: 24-hour and 1-year. The pattern of effects associated with these two averaging periods may differ, in that shorter term effects usually occur closer to the source than do longer term effects.

Based on the above factors, there are 120 possible representative siting situations consisting of all the following combinations:

4 classes of sources
5 classes of terrain
3 classes of meteorology
2 classes of averaging times.

However, for the purpose of identifying methodologies to use in determining siting needs, the same approach is applicable to many of the combinations. One need not use different approaches to treat different averaging times. Also, the meteorological influences are associated with the influences due to terrain and need not be treated as independent factors. Eliminating time and meteorology reduces the number of combinations to 20. With regard to air quality levels associated with background or distance sources that affect a general region as a whole, variations in terrain are not important. The concentrations of PM_{10} will be homogeneous over large areas and not affected by terrain variations. Siting methodologies are limited to simple situations in which a single dominant terrain is identified. At the present time, pratical methodologies have not been developed for treating multiple sources in other than simple terrain situations. Practical models for treating coastal, ridge/valley, and irregular terrain for general urban sources or a major source in conjunction with general urban sources are not presented here. These two source categories are not applicable to the terrain type, leaving only the urban terrain situation. This leaves the terrain variation being treated only with respect to isolated sources.

There are only two terrain situations applicable to isolated sources since the isolated source with urban terrain is the same case as a major source within an urban area. This results in four categories of sites. Because of the range of alternative configurations of sources in urban areas, two categories are included, which may be designated complex and uniform.

As a result of these considerations, we have defined the following six representative siting situations for which specific guidelines are presented in the next section:

- Regional scale (1)
- General urban area
  - Complex (2)
  - Uniform (3)
- Major source within urban area (4)
- Isolated source
  - Plains (5)
  - Irregular terrain (6)

SECTION 5

SITE SELECTION METHODOLOGY

The general procedure recommended for selecting sites for monitoring PM_{10} is similar to that followed for monitoring any pollutant. Variations are recommended primarily with regard to specific methodologies or data that are needed for different topographical situations or different configurations of emissions. Procedures are discussed and recommendations are given for treating the six representative siting situations identified for PM_{10} in Section 4.

OVERVIEW OF METHODOLOGY

The siting of monitors is part of a continuing planning cycle for monitoring, which goes on in all air pollution control agencies and operating facilities. The three basic elements of the cycle, as shown in Figure 14, include defining the objective of monitoring, collecting monitoring data, and making judgments about air quality levels. The methodology for selecting monitoring sites is designed with the idea that this is part of an iterative process that has been performed before and will be repeated again in the future. The need for flexibility in the use of monitoring resources was clearly recognized by the Standing Air Monitoring Working Group (EPA 1977). This need has resulted in the development of three types of monitoring activities by state and local agencies, including National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), and Special Purpose Monitoring (SPM). The locations of NAMS and SLAMS must be coordinated with EPA regional offices because these must be designed to meet EPA needs in addition to state and local needs. The siting methodology is applicable to all three types of monitoring stations and will be useful to industrial operating facilities as well as air pollution control agencies.

The general site selection process is illustrated in Figure 15. The procedure is applicable to all PM_{10} siting requirements, although the indicated steps may be considerably simpler for some types of monitoring requirements than for others. Each box shown in the diagram defines a data review and analysis step. The diamonds define decisions, and the rounded boxes define data needs. The process is divided into the following six steps, which are performed in sequence:

1. Analyze existing PM monitoring data

2. Review local situation to determine adequacy of mapping analysis and/or to select a modeling procedure

3. Model air quality scene (if necessary)

4. Determine network requirements

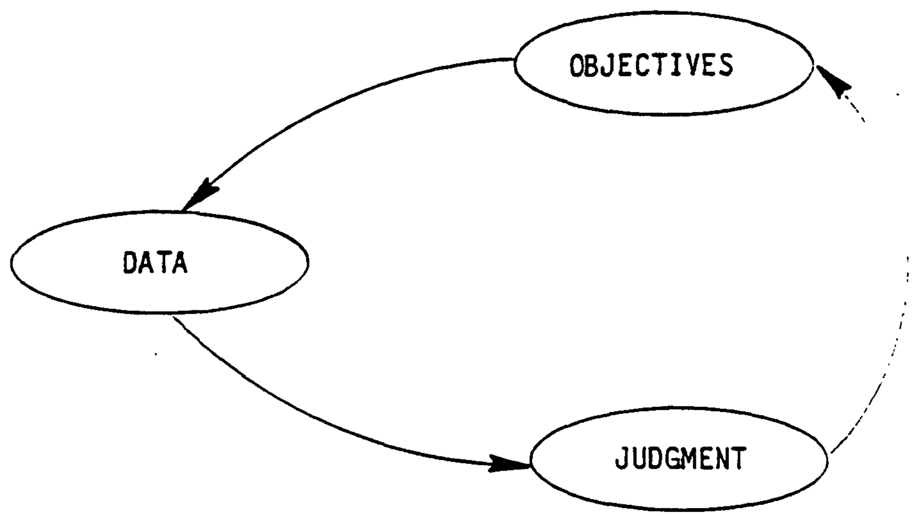

Figure 14. Planning cycle for monitoring.

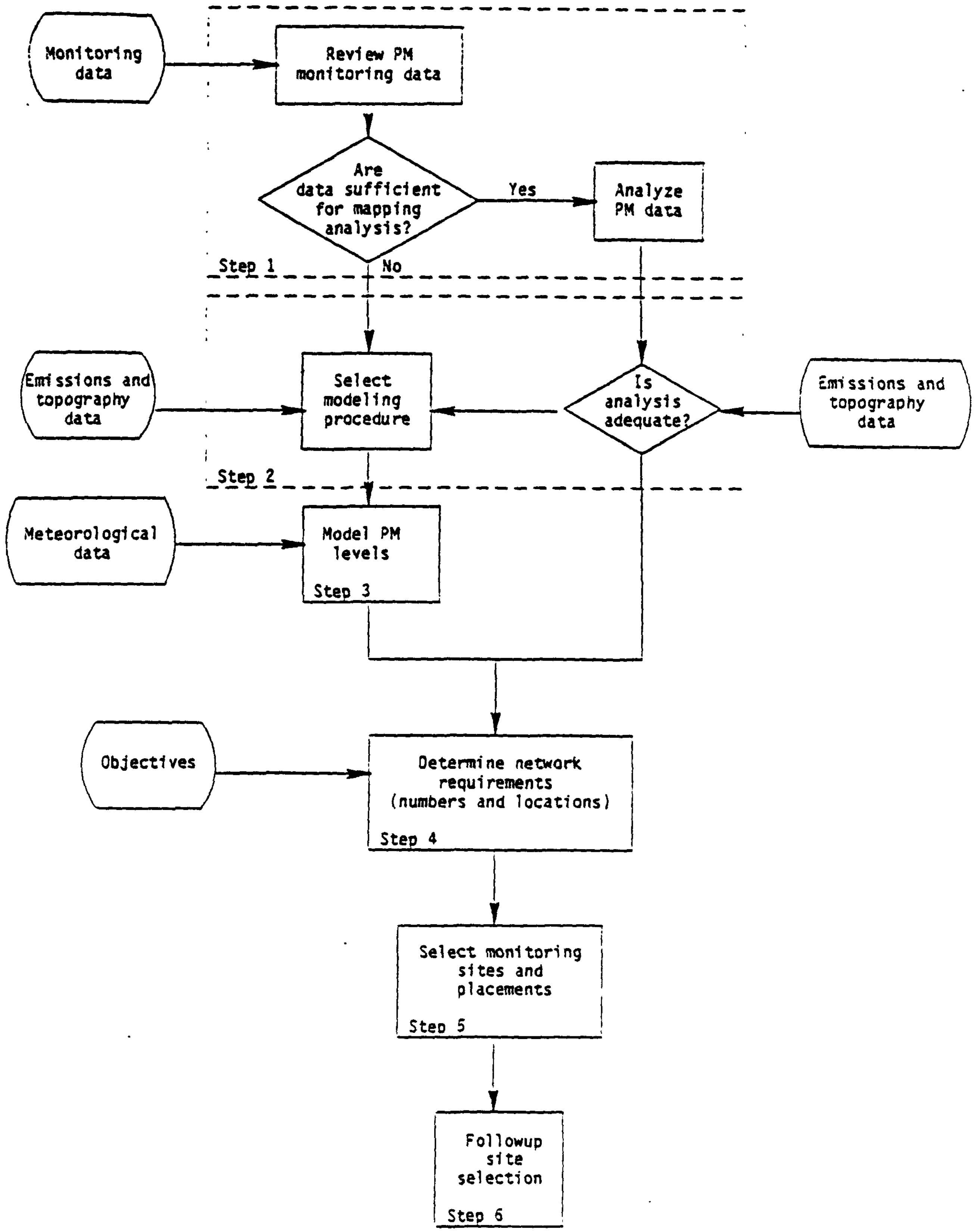

Figure 15. Procedure for selecting PM_{10} monitoring sites.

5. Determine monitoring sites and placement

6. Document and update site exposure experience.

Site planning may vary in scope of responsibility and may include any of the following:

- Design multipurpose network
- Supplement existing network for specific purpose
- Design single-source impact or compliance monitoring network
- Monitor a designated area or location.

Guidelines for performing each step in the site selection process and variations that deal specifically with each of the six types of siting situations are described in the subsequent subsections.

ANALYZE EXISTING AMBIENT PM MONITORING DATA

In order to devise a monitoring strategy and select monitoring sites, the monitoring planner must hypothesize the historical spatial distribution of PM_{10} concentrations over the area of concern. An adequate data base of related measurements, such as for TSP matter, may be available to meet this need. If not, the distribution must be estimated by mathematical simulation modeling or by a reasonable, physically based qualitative analysis. The best method of estimating the distribution of air quality levels will depend on the amount, type, and quality of available information. The information of interest includes the following categories:

- Suspended particulate matter measurements
- Locations and amounts of particulate emissions
- Air pollution climatology and meteorology data
- Maps of topographical features.

As a general rule, the amount of monitoring data available to help design a monitoring network or site new monitors is either nonexistent or very incomplete. However, with regard to siting new PM_{10} monitors, there is likely to be a wealth of hi-vol monitoring data for TSP concentrations that can be very helpful. Other relevant ambient PM measurements include IP measurements, tape sampler measurements, and various types of direct and indirect PM measurements. The EPA SAROAD data base, available from EPA regional offices, is a convenient source of much of the available data. State and local air pollution control offices are also important sources of additional data and information about other data that may have been collected by nongovernment parties or in special studies.

After assembly of all available data and elimination of data that are suspect because of poor quality control, a decision is made as to whether the available data is sufficiently dense to justify mapping analysis, or whether single-station analysis is more valuable. Generally, unless measurements are available from at least six sites concurrently, mapping analysis is not practical.

Mapping Analysis

When performing mapping analyses, different types of measurement data should not be mixed on the same map unless an adequate calibration correction is made for different types of data. If corrections are to be made, it would be convenient if the different types of measurements were corrected to estimates of PM_{10} concentrations. As a minimum, two types of maps should be constructed, including one for annual means and one for peak 24-hour concentrations (not concurrent) for each year of data, particularly the most recent years. In addition, it will be useful to plot concurrent 24-hour data for a few days that are distinguished by having one or more high values. The maps may be constructed by locating the observing sites on a convenient mapping display. The appropriate values may be entered at each site to provide a guide for drawing a set of representative contours of concentrations. The number and value of contours to be drawn will depend on the range of values observed and the nature of their spatial distribution. Computer graphics packages are available to perform the contouring analysis if manual analysis is not practical. Generally, about six contours will provide a useful display. However, as few as one or as many as 10 may be appropriate, depending on the magnitude of the range relative to the mean of the values observed. The maps will be used to identify representative spatial scales and preliminary siting selections.

While the mapping and station analysis data may be helpful in identifying the spatial distribution of PM_{10}, they may be inadequate. Having analyzed the available data, the monitoring planner must consider whether modeling is needed to supplement the available monitoring data. Consideration should be given to gradients evident in the observations, locations of major sources, terrain, and meteorology. In most cases the available PM observations will not be adequate for planning a new monitoring network.

Single-Station Analysis

When single-station analyses are performed, it is desirable to identify the significant influencing factors that affect the PM_{10} air quality levels observed. This identification process will help determine how wide an area the station represents. Conclusions drawn from one station should be compared with results from other stations in the area of interest. Trends and frequency distributions help in analyzing single-station data. Case study analyses of peak values will also be helpful. Figure 16 shows an example of 12-month running means for three sites in Youngstown, Ohio. When significant trends exist, they may indicate the influence of a nearby source. This would be especially true if trends at one site are more pronounced than at other sites. The down trends at the three Youngstown stations might be attributed to decreasing steel production in the local area. The differences among the stations might be attributed to the locations of sites relative to steel production areas and the prevailing wind directions. Shorter averaging periods, such as 3-month averages, would be helpful in identifying seasonal variations that might be associated with specific sources or meteorological conditions.

An example of statistical analysis of single-station data is presented in Table 9. Locations that have similar frequency distributions, particularly over a period of several years, can be considered to be in homogeneous areas. To further support the identification of homogeneous areas, it is useful to review meteorological conditions associated with a selected range of high values. Because TSP measurements represent 24-hour values, a good deal of care is required in selecting meaningful meteorological values. The prevailing (most frequent) and the range of wind directions corresponding to the measurement period are useful. Wind persistence (ratio of vector mean to scalar mean wind speed), height and magnitude of nocturnal temperature inversion, scalar average wind speed, and range of Pasquill stability categories (see definition in Turner 1970) are other meteorological parameters that may show consistent values with the high TSP measurements. If the meteorological conditions associated with high measurements differ significantly between monitoring sites, this result indicates that the sites represent different zones of air quality and has an important bearing in planning a monitoring network.

Another useful single-station analysis is the pollution rose. Figure 17 shows pollution roses constructed for four sites near a coking plant. The pollution rose is constructed by computing the average measured concentration for all values when the prevailing wind was in a given direction. The values may be limited to days when the wind persistence index (ratios of vector to scalar wind speed) exceeds a certain value. In Figure 17, the data include only days with a wind persistence index equal to or greater than 0.85.

REVIEW OF LOCAL SITUATION

An important step in the process of selecting monitoring sites is to identify the unique local influences that are affecting air quality. The types of topographical features, the magnitudes of PM emissions, and the locations of both with respect to one another have a major impact on where the worst air quality levels will occur. In assessing the value of available monitoring data and in selecting an air quality simulation model, it is necessary to take these local influences into account. After a brief

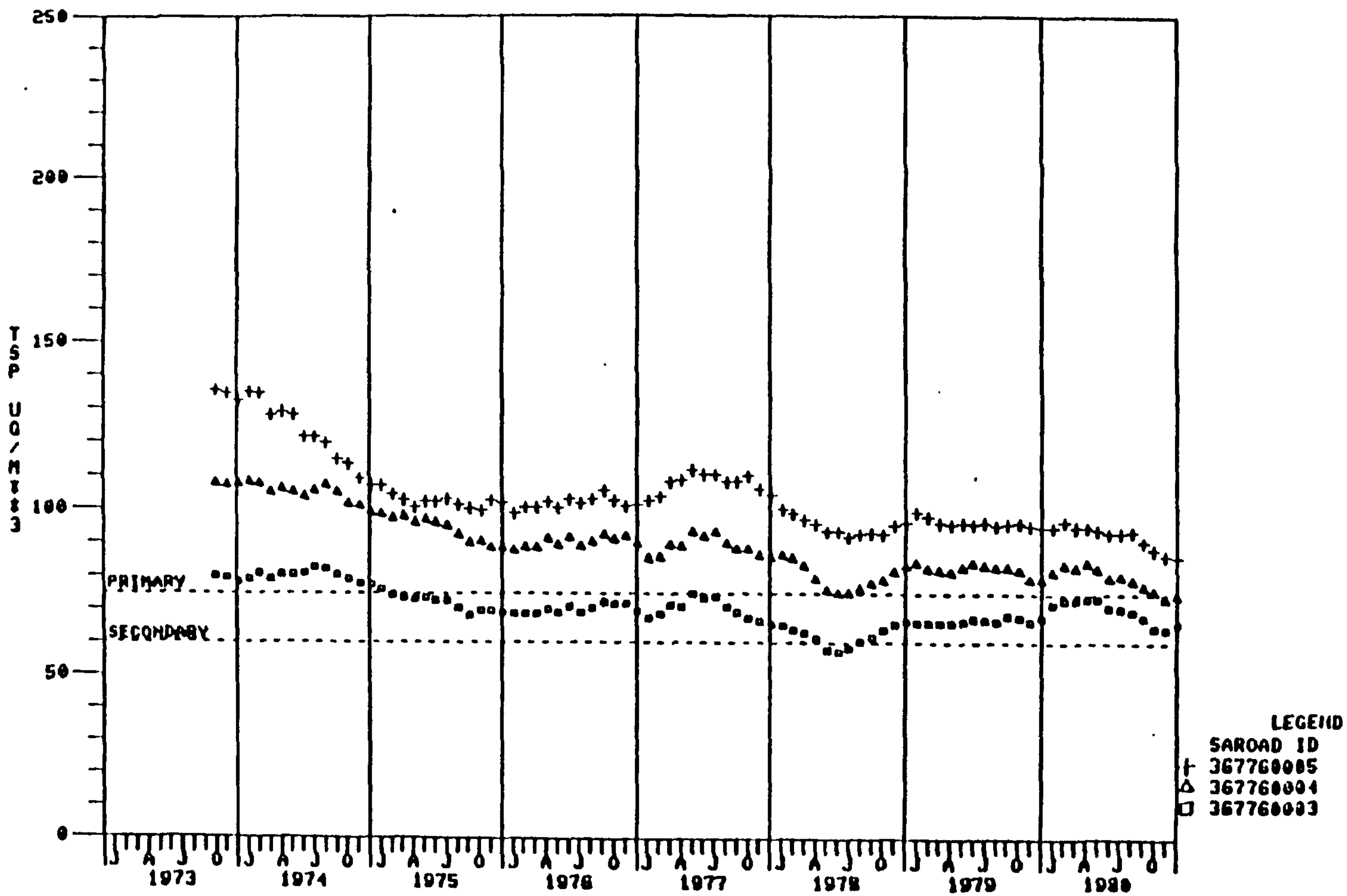

Figure 16. Twelve-month running geometric means (Pickering, Vilardo, and Rector 1981).

TABLE 9. TSP DATA SUMMARY FOR SAROAD STATION #391720001
(Units in micrograms/m^3) (Pickering, Vilardo, and Rector 1981)

YEAR	1973	1974	1975	1976	1977	1978	1979	1980
# OF READINGS :	59	81	95	109	113	110	113	7
GEOMETRIC MEAN:	122.5	114.9	109.2	90.2	99.2	95.9	80.0	93.
GEOMETRIC S.D.:	1.8	1.6	1.6	1.5	1.7	1.7	1.5	1.
HIGHEST BY LARSEN EXTRP:	635.4	460.4	406.4	326.1	440.3	431.4	288.5	319.
1ST HIGHEST:	486.0	296.0	314.0	259.0	275.0	368.0	273.0	356.
DATE :	730416	740117	750418	760915	770310	780426	790322	80053
2ND HIGHEST:	339.0	281.0	277.0	204.0	231.0	237.0	226.0	194.
DATE :	730425	740806	750924	760924	771106	781122	791123	80080
# OF READINGS EXCEEDING 260 :	4	4	3	0	1	1	1	
# OF READINGS EXCEEDING 150 :	24	20	22	17	27	19	8	1
RANGE								
0- 65:	9	11	15	29	25	27	36	1
66-130:	20	37	48	54	49	48	62	4
131-195:	20	22	20	23	32	27	11	1
196-260:	5	7	9	3	5	7	3	[illegible]
261-325:	2	4	3	0	1	0	1	0
326-390:	1	0	0	0	0	1	0	1
391-455:	0	0	0	0	0	0	0	0
>455:	1	0	0	0	0	0	0	0

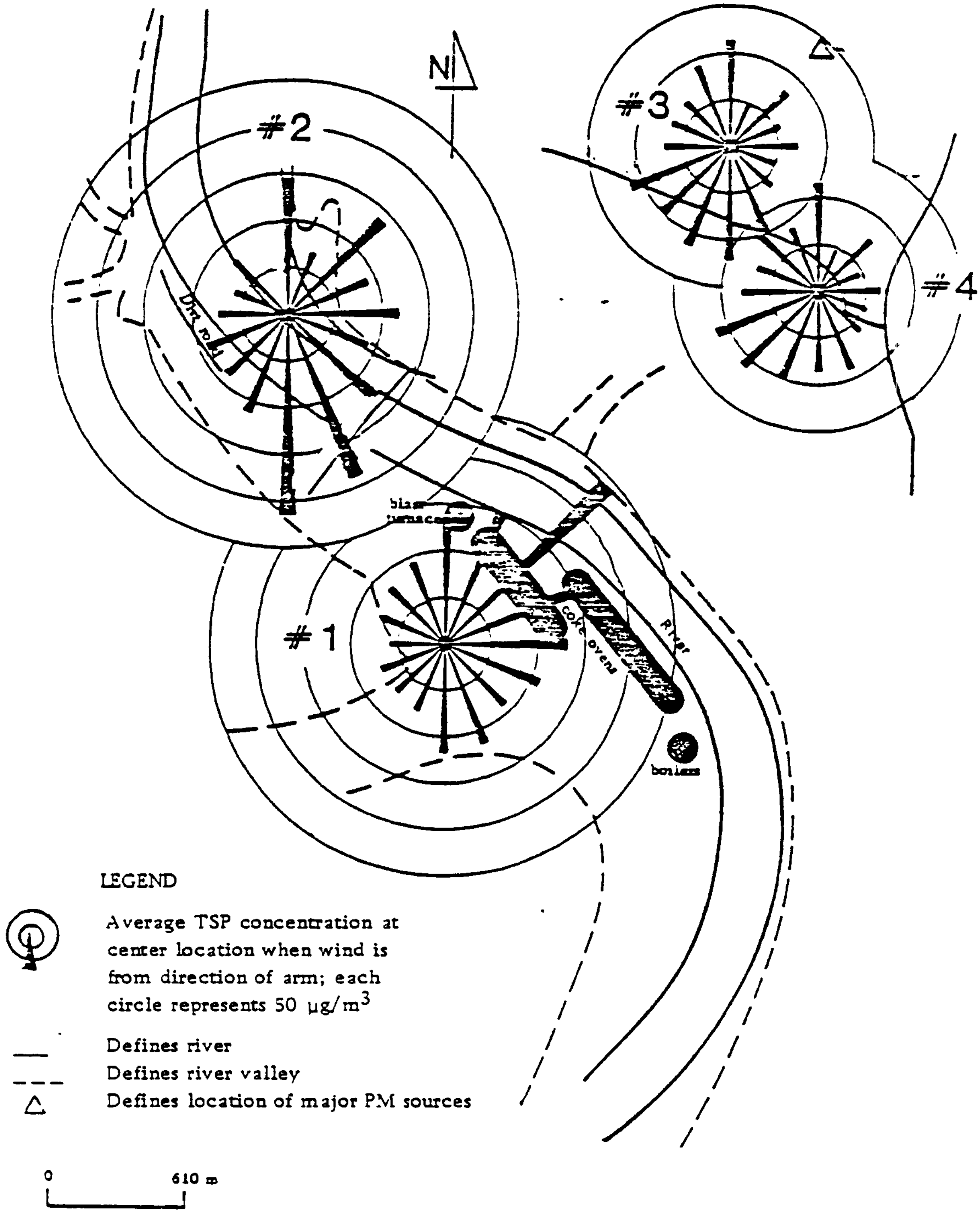

Figure 17. TSP roses for four sites near a coking plant (Pickering, Vilardo, and Rector 1981).

description of the information needed, suggestions are given for steps to take in evaluating available air quality and for estimating PM_{10} air quality levels by the use of mathematical models.

Emission Data

Information on the locations and magnitudes of sources of particulate matter emissions is needed. The influence of PM_{10} sources can be determined by the use of air quality dispersion models and graphical aides that treat the contributions of sources to receptor locations, and by qualitative interpretation of the model results in the light of known topographic influences and monitoring data. Available sources of data and how they may be used in monitor siting analysis is provided here.

Two useful items of information are a detailed and accurate land use map and an accurate point source emission inventory. Large-area, statewide, or multistate maps are needed to show the locations of major population and industrial areas. Smaller area maps that show the size and location of different types of urban development within a single city are also needed for most monitoring objectives. There are many sources for the large-area maps. City-size land use maps are usually available from city and county planning offices. U.S. Geological Survey maps or Sanborn maps may be useful if other sources of land use maps are not available. Another very useful source of data on land use is the U.S. Geological Survey's records of aerial photographic coverage and space imagery. Reference files of data available on microfilm are maintained at the EROS Data Center of the U.S. Geological Survey in Sioux Falls, South Dakota. (See Appendix B for recommended contacts.)

Detailed information on specific sources of particulate emissions is available in state and local emission inventories. Both area and point source emission data are needed. Area source emissions are typically estimated on a countywide basis. However, estimates are frequently allocated to a fine grid in order to provide inputs to dispersion models or for other purposes. Gridded area source data that include location, emission rate, and stack parameters (e.g., temperature and volume flow rate) are needed. When accurate and complete, the NEDS data available from EPA include peak and average emission rates and seasonal variations in addition to the minimum information on location and emissions.

In addition to the emission inventory, census data and traffic data may be used to help define the spatial distribution of particulate emissions, particularly emissions associated with fuel combustion for space heating and emissions from vehicle kickup and tailpipe exhaust. If seasonal variations of emissions due to space heating are not available, they can be estimated on a seasonal or daily basis by use of degree days.[1]

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[1] A degree day is the amount that the average of the daily maximum and minimum temperatures is less than 65° F. Days on which the average is 65° F or greater are not counted.

Emission data for particulate matter are most complete and most accurate for stack emissions from large point sources. However, the principal sources of PM_{10} concentrations are fugitive emissions, secondary particles, and emissions from automobile exhaust (Watson, Chow, and Shah 1981). Special attention is needed to ensure that the emission inventory is reasonably accurate with respect to industrial material handling operations, fumes from uncontained processes, mechanically reentrained road dust (both paved and unpaved roads), and windblown dust from disturbed soil, or a variety of industrial sources (Pace 1980).

Topography

The topography of an area will affect the transport and dispersion of pollutants released to the atmosphere. It is important to take note of topographical features in evaluating how adequately monitoring data represent the expected air quality levels and in selecting a modeling approach for simulating air quality levels. The following topographical features are of interest:

- Shorelines of major bodies of water
- Boundaries of significant urban areas (primarily covered by buildings and pavement)
- Significant terrain elevation features, including ridges, valleys, and areas of complex terrain.

The influence of topography on atmospheric transport is discussed in Section 4. The location of air monitoring sites in relation to sources of PM emissions must be reviewed in the light of these influences. An air pollution meteorologist may be consulted regarding the significance of topographical effects, if there is a doubt about the effect.

The locations of these features are easily identified on topographical maps available from the U.S. Geological Survey.

Reviewing Local Effects

Having assembled data that describe the local situation with regard to measurements of air quality, sources of emissions, meteorology, and terrain, the monitoring site planner is ready to assess the nature of these influences and determine whether to use modeling or qualitative analysis for assistance in selecting monitoring sites.

With regard to sources of particulate emissions, it is necessary to identify the locations of major sources and the quantity of emissions emanating both from stacks and as fugitive dust. Smaller sources of particulate emissions may be represented as area sources, e.g., as emission densities over 1 km squares. The area source emission densities should include particulate emissions from fuel combustion by smaller commercial and industrial sources, by residences, and by all types of mobile sources; also, process and fugitive dust emissions from industrial, waste disposal, and construction operations should be included. Guidelines on how to conduct an emission inventory and to allocate emission data to a gridwork are available from EPA (1973) and are not documented here. Both annual mean and seasonal, monthly, or daily maximum (if they are significantly different from the annual) emission rates should be determined. When plotted on maps, the area emission densities (both mean and maximum) will indicate areas of relative maximum and minimum emission levels and the degree of homogeneity in the area source emissions over the monitoring area of interest.

The nature of major topographical features and their locations relative to the sources of particulate emissions need to be identified. Major topographical features include coastlines, ridge lines, valley walls, and hilltops. In addition to specific topographical features, the area may be generally characterized by its roughness, e.g., built-up urban area, moderately rough rolling hills or river valley, or extremely rough valleys and ridges of a mountainous area. The treatment of terrain roughness is further complicated by the need to deal with terrain transitions. Cities and other areas of interest are frequently located near the base of a mountainous area or on a coastline where major terrain transitions exist.

While the location and nature of terrain features help to identify their influence, meteorological data are the demonstrated evidence of the effect. All of the air quality models recommended in the EPA Guideline on Air Quality Models (Revised) (1986) assume that meteorological conditions are homogeneous between all combinations of sources and receptors. Therefore, the available meteorological data should be reviewed to delineate areas and time for which the homogeneity assumption and the recommended models are applicable.

The single most significant meteorological parameter that must be homogeneous is wind direction. Since wind direction at a single site is generally accurate within 10° azimuth,[2] the variance in wind direction differences between sites should not exceed the sum of that variance due to measurement errors at the two sites. A useful rule of thumb is that the standard deviation of the differences in wind direction at two sites should not exceed $\sqrt{2}$ times 10°, or be less 15°, if the two sites are assumed to be measuring the same wind direction.

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[2]This is related to the spatial representativeness of the observations and not the accuracy of the wind vane.

If meteorological data are not available to demonstrate the homogeneity of meteorological conditions, one can require that there be no major topographic features between sources of pollution and potential receptor monitoring sites in areas selected for modeling analysis. While this may be helpful in the immediate area, it does not treat indirect effects in nearby areas due to wind flow away from major topographical features. Lake breeze fronts and valley drainage flow fronts are examples of air boundaries that lie away from the topographical features that generate them. Winds on opposite sides of these air boundaries may differ by 90° or more, and the boundary may lie several miles away from the terrain feature. Air quality models that treat the effects of these terrain-generated air boundaries are under development and evaluation. One important effect of these boundaries, namely limited vertical mixing, can be treated by the available models.

Is the Analysis of Monitoring Data Sufficient?

The patterns and directions of maximum levels may differ for long- and short-term PM_{10} concentrations. Both types of patterns should be reviewed separately. The important judgment to be made is whether the effects shown by the monitoring data are reasonable in the light of other available information, or whether modeling is needed to better define the spatial pattern of PM_{10} concentrations.

In order to be useful for siting purposes, the monitoring data should define the shape and magnitude of the air quality pattern. Based on the distribution of sources, topography, and meteorology, the pattern should reflect these influences or at least not be inconsistent with respect to them. If these expectations are met, one may accept the pattern shown by the monitoring data as adequate. If the expectations are not met, a more detailed analysis based on results from air quality simulation models or from supplementary mobile monitoring may be required. There are two types of comparisons that can be made to help judge whether the air quality patterns are acceptable. One comparison examines the time history of the pattern. The other comparison examines the shape of the air quality pattern with respect to the shape of the pattern of emission densities and topographical features.

If the patterns of annual means or maximum 24-hour concentrations for several years show the same shape and same locations of peaks when superimposed on each other, the pattern is consistent with time. This consistency is evidence of a stable pattern, which is a reasonable guide for planning monitoring sites. If the pattern is changing with time. the analysis may be adequate, but the reasons for the changing pattern should make sense in terms of changes in sources or in meteorological conditions. If there are no apparent reasons for the changes, modeling results should be obtained and reviewed.

Emission densities that are chronologically consistent with the air quality data should be plotted and used to generate contour patterns. Topographical features may also be located on these patterns. When the emission density contours are superimposed on the air quality patterns, there should be a reasonable relationship. One possible cause of deviations might be due to significant amounts of emissions from stacks. The heights of the stacks should be noted as an aid in identifying this influence. As a general rule, most IP and TSP emissions are from ground-level sources; however, uncontrolled or undercontrolled emissions from stacks can be major sources of pollution, which significantly alters the pattern of air quality from what would be observed from ground-level sources. A reasonably consistent pattern would be one in which the air quality pattern is offset from the emission pattern in the direction of prevailing wind flow. If the influence of major peaks in emission density are not evident in the air quality pattern, a modeling analysis may be helpful in identifying the magnitude of the pattern deformation that can be expected.

Selecting a Model

Major unsolved problems are associated with modeling PM concentrations. When using the results of model simulations to select monitoring sites, one should keep the following uncertainties in mind:

- Most of the IP matter that makes up the concentrations occurring in urban locations may not originate from local sources.
- Air quality simulation models recommended in the Guideline (EPA 1986) do not treat the physical and chemical processes that alter the size of airborne particles and may not adequately treat their removal by wet and/or dry deposition.
- Emission factors and emission data that are available to estimate emissions of particulate matter do not identify IP emissions as a portion of total PM emissions.
- Most IP emissions originate from fugitive sources rather than stacks. The uncertainly associated with available fugitive emission estimates is very high.
- Air quality simulation models recommended in the Guideline (EPA 1986) very simplistically treat the topographical influences on atmospheric transport and dispersion of pollutants.

In spite of these uncertainties it is still useful to use modeling to identify areas of relatively good and poor air quality and to select sites for a monitoring network. Models that may be useful in each of the six monitoring situations described at the end of Section 4 are listed in Table 10. No modeling results are needed to site a regional scale monitoring station, because this type of site is representative of a large, relatively homogeneous area of air quality in which influences from nearby sources are

TABLE 10. AVAILABLE EPA MODELS FOR SIX MONITORING SITUATIONS*

Monitoring Situation	Recommended model	
	Annual Mean	Maximum 24-hour
Regional scale	None**	None**
General urban area		
-- uniform	CDM-2.0	RAM
-- for complex sources in urban areas	ISC	ISC
Urban area with single or multiple major IP source(s)	CDM-2.0	RAM
Single source with terrain height below stack top# (complex source)	CRSTER	CRSTER (ISC
Single source near terrain above stack top§	COMPLEX I*** or VALLEY	VALLEY or COMPLEX I**

* Available on EPA's UNAMAP Version 6.

For multiple sources where it is not appropriate to consider the emissions as located at a single point, the MPTER model is appropriate.

§ COMPLEX I and VALLEY are considered screening techniques. For regulatory purposes, COMPLEX I should be used only with onsite meteorological data as input.

** Selection of model is a case-by-case decision.

*** The SHORTZ model is an appropriate screening technique for use in urbanized valleys with onsite meteorological data as input.

negligible. With regard to selecting a model, a distinction is made betwen monitoring situations with a single source in a rural setting and monitoring situations with multiple sources in an urban setting. A distinction is also made between rural monitoring situations with and without complex terrain. For modeling purposes, complex terrain is usually defined as terrain that exceeds the stack top of the source.

For estimating annual means, the CDM model is appropriate for multiple source urban situations, and the CRSTER model is recommended for single-source rural situations in the absence of complex terrain. In the presence of complex terrain, the COMPLEX I screening model for rural areas and the SHORTZ screening model for urban areas (available in the EPA UNAMAP Program System, Version 6) are more appropriate than VALLEY, if at least 1 year of onsite meteorological data are available. These models are relatively easy and inexpensive to use. For estimating maximum 24-hour concentrations, the RAM model is recommended for urban situations and CRSTER for single-source, rural situations. When the single source or multiple major IP sources are complex (as is frequently the case when treating fugitive emissions from large industrial sources), the ISC model is recommended in place of RAM or CRSTER.

Procedures for using these models and for compiling data for them are discussed in detail in the Guideline on Air Quality Models (Revised) (EPA 1986), and the PM_{10} SIP Guideline. In addition, Appendix A contains a list of cities for which STAR data have been compiled. These data should be helpful to modelers who wish to execute CDM or ISCLT. Appendix B contains a list of information sources that should also prove helpful.

Selecting Representative Sites Without Monitoring or Modeling Data

There may be situations in which it is not possible to use monitoring data or the results of a modeling analysis to define the pattern of air quality levels in an area that is to be monitored. In this case, the monitoring network can be planned by identifying representative sites on the basis of available information on sources of emissions, climatological data, and topographical considerations. Section 4 presents a discussion of how these physical characteristics of the area to be monitored influence the air quality with respect to PM_{10}. On the basis of these considerations, six representative monitoring situations were identifeid. Observations from other locations and previous modeling analyses of general classes of source influences may be used to select PM_{10} monitoring sites for these situations.

Figures 18 through 21 summarize the steps that need to be followed in selecting sites for the six types of representative monitoring situations. Figure 18 treats regional scale siting. Figure 19 treats siting neighborhood-scale sites in urban areas, and Figure 20 treats siting middle scale sites with and without the presence of major point sources. These two figures cover the three urban representative siting situations identified in Section 4. Figure 21 treats siting around an isolated major point source in flat or

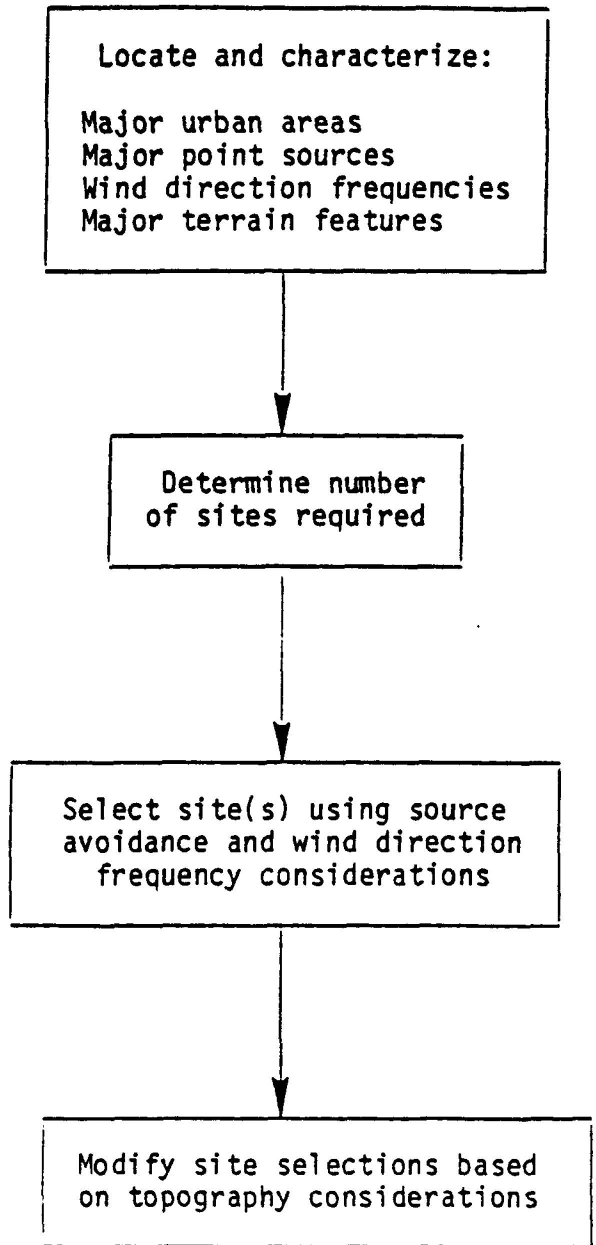


Figure 18. Steps for locating regional scale monitoring site.

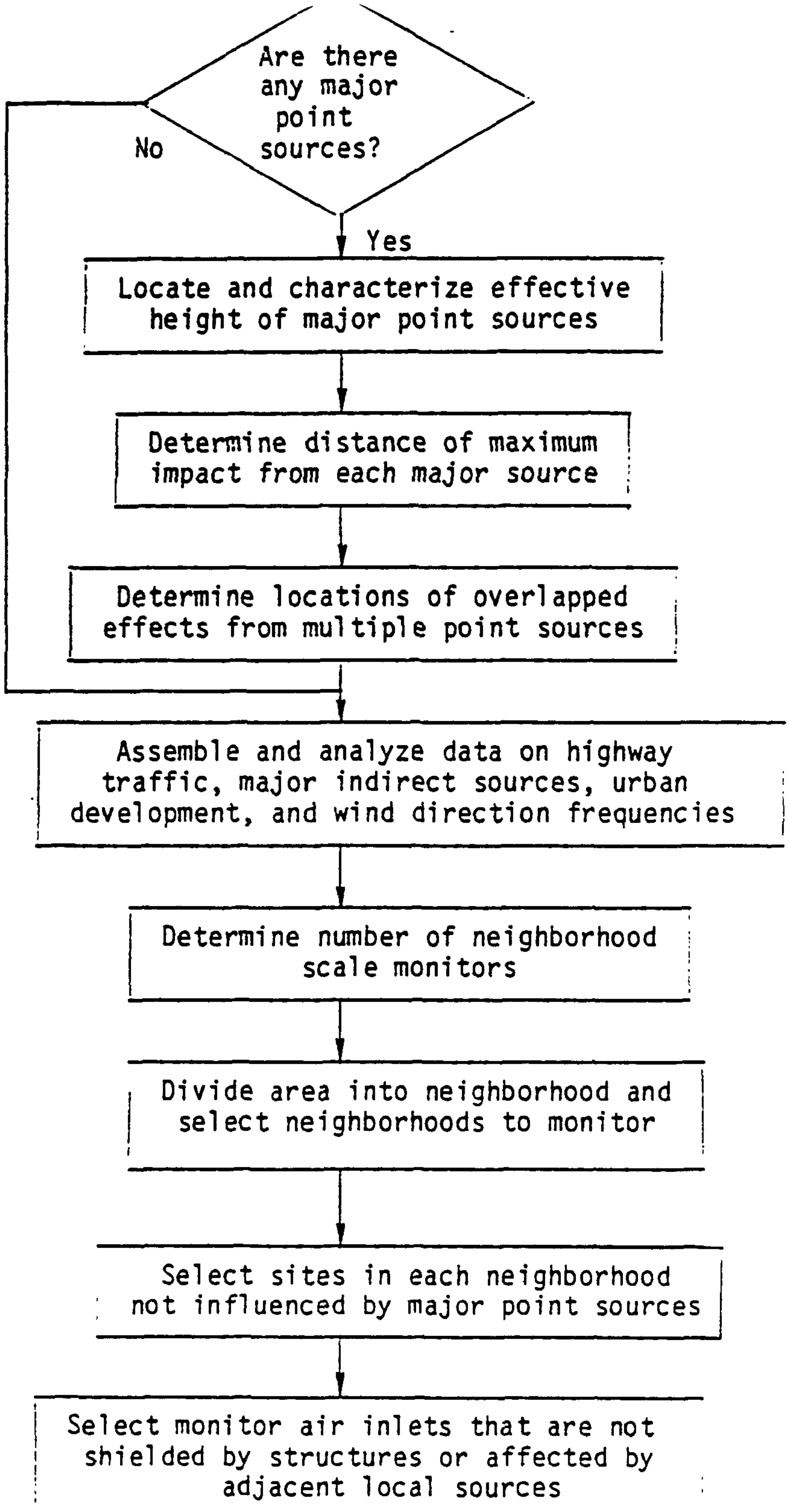


Figure 19. Steps for locating a neighborhood scale monitoring site in an urban ar

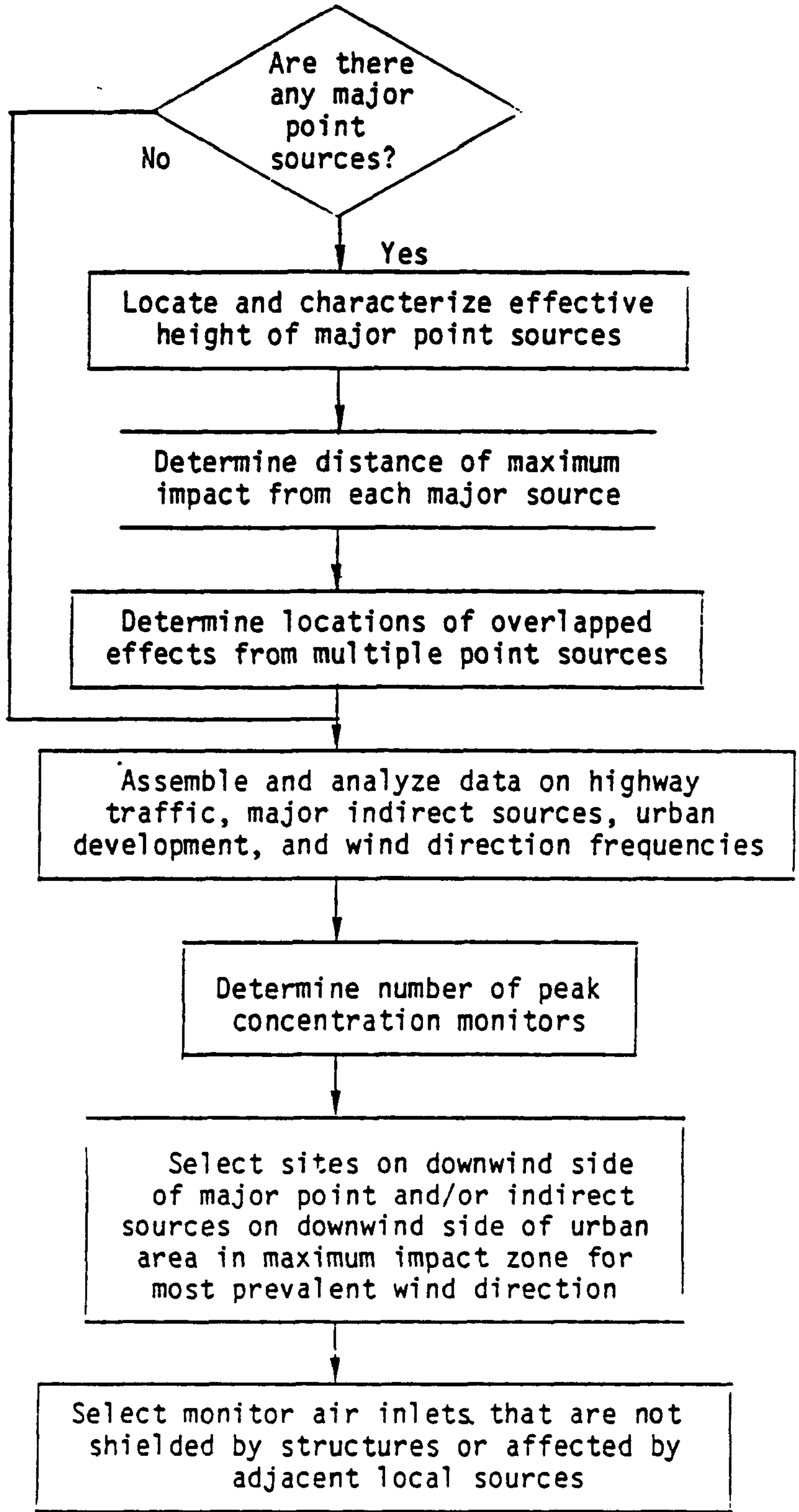


Figure 20. Steps for locating micro-/middle scale monitoring sites in urban areas

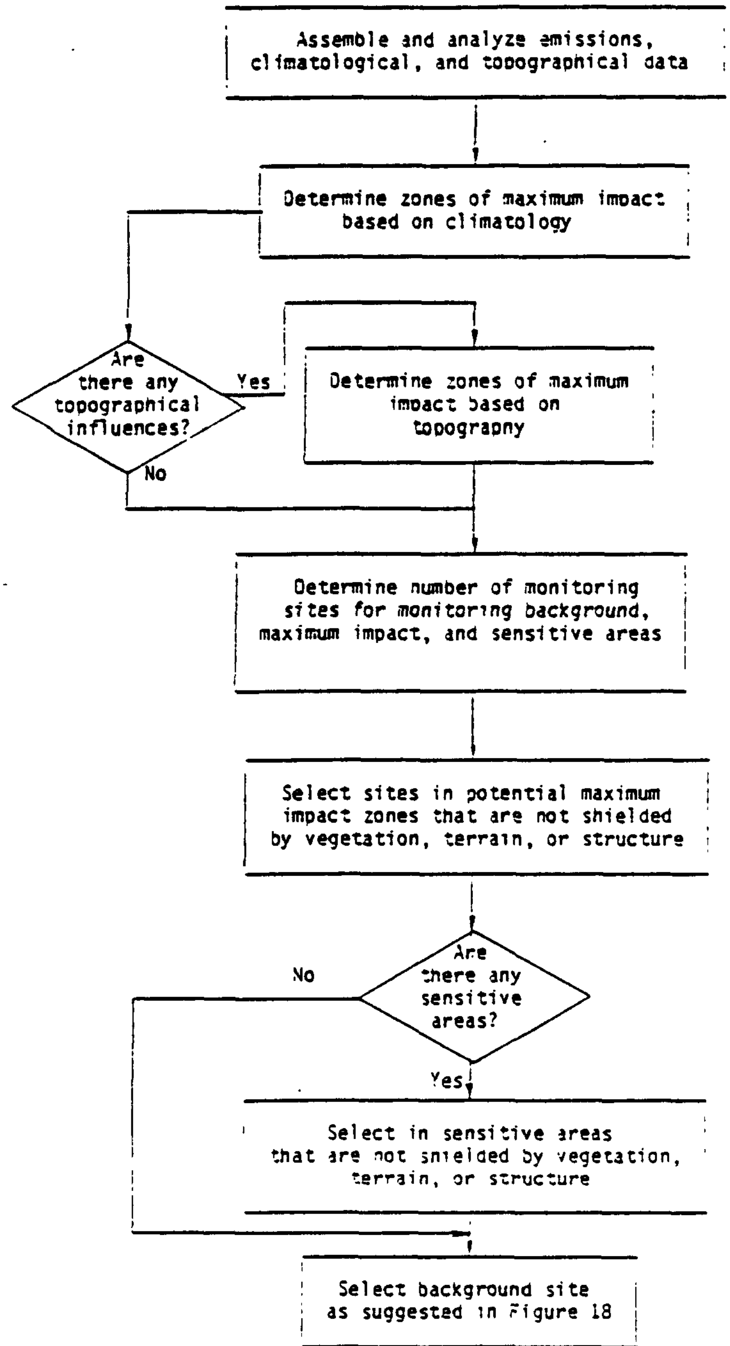


Figure 21. Steps for locating monitoring sites near isolated major sources.

complex terrain. This includes two of the representative siting situations. These three figures deal with all six representative siting situations. Specific guidelines that may be used in performing these steps are discussed below.

Regional Scale Monitoring Sites

Regional scale monitoring sites are needed to measure background levels of PM_{10} that are transported into the area being monitored. It is important that regional scale monitoring sites not be affected by nearby sources, which would significantly alter their scales of representativeness, for large periods of time. It may be necessary to use two or more sites to measure background concentrations when a single site cannot be found that is never influenced by nearby sources. Figure 18 suggests four steps to follow in selecting the site(s).

The first step is to identify all major urban areas and all major operating facilities that may have an effect on PM_{10} air quality levels in the area of concern. Locations and populations of nearby urban areas are readily determined from maps and standard library references. Large cities as far away as 100 km are of concern. This is based on the use of models to estimate the distance to which emissions of 1.0 $\mu g/m^2/sec$ from a metropolitan area 40 km in diameter will extend before the peak concentration is less than 20 $\mu g/m^3$ under neutral atmospheric stability conditions and a light wind speed of 2 m/sec. Distances from smaller cities are less critical; e.g., a concentration of 20 $\mu g/m^3$ will extend 60 km downwind of a city that is 20 km in diameter and 15 km downwind of a city that is 10 km in diameter. These estimates were derived using the methodology for Estimation of Concentrations from Area Sources proposed by D.B. Turner (1974). A concentration of 20 $\mu g/m^3$ is significant because this is the 1-hour concentration that is likely to be associated with an observed 24-hour concentration of 5 $\mu g/m^3$, and because 24-hour concentrations as low as 5 $\mu g/m^3$ are small in comparison to observed variations in regional scale IP concentrations. Annual mean concentrations of IP at 17 monitoring sites in nonurban areas (Watson, Chow, and Shah 1981) showed a mean of 30 $\mu g/m^3$ and a standard deviation of 9 $\mu g/m^3$. A concentration of 5 $\mu g/m^3$ is about half of the standard deviation of regional scale or background level concentrations of IP.

Major operating facilities can be identified from state emission inventories that are available from state and Federal offices listed in Appendix B. Estimates of significant impact distances are listed in Table 11 for various emission rates and effective source heights. Effective source height refers to the height above the ground at which the center of the plume of emissions from a plant is transported. This includes the height of release from a stack or vent plus the rise that may occur due to momentum and/or heat in the exhaust stream. For fugitive emissions blown from the ground or vented from open windows and doors, the effective height may be essentially zero or ground level. All areas affected by major sources can be circled on a map by a radius scaled to the significant impact distance. The circles should include the urban area and major sources in the area being monitored as well as nearby sources outside of the area. Any areas not covered by circles are suitable for regional-scale monitoring sites. Sites within 40 m of major highways (see Figure 22) or unpaved roads are also not suitable. This is because emissions from motor vehicles in heavy traffic and the reentrainment of dust from unpaved roads are also significant sources of particulate matter. If there are no uncovered areas or if the uncovered areas are unsuitable because of accessibility or other considerations, it is necessary to use more than one site to monitor the regional scale. Operations from different sites would be applicable to background levels on different days.

TABLE 11. DISTANCES FROM MAJOR POINT THAT AFFECT REGIONAL SCALE MONITORS

Emissions rate (g/sec)	Effective source height (m)	Downwind distance (km) beyond which the product of concentrations and wind speed does not exceed 40 $\mu g/m^3$ x m/sec for four Pasquill stability classes			
		B	C	D	E
400	all	14	30	>100	>100
100	300	7	14	33	--*
	≤150	7	14	50	>100
40	300	4.5	7	--	--
	100	4.5	8	25	50
	≤70	4.5	8	27	57
10	≥300	--	--	--	--
	100	2.1	4	8	11
	≤30	2.1	4	10	19
4	100	1.2	2.0	--	--
	≤30	1.4	2.4	5	9

* Dashes indicate values as high as 40 $\mu g/m^2/sec$ do not occur.

NOTE: 40 $\mu g/m^2/sec$ represents the lowest value that is expected to produce a 24-hour concentration contribution of at least 5 $\mu g/m^3$. This is based on the assumptions that a 24-hour value will be about 25 percent of the 1-hour peak concentration and that wind speed will be 2 m/sec. A concentration contribution of 5 $\mu g/m^3$ is small in comparison to variations in regional scale IP concentrations (see text). Tabulated values are based on curves from the EPA Workbook of Atmospheric Dispersion Estimates (Turner 1970).

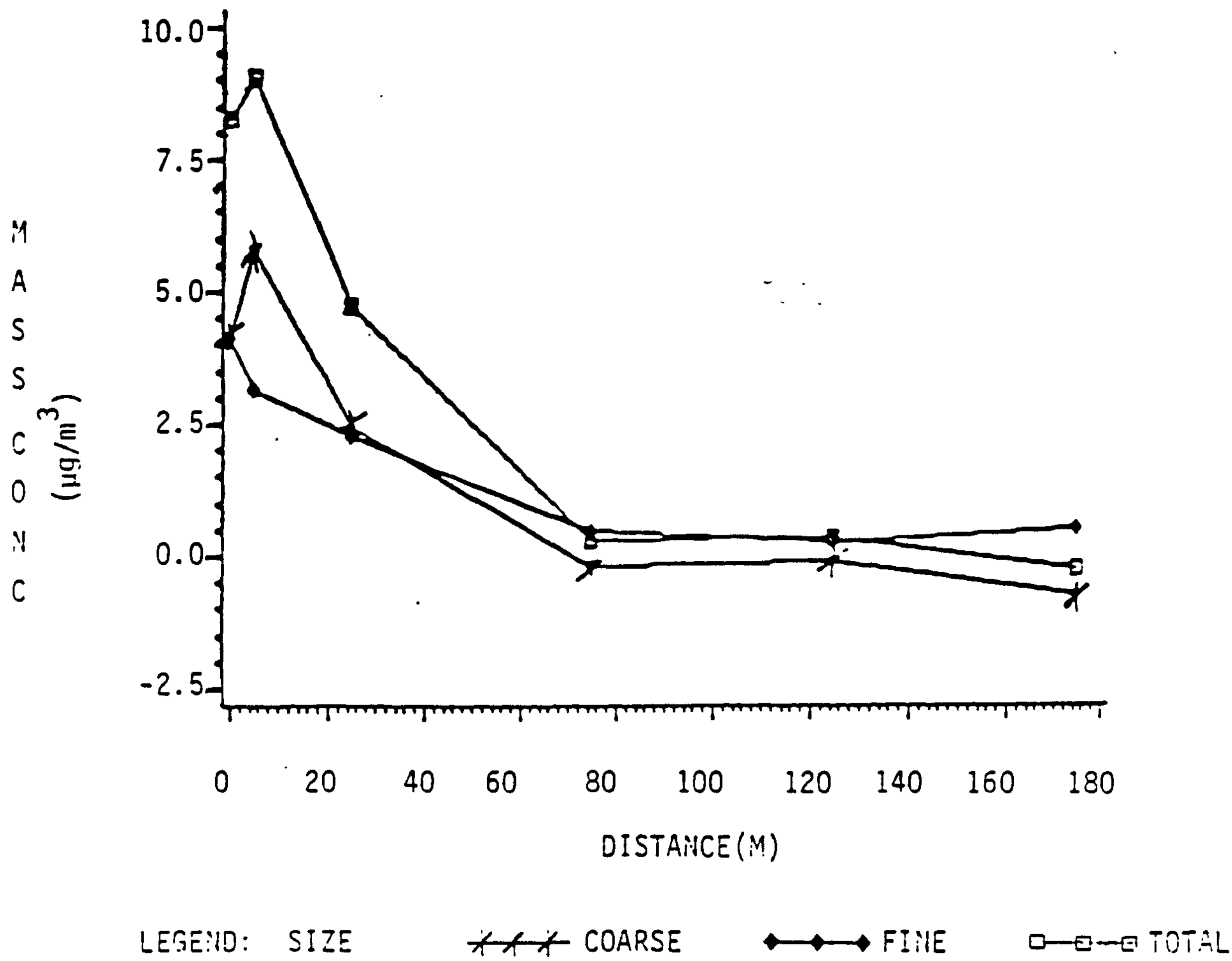


Figure 22. Average measured PM concentrations (downwind less upwind) from a major Philadelphia highway (Burton and Suggs 1982).

When two sites are needed to monitor background concentrations, one station should be selected that is upwind of the area of concern most frequently or downwind least frequently. If this site cannot be clear of contributions from nearby sources for all wind directions, a second site is required. This site should be selected to supplement information obtained from the first site to the maximum extent possible, so that one site or the other is measuring the background level at all times. One strategy is to place the second site in the direction that is upwind of the area of concern second most frequently. If the first and second most frequent wind directions are more than 120° apart, this may be a good plan. If they are less than 90° apart, both sites may be downwind of the primary area of concern or of the same large source on the same day. This risk can be minimized by selecting a second site that has bearing from the primary area of concern that is 180° from the bearing to the first site. A climatological wind rose showing the frequency with which the wind blows in each direction is useful for selecting sites. The map of circled major sources may be used to show areas that are not affected by major sources for specific wind directions. Figure 23 shows an example. In this case the monitoring agency must select a site within 24 km (15 miles) of its offices. However, the impact zone of the city (City A) extends out 90 km, so the agency must monitor on both sides of the city. The most frequent and second most frequent wind directions, shown in the lower right-hand corner of the figure, are about 120° apart. However, a site directly south of the city is not desirable because of interference from City D. An alternative site slightly to the east of south would still be representative for south winds and less affected by City D. Another alternative site is 180° from the direction for which the first site was selected. Selected regional scale monitoring sites should not be influenced by topographical features. Sites along shorelines, in or at the base of pronounced valleys, near sharp bluffs, or in low-lying areas should be avoided. The topography around the most suitable sites is uniform.

Urban Areas with No Major Point Sources

Some urban areas will have no major sources of PM_{10} emissions. Because most of the measured IP concentrations come from geological materials, from motor vehicle traffic, or from secondary aerosols formed in the atmosphere (EPA 1981; Watson, Chow, and Shah 1981), this may be the situation in a number of areas for which monitoring is planned. Figures 19 and 20 describe steps that may be used to select monitoring sites in such situations.

The first step is to obtain and analyze traffic and urban development data that can be used to identify potential variations in otherwise homogeneous neighborhood scale patterns of PM_{10} concentrations. Areas of high traffic density, such as major highways, shopping centers, sports areas, amusement parks, airports, and parking facilities, need to be identified and analyzed. Also, areas that are concentrated sources of particulate matter emissions, such as solid waste handling facilities, unpaved roadways, central business districts, and construction operations, need to be analyzed.

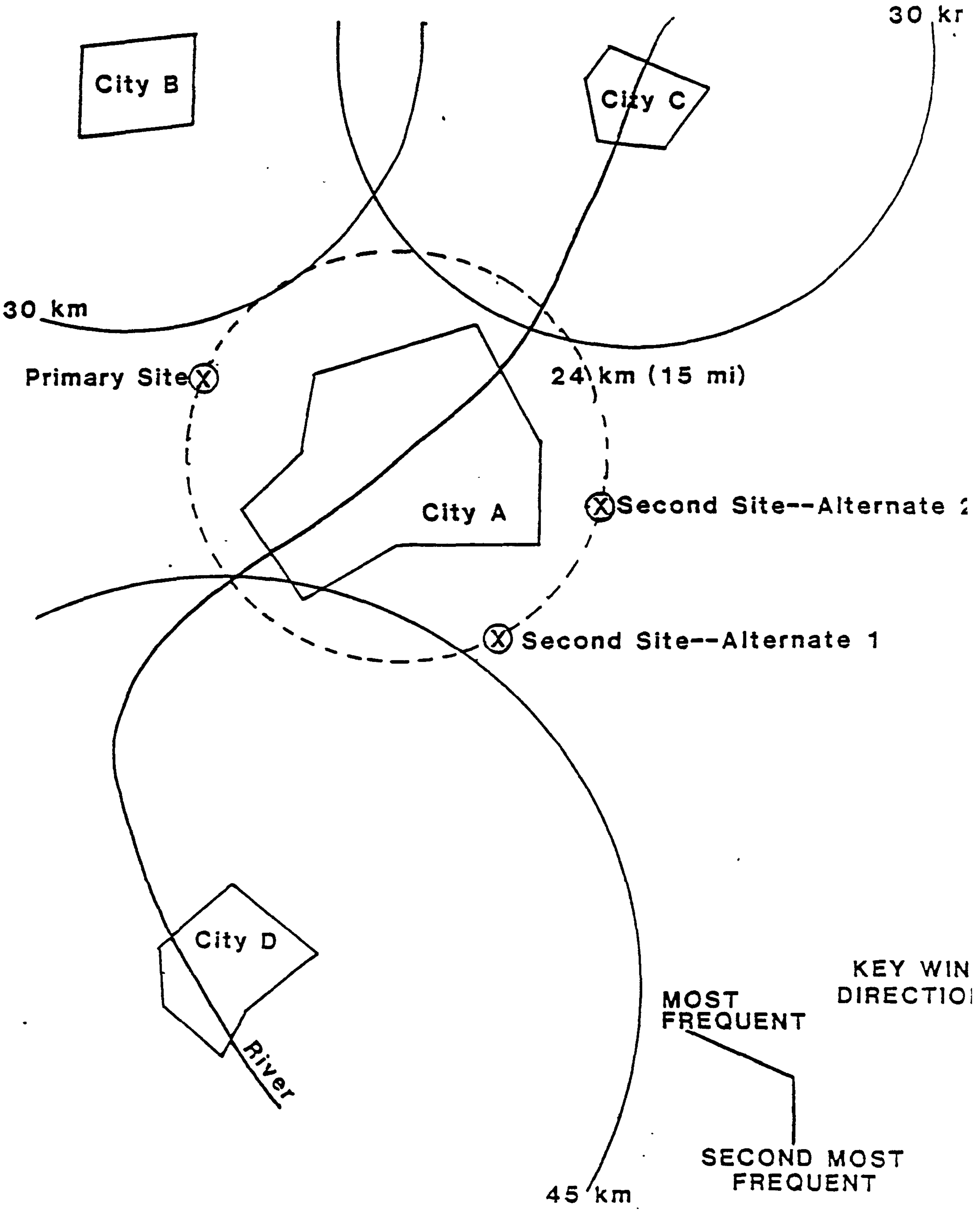


Figure 23. Example of background site selection within 24 km (15 mi) of City A.

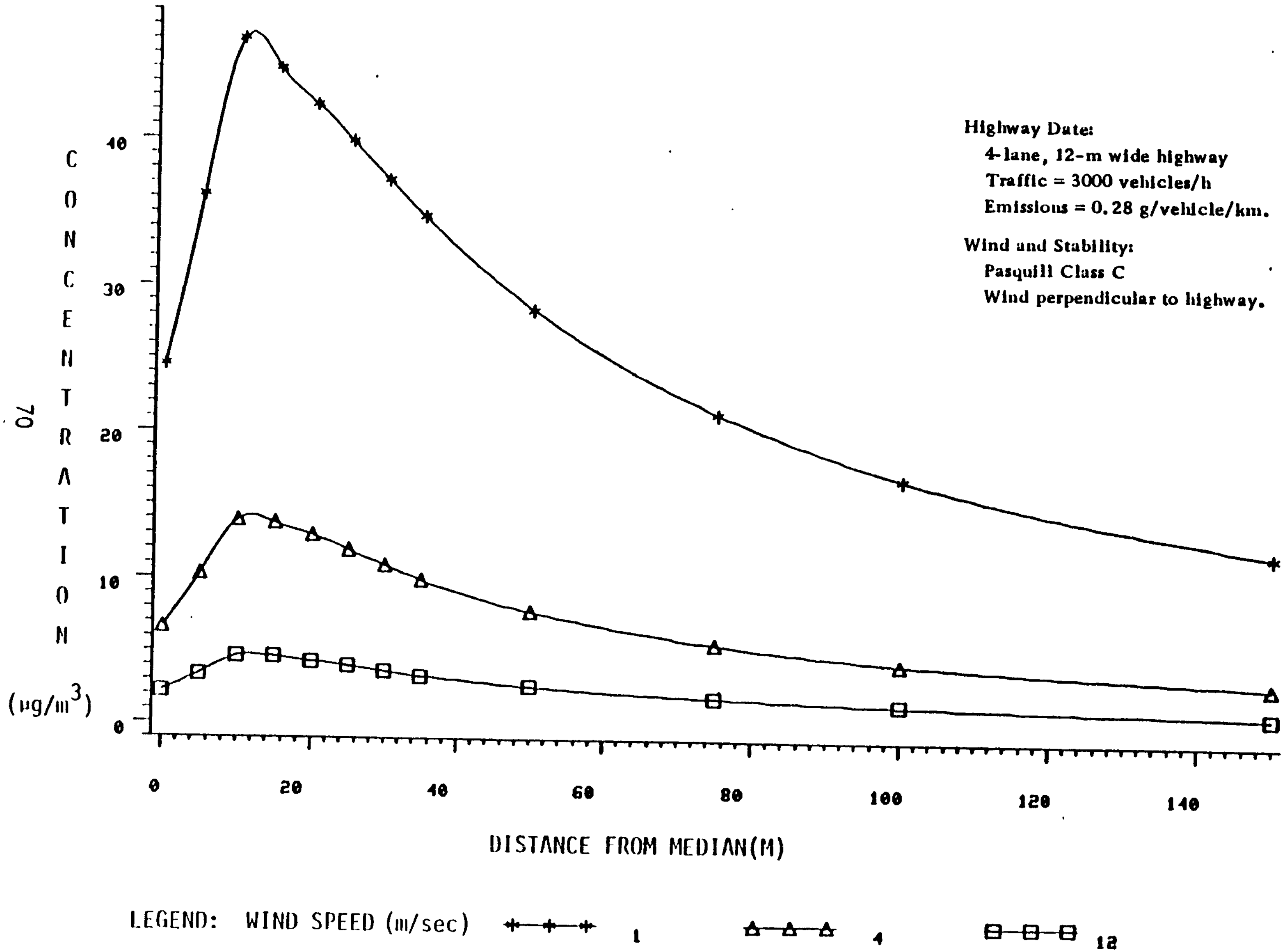
Figures 24 through 26 show the model peak concentrations downwind of highways that occur within 15 m of the roadway. Data in Table 12 show the peak concentrations expected downwind of other sources that are centers of intensive traffic-generated emissions. These guides can be used to estimate where the pollution increases above general neighborhood levels will occur, which can be expected in the vicinity of these sources.

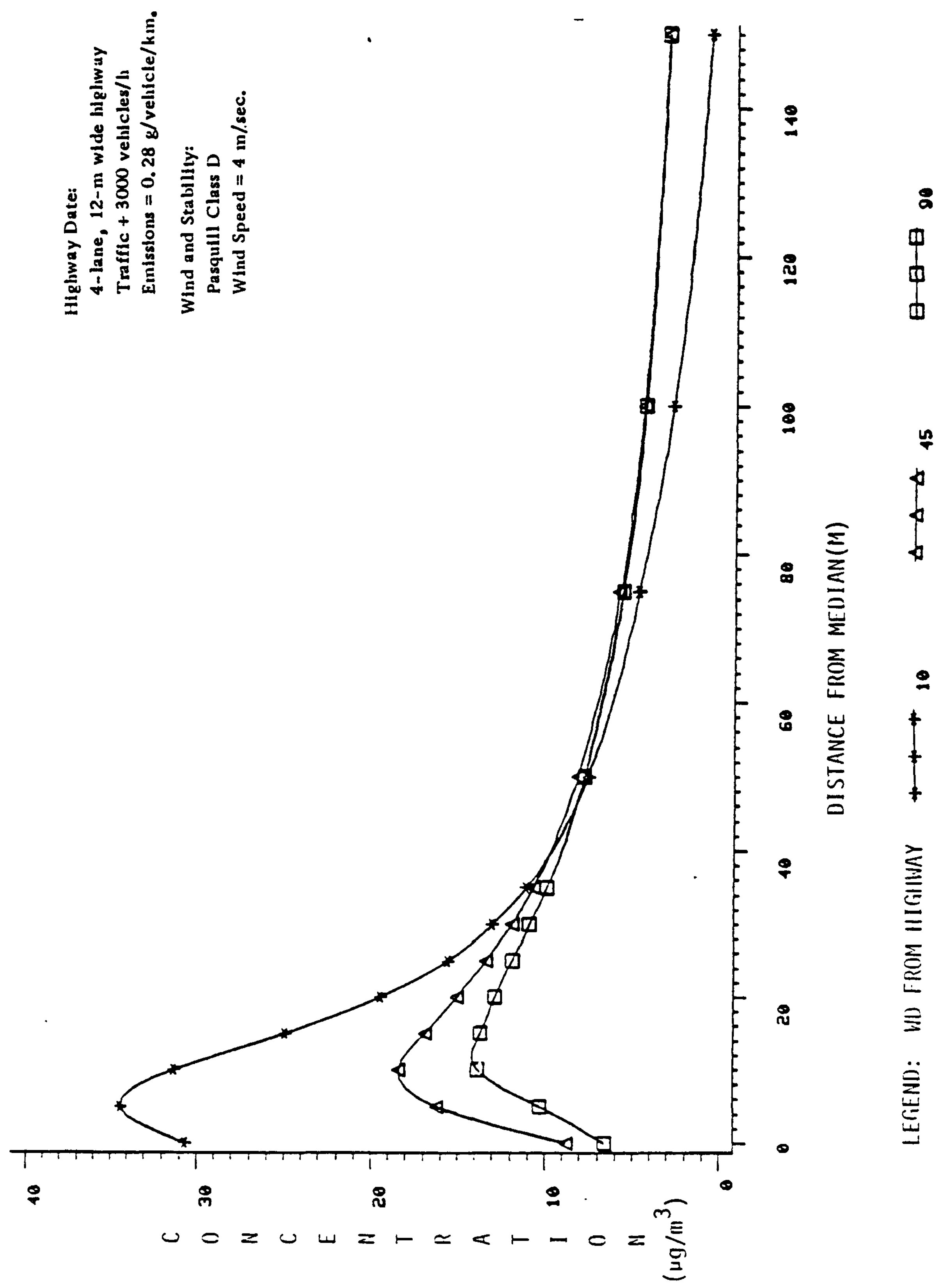
On the basis of the magnitudes of the PM_{10} enhancement predicted for all the traffic-concentrated areas and the locations of the source areas relative to the downwind edge of the city for the most prevalent wind direction, a decision must be made on how many monitors will be used to measure the maximum PM_{10} concentration. Unless a single source or source area is clearly more significant than any other, a number of sites should be selected as potential peak concentration monitoring sites. These sites will be representative of micro- or possibly middle scale areas. The monitoring site should be located as close to the source as possible without infringement or interference from the source. The most suitable sites are within 5 to 15 m of the sources on the downwind side of the prevailing wind direction. It is usually not practical to locate a site less than 5 m from a source. Generally, one site is sufficient for each source area.

Neighborhood sites are needed to represent the areas that encompass or surround the peak concentration sites. Due to variations in the type and intensity of land uses throughout an urban area, a large metropolitan area may be characterized by well over 1000 different neighborhoods. The process of identifying and classifying all neighborhoods in a metropolitan area in terms of their potential PM_{10} air quality levels is a worthwhile effort for air pollution control planning purposes. The use of monitoring or modeling data is the most satisfactory way to making such classifications. However, it is also possible to characterize neighborhoods in a qualitative fashion by preparing a detailed emission inventory that identifies the spatial distribution of emissions from the many indirect and fugitive sources of PM_{10}.

By examining the locations and magnitudes of these sources in relation to the climatology of wind direction frequencies, one can rank neighborhoods in terms of their expected levels of high PM_{10} concentrations. Neighborhoods that encompass the middle or microscale areas that are expected to contain high concentrations are clearly high priority neighborhoods for monitoring sites. One or two neighborhoods adjacent to the maximum concentration neighborhoods are desirable secondary sites. A third category of monitoring sites includes neighborhoods that are of special interest because of large population density; because of rapid growth expectations; or because of a highly sensitive population such as elderly (e.g., nursing home), ill (e.g., hospital), or young (e.g., day care center).

Sites in the third category of interest may also meet the second category of interest. There are no firm rules to determine how many sites to monitor. Each monitoring jurisdiction must determine what its priorities are and how far down the priority list of potential sites it is able and willing to go.


Highway Date:
4-lane, 12-m wide highway
Traffic = 3000 vehicles/h
Emissions = 0.28 g/vehicle/km.
Wind and Stability:
Pasquill Class C
Wind perpendicular to highway.
CONCENTRATION (µg/m3)
0
10
20
30
40
0
20
40
60
80
100
120
140
DISTANCE FROM MEDIAN(M)
LEGEND: WIND SPEED (m/sec)
1
4
12


Highway Date:
4-lane, 12-m wide highway
Traffic + 3000 vehicles/h
Emissions = 0.28 g/vehicle/km.
Wind and Stability:
Pasquill Class D
Wind Speed = 4 m/sec.
C O N C E N T R A T I O N (μg/m3)
0
10
20
30
40
0
20
40
60
80
100
120
140
DISTANCE FROM MEDIAN(M)
LEGEND: WD FROM HIGHWAY
10
45
90

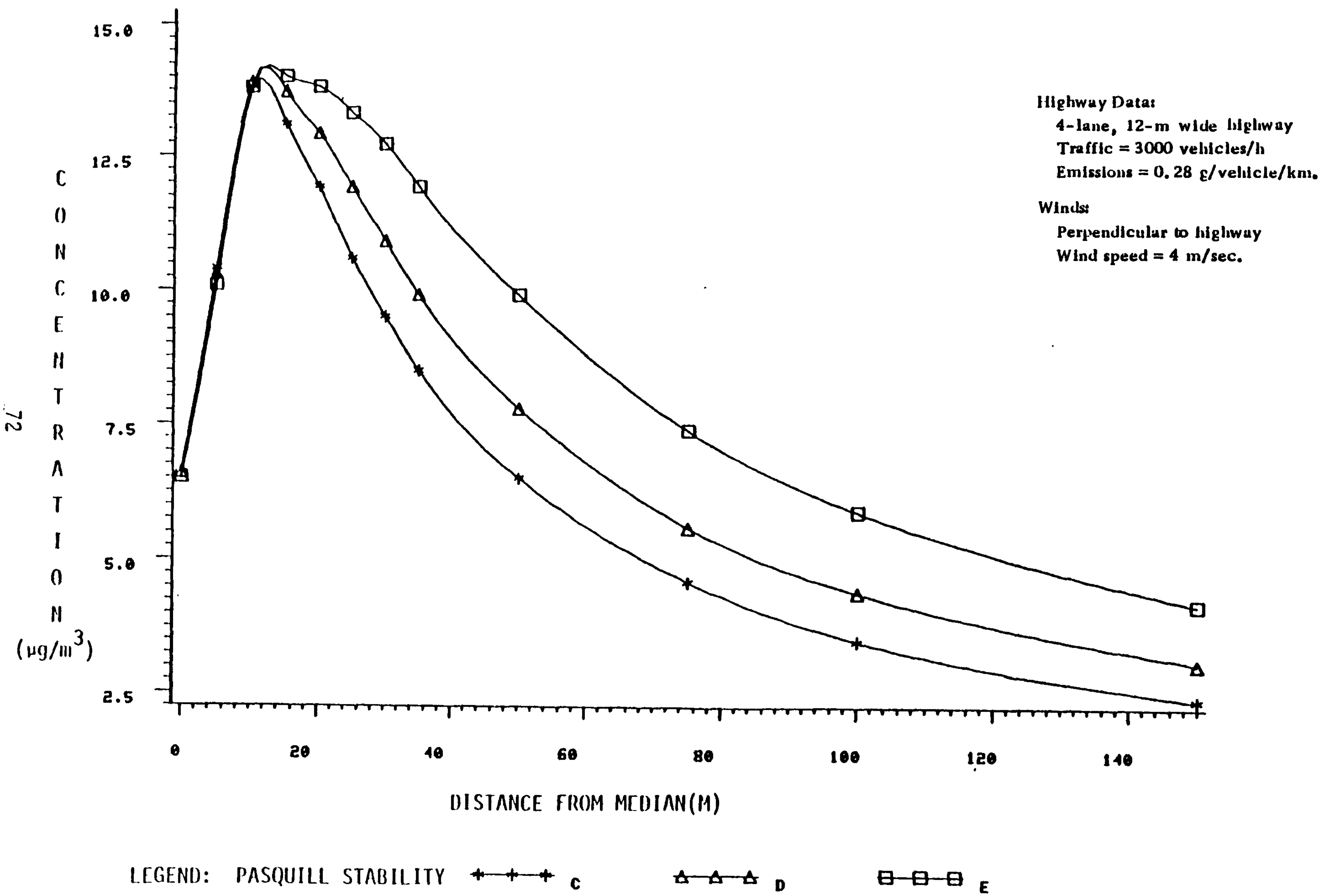

CONCENTRATION (µg/m³)
15.0
12.5
10.0
7.5
5.0
2.5
0
20
40
60
80
100
120
140
DISTANCE FROM MEDIAN(M)
Highway Data:
4-lane, 12-m wide highway
Traffic = 3000 vehicles/h
Emissions = 0.28 g/vehicle/km.
Winds:
Perpendicular to highway
Wind speed = 4 m/sec.
LEGEND: PASQUILL STABILITY C D E

TABLE 12. MAXIMUM CONCENTRATIONS NEAR DOWNWIND EDGE OF TYPICAL URBAN AREA SOURCES

Type Source	Typical Maximum 24-hour Concentration (μg/m^3)	References
Urban Expressway (1)	85	Burton and Suggs 1982
Street Canyon (2)	45	Ingalls 1981
Parking Garage* (3)	45	Ingalls 1981
Roadway Tunnel (2)	650	Ingalls 1981
Shopping Mall (4)	80	Ingalls 1981
Sports Stadium* (4)	10	Ingalls 1981

* Very high short term concentrations may occur near this source.
(1) Based on observed upwind-downwind differences in IP over 14 hours, corrected to 24 hours and PM_{10}.
(2) Based on a 24-hour average to peak ratio of 0.5, a vehicle emission rate of 0.28 g/km, and a peak traffic flow of 3000 vehicles/hour.
(3) Based on model estimates and an emission rate of 0.085 g/min.
(4) Based on CO observations of 2.5 ppm (24 h) for shopping centers, and 22 ppm (15 min) for sports stadiums, and ratio of PM_{10} to CO emissions of 0.0286.

Table 13 illustrates a rationale for selecting 15 sites. In this example, four neighborhoods are identified that potentially have high micro- and middle scale PM_{10} levels. The neighborhoods that border on a neighborhood containing high concentrations are also expected to have a chance of exceeding the NAAQS for PM_{10}. As a result, two sites in adjacent neighborhoods will be selected. There are also three neighborhoods that contain health care treatment facilities with persons who are highly sensitive to air quality. After discussions with various officials responsible for providing funds for air monitoring operations, a decision is made to put monitors at 15 sites.

TABLE 13. EXAMPLE DETERMINATION OF THE NUMBER OF MONITORING SITES IN A METROPOLITAN AREA*

Priority	Type of scale for PM_{10}	Recommended number of sites	(X) Number of areas	(=) Number of sites
1	Includes selected micro- or middle scale site	1	4	4
2	Adjacent to major source area	2		8
3	Special interest	1	3	3
			Total	15

* This case was selected to be representative of a city with a population of 500,000 and four major source areas. Smaller cities and cities with fewer source areas may require fewer monitoring sites.

Each neighborhood selected for monitoring must be reviewed carefully to identify areas containing micro- or middle scale PM_{10} effects. Neighborhood scale sites must be selected to avoid these areas. The data presented in Tables 14 through 16 identify the distances to which middle scale effects extend from the types of sources associated with PM emissions. These distances should be shown as circles around sources in neighborhoods selected for monitoring.

TABLE 14. SIGNIFICANT IMPACT DISTANCES OF SMALL GROUND-LEVEL AREA SOURCES

Area (m x m)	Emission rate (kg/km^2/day)	Maximum downwind distance (km) with significant impact*
250 x 250	10	0.25
	10^2	1.0
	10^3	5
500 x 500	10	0.6
	10^2	2.5
	10^3	14
10^3 x 10^3	10	1.4
	10^2	7
	10^3	45

* Based on 24 μg/m^3, F stability class and 2 m/sec wind speed. Estimated using Workbook of Atmospheric Dispersion Estimates (Turner 1970) by treating source as a point. This worst case situation is expected to produce a 24-hour concentration of 6 μg/m^3.

TABLE 15. SIGNIFICANT IMPACT DISTANCES OF HIGHWAYS

Average daily traffic (veh/day)	Maximum downwind distance (km) with significant impact*
100,000	0.22
50,000	0.11
25,000	0.05
15,000	0.02
12,000	0

* Based on 6 μg/m^3, Pasquill stability class D, and wind speed of 2 m/sec at 45 degree angle with highway. Estimated using EPA HIWAY2 model and vehicle emission rate of 0.28 g/km. Because concentrations downwind of highways are not sensitive to variations in wind direction, the worst case 24-hour concentration is based on a persistent worst case 1-hour concentration. This allows the effect to be comparable with worst case effects from elevated points (Table 16) and small areas (Table 14).

TABLE 16. SIGNIFICANT IMPACT DISTANCES OF ELEVATED SOURCES

Effective plume height (m)	Emission rate (kg/hr)	Critical Pasquill stability class	Maximum downwind distance (km) with significant impact*
30	30	C	3.3
	10		1.7
	3		0.9
100	100	A	1.2
	30		0.8
	10		0.5
300	100	A	1.2

* Based on 24 μg/m^3 and 2 m/sec wind speed. Estimated using Workbook of Atmospheric Dispersion Estimates (Turner 1970). This worst case situation is expected to produce a 24-hour concentration of 6 μg/m^3.

Monitoring Isolated Major Sources in Flat Terrain

Figure 20 suggested steps to be followed in selecting monitoring sites near an isolated major source. A distinction must be made between sources with the principal emissions from a tall stack and sources with the principal emissions from ground level. For ground-level sources, the maximum concentrations will occur immediately adjacent to the source in the most prevalent downwind directions from the source. Wind observations will easily identify the most suitable siting areas. Additional monitors may be used to help define the extent of the area near the source that has high concentrations and the neighborhood scale level of PM_{10} in the vicinity of the source. Two types of information can be helpful in determining the extent of the high impact area: (1) the relative concentration isopleths from the EPA (1970) Workbook of Atmospheric Dispersion Estimates and (2) annual wind direction frequency statistics published by the National Climatic Center (see Appendix A).

It is easily seen from the Workbook data that the peak concentration falls off rapidly with distance for ground-level sources. The peak concentration 100 m from the source drops by a factor of 10 at a distance of 40 km from the source for all stability conditions. The more stable the atmosphere, the more slowly the peak concentration drops with increasing distance from the source. The Workbook curves show that even for very stable conditions (Pasquill Class F), the peak concentration drops by a second factor of 10 within 1600 m from the source. These data show the microscale influences within 100 m of the source are at least 10 times greater than the middle scale influences from 100 to 500 m from the source. If there is public exposure within 100 m, it is important to locate a monitor there. Middle scale monitoring sites within 500 m of the source are desirable in each prevailing wind direction. One of the middle scale sites should be downwind for the wind direction that occurs most frequently with stable conditions and low wind speeds. A Star climatology analysis for the closest weather observing station maybe used to determine this direction (see Appendix A).

If the primary emissions are from a tall stack, the highest ground-level concentrations will be away from the source. Detailed manual computational procedures for estimating the magnitude and location of the maximum impact of tall stack emissions are given in Volume 10 of the EPA Guidelines for Air Quality Maintenance Planning and Analysis (Budney 1977). Figures 27 and 28 (taken from Budney 1977) show how the distance to the maximum short-term concentration varies with the effective height of the exhaust gas plume and atmospheric stability. Figure 27 treats sources in rural terrain, and Figure 28 treats sources in urban terrain. Budney's Guideline describes a method of estimating the effective height of the source. Because the PM_{10} monitors will observe 24-hour and annual mean concentrations, the large variation in distance to the maximum concentration with variations in atmospheric stability class must be taken into account in selecting a site. It may be noted in Figure 27 that the maximum concentrations occur with the greatest instability (i.e., Class A). Therefore, it is important to site a monitor close to the source where the maximum contributions will occur under unstable conditions. As shown by Figure 27, this will be as close as 100 m to a source with a 20 m effective height and as far as 800 m downwind of a source with a 300 m effective height.

Another important factor in selecting a site is the persistence of the wind direction over the observation period. Because the wind direction is highly variable under unstable conditions and because persistent wind directions are generally associated with neutral (Class D) stability conditions, a good strategy is to select a second monitoring site at a distance associated with the peak for neutral stability. The distance downwind to the peak concentration will vary from about 350 m for an effective height of 20 m to between 15 and 20 km for an effective height of 300 m.

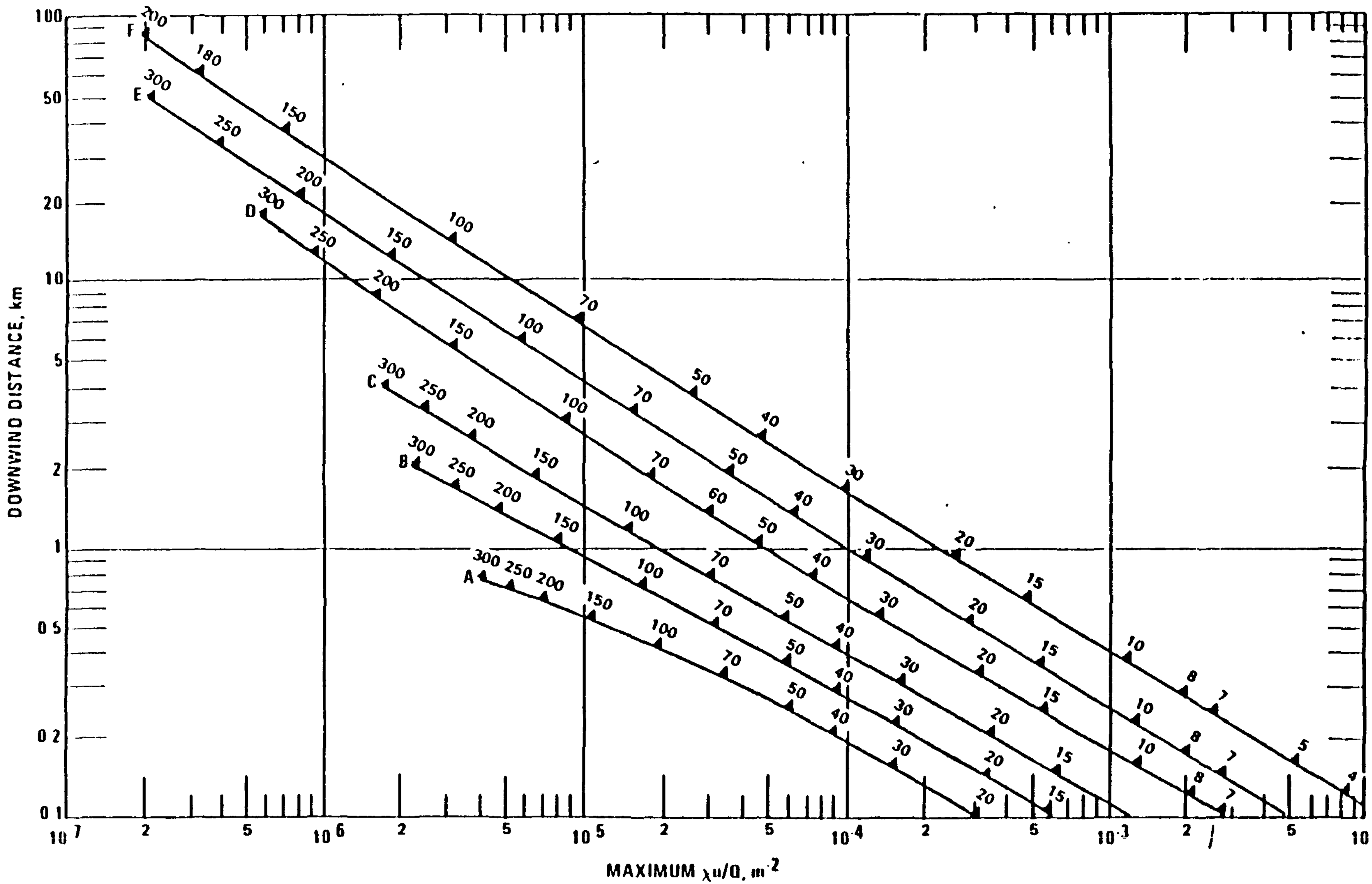


Figure 27. Downwind distance to maximum concentration and maximum relative concentration ($\chi u/Q$) as a function of Pasquill stability class and effective plume height in rural terrain (Turner 1970).

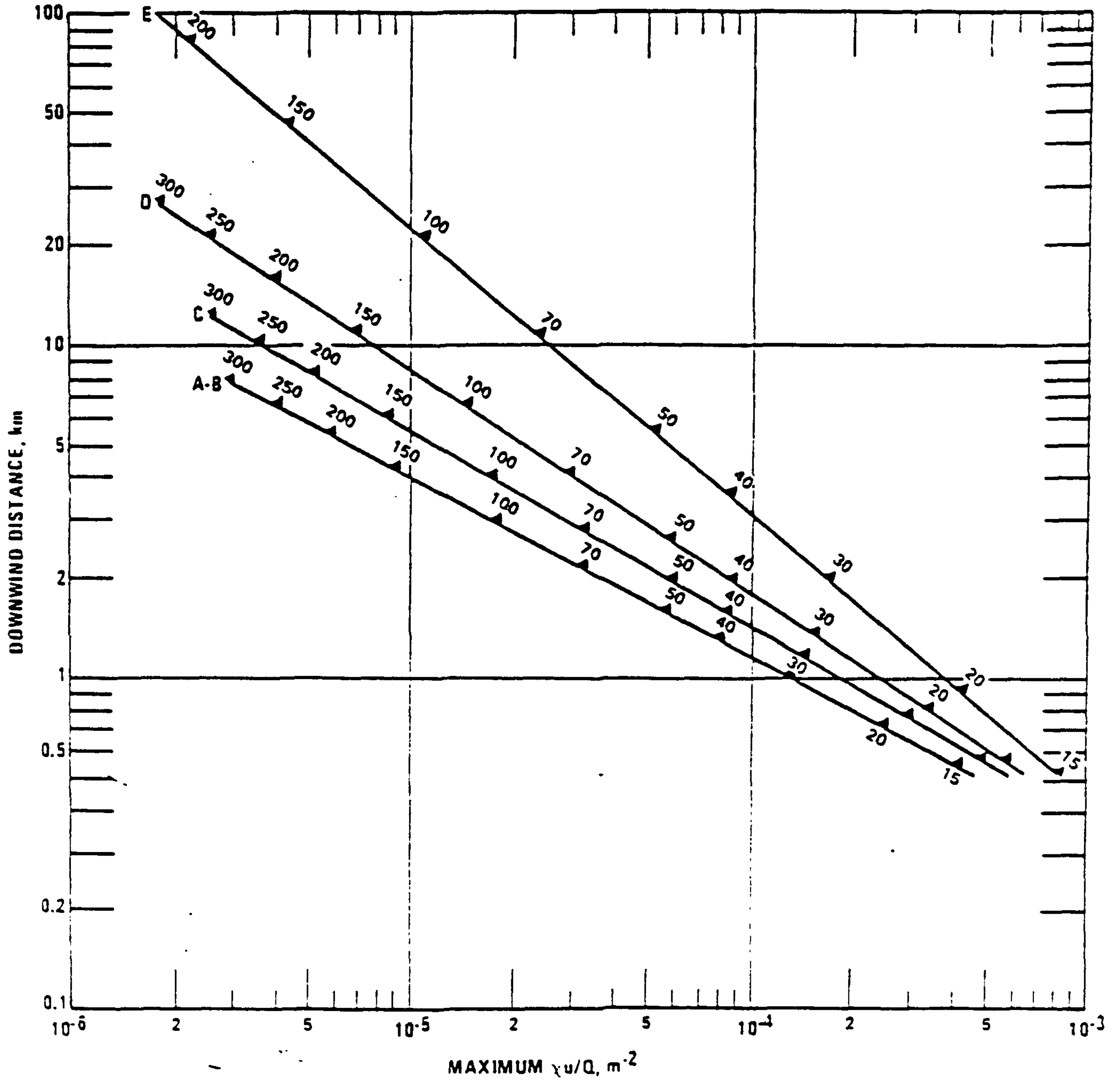


Figure 28. Downwind distance to maximum concentration and maximum $\chi u/Q$ as a function of stability class and effective plume height in urban terrain (Budney 1977).

The peak concentration will be sharp, with high concentrations falling off rapidly with distance from the peak, when the peak is close to the source. This is a middle-scale effect, and the maximum impacts will be observed over an area within 200 to 300 m of the peak. The frequency of wind directions associated with only unstable conditions should be taken into account in selecting sites for observing the middle-scale peak.

When selecting a site to observe concentrations from a tall stack (effective height of 100 m or more) during persistent wind conditions (and neutral stability), the concentrations will fall off gradually with distance from the peak. The impacted area will be on a neighborhood scale, with high concentrations (within 25 percent of the peak) occurring at distances of 2 km from the peak when the effective height is 100 m and to distances of 10 km when the effective height is 300 m. Wind direction frequencies associated with neutral conditions should be used to site monitors. It may be noted that there is a large area within which to select a site.

Wind observations from remote sites (e.g., a regional airport) are very useful for selecting neighborhood-scale sites. When selecting a middle-scale site, it is necessary that the wind observations be representative of the very small scale area in the vicinity of the site. In the next section, topographical influences are discussed that may make wind observations unrepresentative. Suggestions are made for taking the local influences into account in selecting monitoring sites.

Monitoring Isolated Major Sources in Complex Terrain

There are a number of situations in which the complexity of the terrain in the vicinity of a major source will influence how pollutants are distributed in the nearby vicinity. These influences must be taken into account in siting monitors if the observations are going to achieve their objectives. Available meteorological observations may not be adequate to desribe the effects, especially if they are taken from a single site. In particular, the effects of elevated terrain, coast lines, and urban structures need to be taken into account. The air flow characteristics in the vicinity of these types of terrain were discussed in Section 4. Suggestions are given here for using the topographical characteristics of an area to select monitoring sites and to modify the site selection guidelines for flat terrain.

Typical influences due to elevated terrain include two-sided boundaries such as a valley and one-sided boundaries such as a mountain range or a pronounced bluff. Air flow in a valley is subject to nighttime drainage down the slopes and along the valley floor, to upslope covection and fumigation during the day, and to channeled flow when strong winds blow diagonally across the valley. Near one-sided boundaries, emissions on the downwind side of a ridge or hill may become entrapped in the turbulent wake flow downwind of the ridge, or separated from ground-level when overshoot separation flow occurs over the ridge. Emissions near either one-sided or two-sided terrain boundaries may impact the terrain under very stable conditions with the flow directed towards the elevated terrain. Each of these effects produces a pollution impact zone, which is associated with the terrain configuration. Monitoring sites are needed that measure the results of these effects. The following terrain-oriented sites are needed to supplement or replace sites that conform to flat terrain siting selections:

- Down- and up-valley in place of or in addition to downwind of the most prevalent wind directions

- Terrain elevation at the effective height of the source plume or at maximum elevation (if less than effective height) in prevailing downwind directions

- Nearest terrain elevation at effective height of source plume.

Near a lake or ocean coast, there will be an invisible boundary between the air influenced by the temperature of the underlying water surface and the air influenced by the temperature of the underlying land surface. A great difference in the two surface temperatures can significantly alter air flow in the vicinity of the coast line. The two effects that are of interest in selecting sites for monitors are (1) the tendency for the air flow to be perpendicular to the coast and (2) the formation of a vertical circulation with its axis centered on the coast line. The first effect indicates the need for a monitoring site directly inland from a source near the coast. The second effect indicates the need to have sites along the coast on both sides of the source. These sites are to catch the impact of air that initially moves inland, but that subsequently rises, moves back over the water, sinks, and blows back inland at low levels. Under these conditions, pollution moves perpendicular to the apparent ground-level wind observations. The magnitude of the air pollution effect from this recirculation of air over the coast line is difficult to anticipate. It could be an important, controversial contribution to establish. These siting considerations should be taken as supplements to the guidelines given for more uniform terrain situations.

Urban Areas with Major Point Sources

When major point sources of PM emissions are present in an urban area, there is a need to consider the impacts of the point and the urban area sources individually and of their joint overlapped effects. Siting considerations relating to both urban areas and points as individual sources were previously discussed. The overlapped effects can be best identified by considering lines connecting pairs of nearly individual sources. When the connecting lines parallel one of the prevailing wind directions, locations that are downwind of both sources and near the maximum of the second downwind source are likely locations of maximum 24-hour PM_{10} concentrations. However, the maximum annual mean concentration is likely to be in a location that is central to the individual sources. Such a location will be affected by different sources at different times, rather than by the simultaneous overlapping of the effects of two or more sources. These two qualitative criteria regarding the impact of overlapping effects can be used to help identify locations that are probably sites of maximum concentrations. These criteria are helpful when a modeling analysis is not available to evaluate the joint effects of multiple sources.

Simple calculations and graphical analysis may be used to apply the above siting criteria for multiple sources. For instance, in deciding which pairs of overlapped source contributions are most significant, the relative emission sites and distances between sources should be taken into account. The contribution of a source to the PM_{10} concentration at any location is directly proportional to the emission rate and inversely proportional to the distance from the source. Although the distance relationship is a complex function of atmospheric stability conditions and the effective height of the emissions, the distance effect is most frequently very nearly proportional to the inverse square of the distance. For the purpose of evaluating the importance of overlaps from the sources, the following relationship can be used:

$$A = \frac{E}{D^2}$$

where A = Relative contribution from second source
E = Emission rate (second source)
D = Distance to second source.

To illustrate the use of this relationship, consider a major urban freeway with a nearby source only 0.5 km away that emits 10 lb/hr. The overlap contribution from the source will be more important than any other source emitting 100 lb/hr or less at a distance of 1.6 km or more away, since

$$A_1 = \frac{10}{(0.5)^2} = 40$$

$$A_2 = \frac{100}{(1.6)^2} = 39$$

A good way to define the scale and locations of the effect of overlapped sources is to construct a representative graph of peak concentrations versus distance downwind of the second source. This can be done quite easily by the use of the EPA Workbook of Atmospheric Dispersion Estimates (Turner 1970) or

Volume 10 of the EPA Guidelines for Air Quality Maintenance Planning and Analysis (Budney 1977). The following steps may be used:

1. Pick a representative stability condition (e.g., C stability) and find the appropriate $\chi u/Q$ versus distance graph.

2. For the larger of two overlapping sources, use the selected graph to find a dozen pairs of $\chi u/Q$ and distance values that straddle the peak $\chi u/Q$ value, and multiply the $\chi u/Q$ values by the emission rate to get $(\chi u)_1$ values.

3. Add the distance (D) between the two sources to the distances read in step 2 and read a new χ/Q value from the graph for each new distance.

4. Multiply the second set of $\chi u/Q$ values by the second source emission rate to get $(\chi u)_2$ values.

5. Add the two sets of χu values together and plot the sum as a function of the initial distance (without D added).

6. Repeat steps 2 through 5 for additional distances to make the curve complete.

Table 17 shows a sample work table for use with the above steps. The procedure may be repeated for more than one stability class to help identify a range of distances from the source within which the maximum concentrations will occur. The buildup and fall off of concentration with distance will help identify the distance scale that the combined concentrations will affect.

TABLE 17. SAMPLE WORK TABLE FOR OVERLAP EFFORTS

Distance from larger source (x)	$(\chi u/Q)_1$	$(\chi u)_1$	Distance from smaller source (x+D)	$(\chi u/Q)_2$	$(\chi u)_2$	$(\chi u)_1$ + $(\chi u)_2$

This procedure is expected to be adequate for most monitor siting purposes. However, the graphs referenced above do not include any effects of particle removal due to fallout or other atmospheric processes. Actual concentrations may decrease more rapidly with downwind distance than is represented by these curves. More accurate graphical representations of the relationship may become available in the future and should be used when appropriate.

When considering sites to measure long-term concentrations that include contributions from many sources, a simple numerical evaluation procedure may be used to help select the best sites. Over a long-term period, both the distance from the source and the frequency with which the wind blows from each source to the potential monitoring site must be taken into account. The following simple source weighting function takes these two effects into account:

$$B = \sum_{i=1}^{N} \frac{E_i f_i}{(D_i)^2}$$

where B = Monitoring site pollution index
E_i = Source i emission rate
f_i = Relative frequency with which wind blows from source i to the monitoring site
D_i = Distance from source i to monitoring site
N = Number of urban area and major point sources.

This site evaluation equation may be used to rank alternative monitoring sites. The best way to perform the site evaluation process is to plot the major urban area and major point sources on a map. A number of locations in the middle of the sources and close to or downwind of the larger sources may be selected as potential monitoring sites. The evaluation equation may then be used to score the relative pollution levels expected at each potential site. The highest score would indicate the site most likely to measure the highest PM_{10} concentration.

SELECTION OF MONITORING SITES

Number and Locations of Monitors

The preceding steps have been concerned with developing a pattern of PM_{10} air quality that occurs in an area of concern for which monitoring is planned. This may be an area administered by an air pollution control agency or an area impacted by a particular source. In either case, there are three types of information regarding the patterns which are of interest, including:

- Maximum PM_{10} concentration
- Background PM_{10} concentration
- Area impacted by significant PM_{10} concentrations.

Significant PM_{10} concentrations may be levels associated with air quality standards, PSD increments, specific increments above background levels, or other criteria of interest. There is another type of site that does not involve a selection process (i.e., sensitive sites of special interest). In a simple pattern, there will be one maximum and a single regularly shaped contour that defines the area impacted by significant concentrations. Complex patterns have two or more peaks that may or may not lie within a single closed contour of impacted areas of interest. Unless one peak is much higher than the others, two or more peak areas will need to be monitored.

The number of monitors needed to define impacted areas will include a minimum of two and may include six or more depending on how large, how complex and how definitive the impacted area is. A single, well-sited monitor, located well away from any nearby sources or source areas, may be adequate for determining background concentrations. If it is impractical to locate a monitor far away from nearby sources, it may be desirable to select two nearby monitors, one or more of which is measuring background concentrations on any given day, depending on wind direction. Because PM_{10} concentrations are measured over 24-hour periods and because the wind direction is frequently variable over a 24-hour period, this is a less desirable option than a single, well-sited monitor.

In planning and revising air monitoring plans, it is important to bear in mind that the need for monitoring data is dynamic and will change from year to year. Once the nature of the air quality pattern for PM_{10} concentrations has been established or verified, fewer stations are needed to evaluate general ambient conditions and trends. This is especially true for areas where the ambient levels are well within acceptable limits and there is no significant impact area. Reducing the amount of resources allocated to fixed monitoring stations will allow resources to be reallocated to meet other special purpose monitoring needs.

Previous monitoring and modeling provide a first estimate of the PM_{10} air quality patterns, but a large amount of uncertainty may still exist regarding both the shape and the magnitude of the pattern. Therefore, some monitoring resources should be allocated to verifying the assumptions made regarding the pattern. Two forms of monitoring are recommended for this purpose, including temporary sites and mobile monitoring. This type of monitoring is most effective when it is used in conjunction with modeling results to confirm or deny the influence of specific sources on air quality levels. An example of appropriate use of this type of monitoring is to establish the validity of a kink or a bulge in the air quality pattern due to the influence of a specific nearby source or source area. Modeling results could be obtained to show the expected contribution of specific sources to the bulge. Air monitoring results along with appropriate meteorological data could be used to establish the validity of the influence. A temporary monitor could be moved from one location to another to investigate the validity of a number of these influences. The monitoring results would increase confidence in the modeling results or provide the basis for either model improvements or selection of a more accurate model.

Mobile monitoring can also be used to help establish the influence of specific sources. Mobile monitoring is effective when it is used to identify peaks in concentrations during crosswind sampling traverses downwind of large elevated point sources. Another effective use of mobile monitoring is to encircle area sources in order to establish concentrations upwind and downwind of suspected significant sources of ground-level fugitive emissions. A limitation in mobile monitoring is the need to use a continuous type of analyzer. Continuous measurements of PM will necessarily be based on physical measurement other than the weight of size-selected particulate matter collected on a filter. As a result, it will be necessary to correlate the mobile measurements with fixed station measurements before interpreting the mobile measurement data. Some guidelines on ways of making these correlations are provided in the Guidelines for PM-10 Episode Monitoring Methods (Pelton 1982).

Specific Site Selection

Once a general area for a monitoring site has been selected, it is necessary to select a specific location for the sampling operation. The intake for the monitor must be representative of the siting area, as close to the breathing zone as possible, and not biased abnormally high or low by influences which are only representative of the probe intake. The nature of biasing influences is documented in CFR 40 Part 58 and includes the following:

- Chemical reactions due to the air stream passing near reacting surfaces
- Unusual micrometeorological conditions
- Vegetation that serves as a pollutant sink
- Undue influence from nearby small sources (e.g., incinerator or furnace flue)
- Shielding influences from nearby obstructions.

Based on the consideration of these factors, the following guidelines for siting problems were promulgated in CFR 40, Part 58:

- 2-15 m above ground, as near to breathing height as possible, but high enough not to be an obstruction and to avoid vandalism
- At least 2 m away horizontally from supporting structures or walls
- Should be 20 m from dripline of trees
- Should not be near furnace or incinerator flues
- No nearby obstructions to air flow due to buildings, structures or terrain, at least in directions of frequent wind.

These guidelines were provided for TSP but are equally applicable to PM_{10}.

INSTALLATION AND FOLLOWUP

Each time a monitoring site is established, a documented description of the site is established. This record will help in the interpretation of results obtained from the site and in the evaluation of the need for changes. The following information is useful in documenting a site with regard to effects on measured PM_{10} concentrations:

- Exposure diagram
  - Horizontal depiction showing location relative to nearby streets, buildings, and other significant structures, terrain features, or vegetation
  - Vertical depiction showing location relative to supporting structures, including buildings, walls, etc.
- Height of sampling intake above ground level
- Microinventory map showing locations of roads (with traffic counts), open fields, storage piles, and any visible emissions within 500 m of sampler
- List of all inventoried point and area sources within 1.5 km of sampler and all major point sources within 8 km of sampler

- Make and model of PM_{10} monitor

- Types of meteorological and other air monitoring equipment operated at the site.

Once a monitoring site is selected and approved, the above site information should be compiled. As soon as it is practical, data collected from the site should be reviewed and scrutinized to determine that they do not contain undue influences from nearby sources. The suggestions for analyzing single-station air quality records, presented earlier in this report, should be used to evaluate the observations.

SECTION 6

EXAMPLE STUDY

To illustrate and test the ideas for selecting monitoring sites that were described in Section 5, TSP data for the City of Baltimore and surrounding areas for 1980 and 1981 are listed in Table 18. Figure 29 shows the locations of monitoring sites within the city limits; Figure 30 shows monitoring site locations outside the city limits.

For the purposes of this example, it is assumed that the State of Maryland and the City of Baltimore will cooperatively operate monitoring stations in the city for the following objectives:

- Evaluate progress in meeting and judge the attainment or nonattainment of NAAQS
- Develop and revise as necessary the Maryland Implementation Plan for controlling PM_{10}
- Provide data to EPA to meet national monitoring needs and to evaluate the State's management of air quality
- Provide data for model research and development
- Support enforcement activities
- Provide the public with information on air quality exposure and trends
- Provide data to identify and document episode exposure situations.

The annual mean concentrations for 1980 and 1981 are plotted in Figures 31 and 32. Isopleths are also shown to help interpret the patterns indicated by these data. The locations of the eight major point sources with particulate matter emissions in excess of 100 tons/yr are also shown and identified by number. The estimated emission rates for these sources are listed in Table 19. Fugitive emissions shown by squares in the air quality maps are listed in Table 20.

The maximum 24-hour concentration of TSP that were measured during 1980 and 1981 are shown in Figures 33 and 34. The 1981 pattern is based on 15 observations, while the 1980 pattern is based on 10 observations. The patterns of maximum concentration are quite different between the 2 years. The tongue of

TABLE 18. HI-VOL MEASUREMENTS OF TSP IN THE VICINITY OF BALTIMORE (MARYLAND AIR MANAGEMENT ADMINISTRATION 1980, 1981)

Site, county	Geometric mean		Maximum (6-day cycle)	
	1980	1981	1980	1981
35. Fire Department Headquarters, City	82	70	284	203
38. NE Police Station, City*	54	48	138	129
39. NW Police Station, City*	69	56	275	122
40. SE Police Station, City*	81	68	269	166
41. SW Police Station, City*	65	55	201	135
42. Fire Department #10, City	--	88	--	325
44. Fairfield, City	89	89	206	310
47. Canton Pier #4, City**	--	(141)[2]	--	(575)[2]
48. AIRMON-02, City	--	67	--	146
49. Fire Department #22, City**	82	(85)[2]	222	(165)[2]
50. Ft. McHenry, City	103	89	195	231
51. Holabird Elementary School, City**	(72)[2]	71	(175)[2]	161
52. Westport, City	93	71	178	140
53. Canton Recreational Center, City**	--	(75)[2]	--	(176)[2]
54. I-95, City**	(73)[3]	73	(133)[3]	155
23. Garrison, County	49	47	94	93
26. Catonsville, County	47	46	86	112
28. Essex, County	64	61	134	136
29. Padonia, County	67	60	183	114
33. Chesapeake Terrace Elementary School, County	66	60	147	140
34. Sollers Point	79	80	145	176
18. Linthicum, Anne Arundel County**	(56)[2]	--	(81)[2]	--
20. Glen Burnie, Anne Arundel County	68	61	132	125
23. Riviera Beach, Anne Arundel County	60	58	85	137

* Operated on a 3-day cycle, rather than a 6-day cycle.

** Values in parentheses represent only two or three quarters.

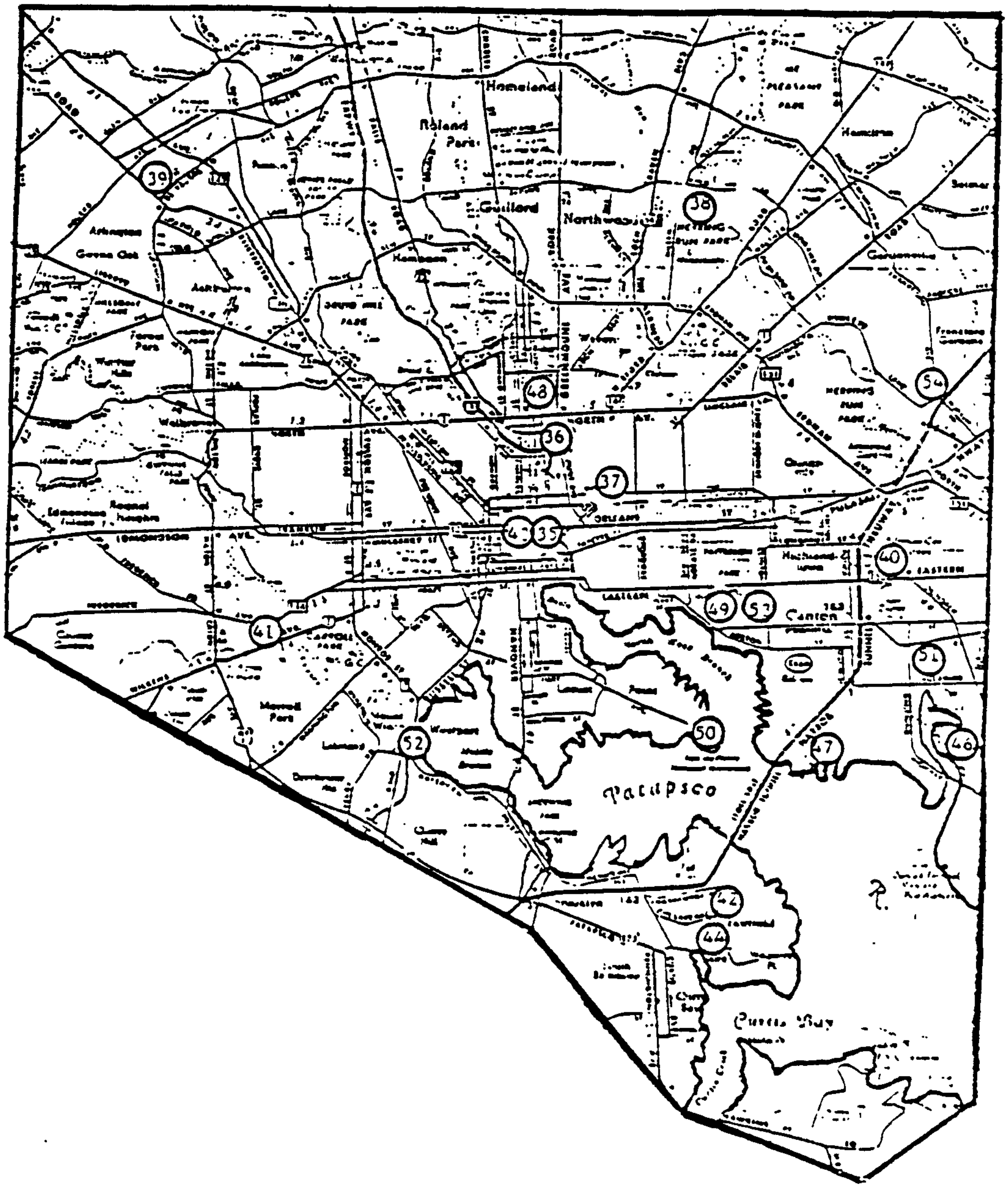


Figure 29. TSP monitoring sites in Baltimore City.

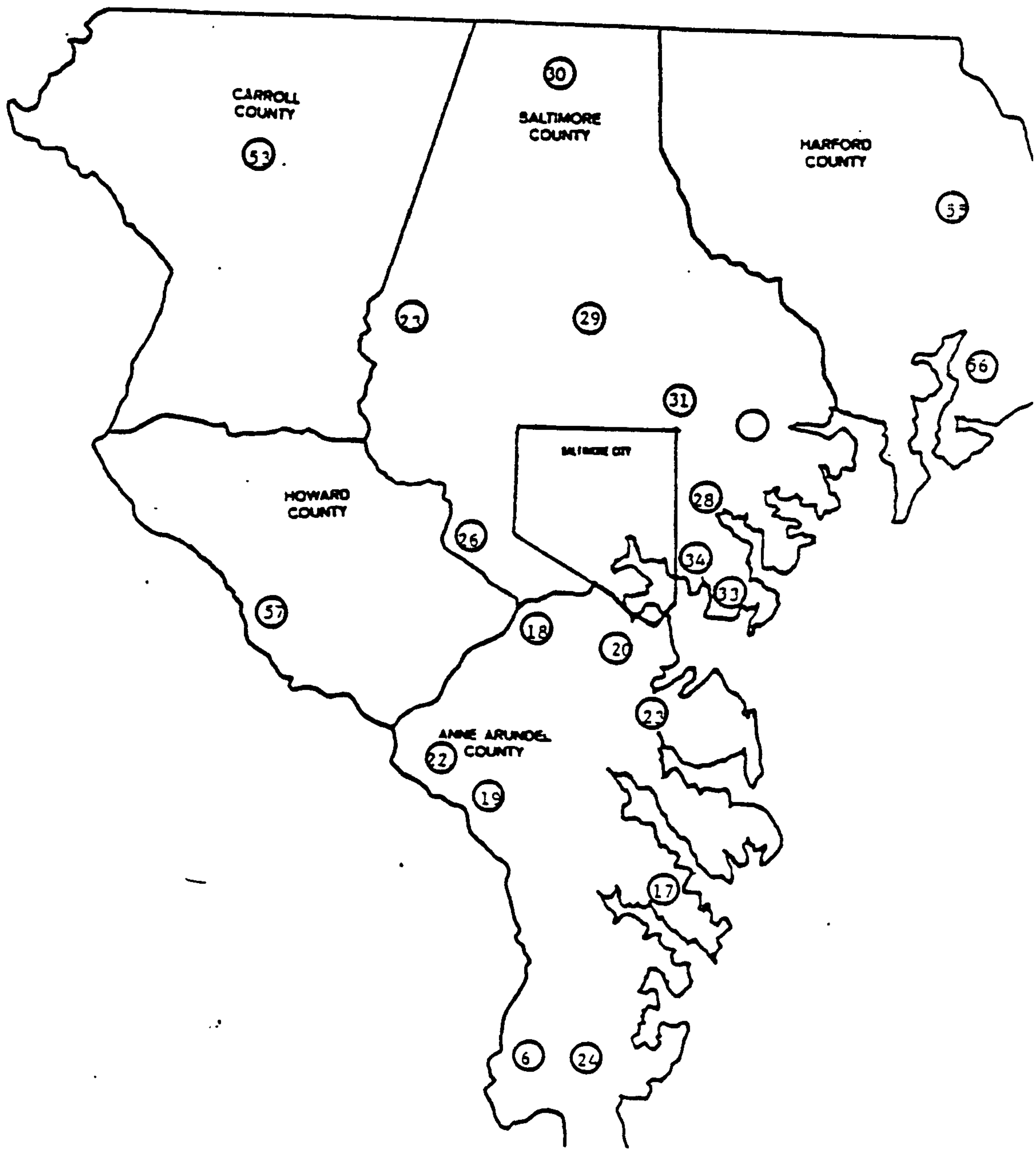


Figure 30. TSP monitoring sites in the Baltimore AQCR, excluding Baltimore City.

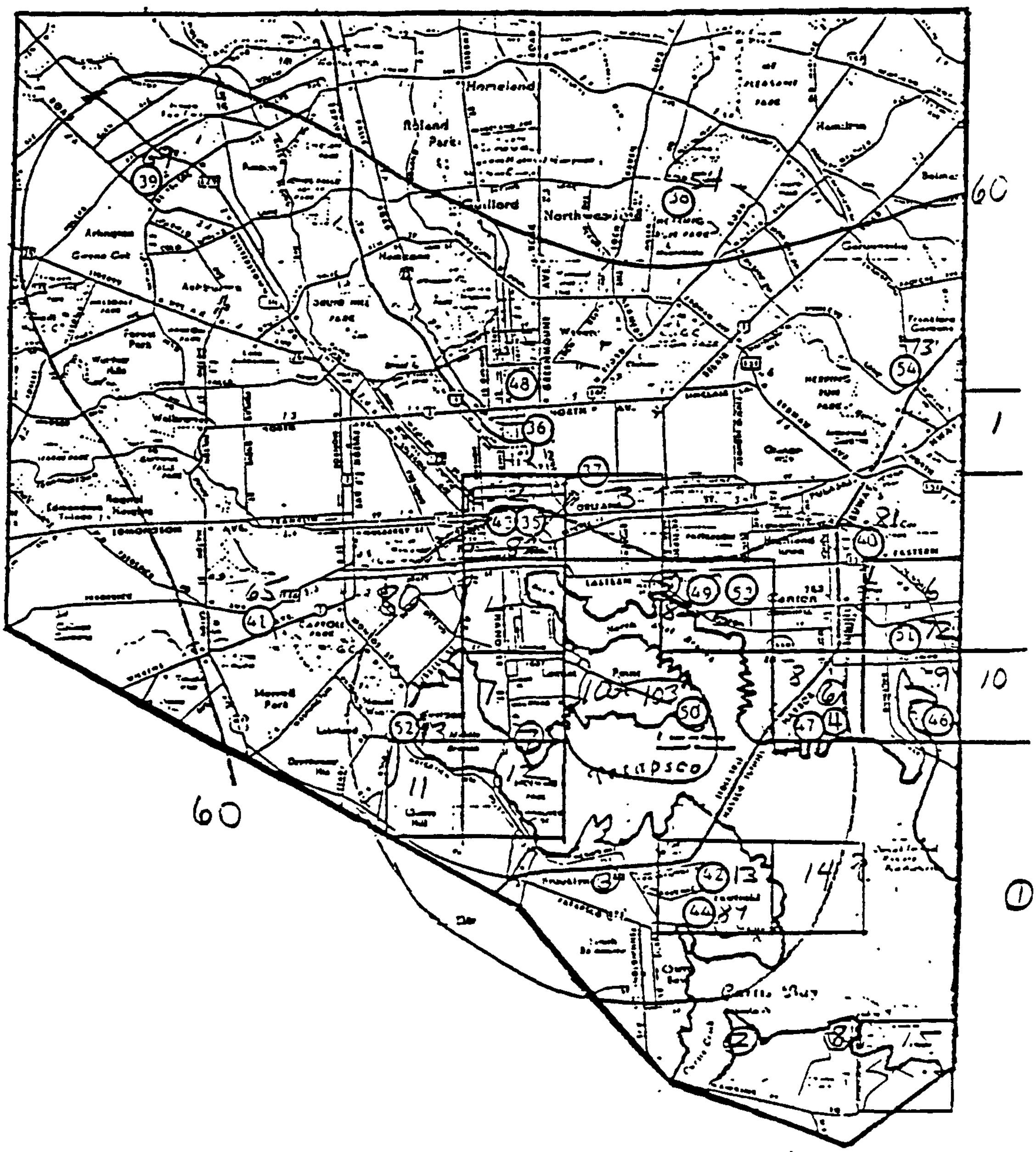


Figure 31. Annual mean TSP concentration for 1980.

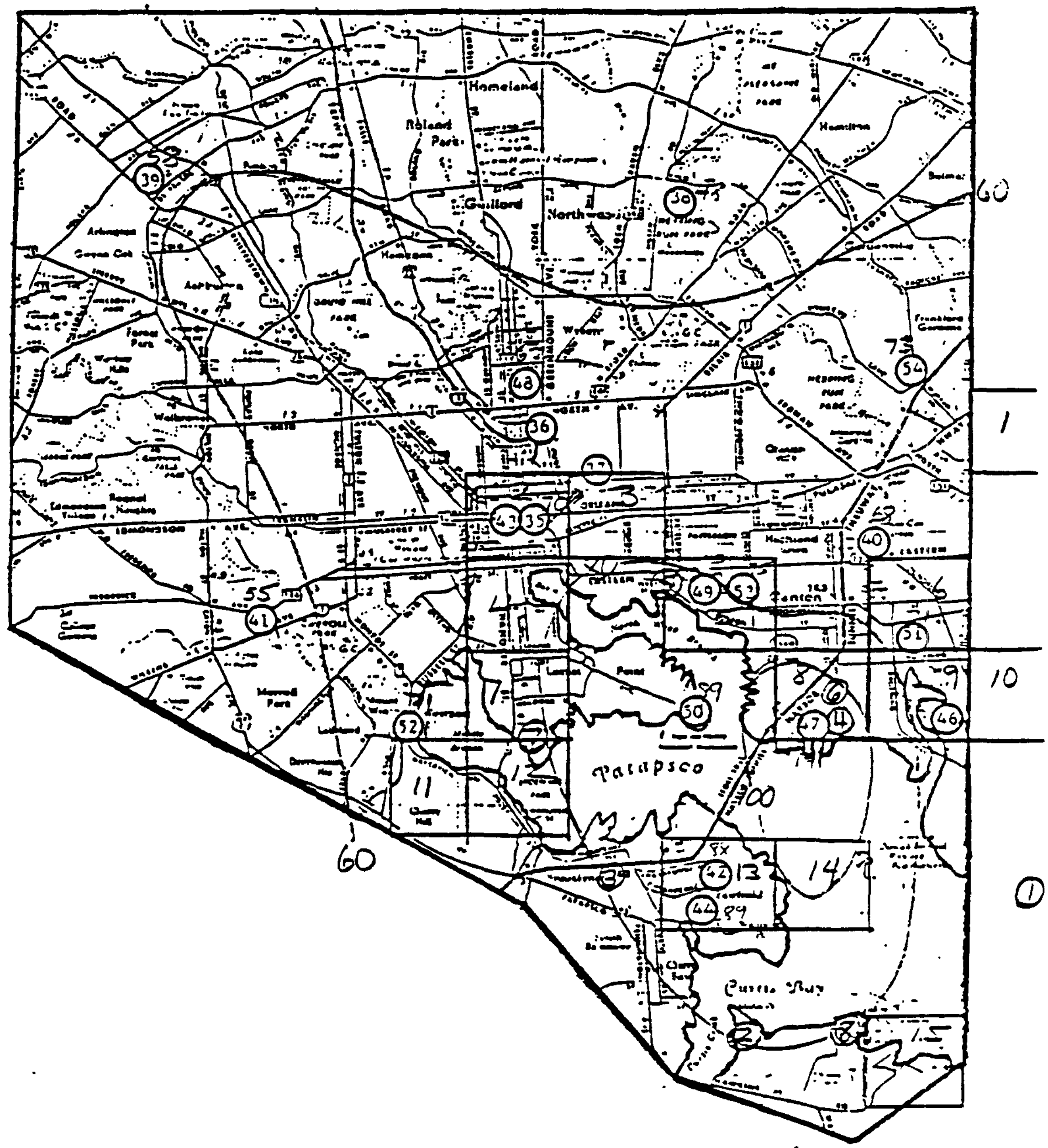


Figure 32. Annual mean TSP concentration for 1981.

TABLE 19. TSP EMISSIONS BY EIGHT LARGEST POINT SOURCES IN BALTIMORE CITY

Number	Name	Emissions (tons/year)	Type
1	BG&E	181	Fuel burning
2	Davison Chemical	133	Process
3	General Refractory	116	Process
4	Carton Elevator	1,475	Process
5	Allied Chemical	145	Process
6	National Gypsum	126	Process
7	Louis Dreyfus	2,193	Process
8	U.S. Gypsum	1,612	Process

TABLE 20. FUGITIVE EMISSIONS BASED ON 1977 SURVEY
(Schakenbach and Koch 1978)

Area identification	Emission rate (tons/day)	Principal sources
1	11.7	Dirt roads
2	8.0	Dirt roads, construction sites
3	2.2	Dirt and gravel roads
4	4.1	Dirt and gravel roads
5	2.2	Dirt and gravel roads
6	7.3	Dirt roads
7	2.4	Dirt roads, construction sites
8	2.6	Dirt and gravel roads
9	10.9	Dirt and gravel roads
10	2.7	Dirt and gravel roads
11	1.8	Gravel roads
12	1.7	Construction sites
13	3.8	Storage piles, gravel roads
14	4.1	Gravel roads
15	2.1	Gravel roads

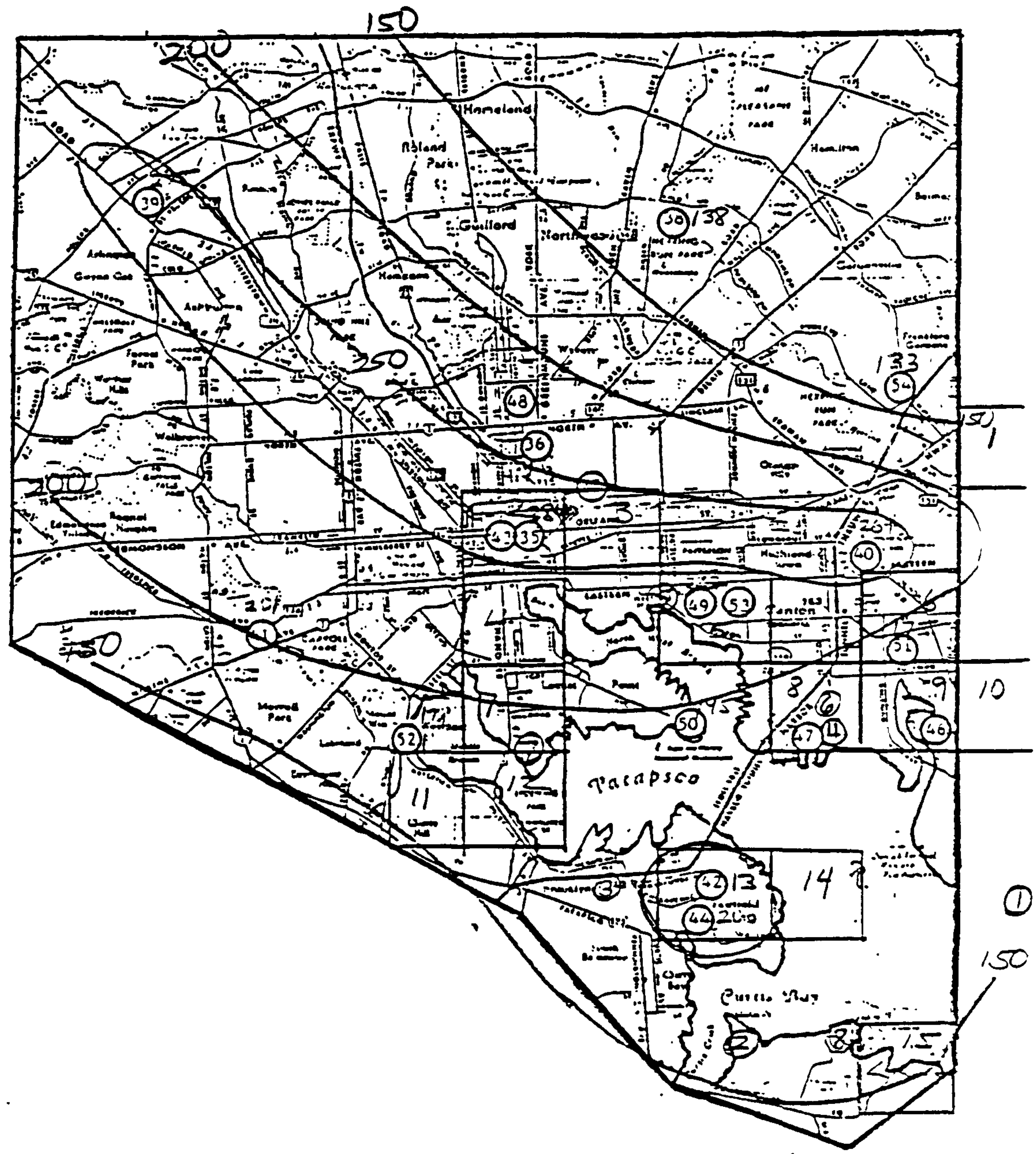


Figure 33. Maximum 24-hour TSP concentration for 1980.

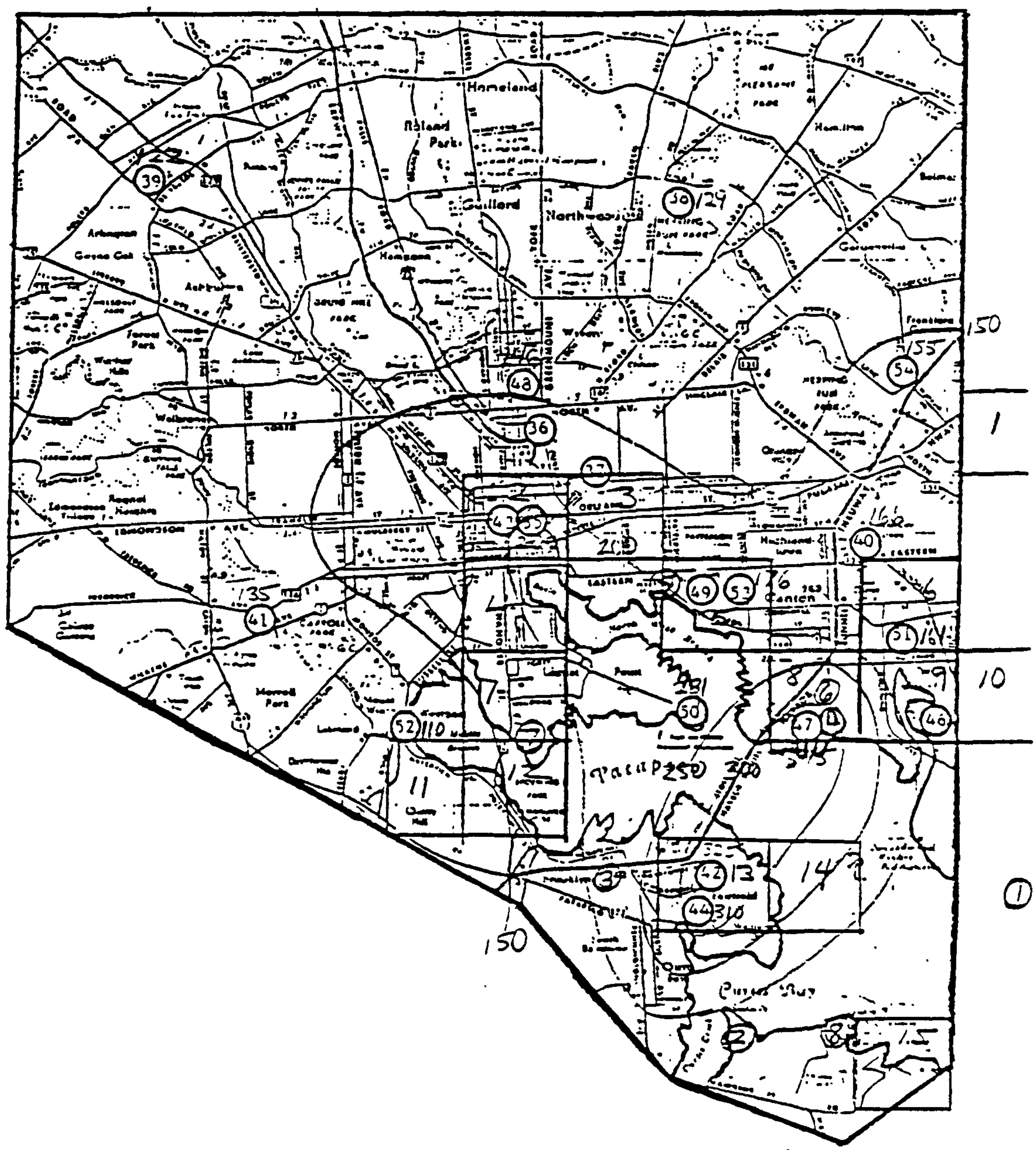


Figure 34. Maximum 24-hour TSP concentration for 1981.

high concentrations shown for the 1980 data is not confirmed in 1981. It is possible that the two high observations to the east and northwest ends of the tongue were not properly sited and showed unrepresentative local influences. The 1981 pattern for maximum 24-hour concentrations is more compatible with the two annual mean patterns, showing a primary peak around the open harbor area an a secondary peak over the primary central city area just west of site 35.

The TSP monitoring data indicate a core area of high concentrations centered on the Baltimore harbor region. The highest point and area source emissions of particulate matter also form a ring around the harbor zone.

Figure 35 is a wind rose showing the frequency of 24-hour mean wind directions with a wind persistence index of 0.85 or greater. (An index of 1.0 indicates a continuous wind direction without variation.) The wind directions with the most frequent occurrence of a persistent wind are west-northwest, west, and northwest. The persistent wind directions closely parallel the orientation of the harbor along the Patapsco River. Therefore, the persistent winds also favor a core of high particulate matter concentrations around the harbor zone. The tongue of high values north of the principal sources shown in the peak 1980 concentrations is not well supported and is not evident in the 1981 data.

PM_{10} concentrations may be expected to show a flatter pattern with less pronounced peaks than the TSP data. This is because there will be lower contributions from the larger particles released close to local sources. Monitoring sites farther from the local sources will be less affected by the deletion of larger particles and will show smaller reductions. This will result in a smoother pattern.

At least one site in the harbor area is needed to measure the peak PM_{10} concentrations. Since the area is presently out of compliance with NAAQS for particulates, there will need to be sufficient monitors in the area surrounding the harbor to delineate the general shape of a potential noncompliance area for the new PM_{10} standards. One strategy would be to select locations northwest, northeast, and south or southwest of the harbor area. In view of the potential for high levels of PM_{10} concentrations, there is a need to inform the public of PM_{10} exposure levels and trends, to document episode situations, and to support enforcement activities. For these reasons, it is desirable to site at least one and ideally two additional PM_{10} monitors in the harbor area. Once the magnitude of PM_{10} concentrations relative to PM_{10} standards has been established, the siting requirements need to be reevaluated. There is also a need for a background monitoring site. There are many suitable sites that are presently monitoring TSP concentrations. Baltimore County Site 23, about 15 km northwest of Baltimore City, is upwind of the persistent prevailing wind directions. Furthermore, TSP measurements made at this site are indistinguishable from TSP measurements made at a site 35 km to the northwest (site 53) in very rural Carroll County (see Figure 31).

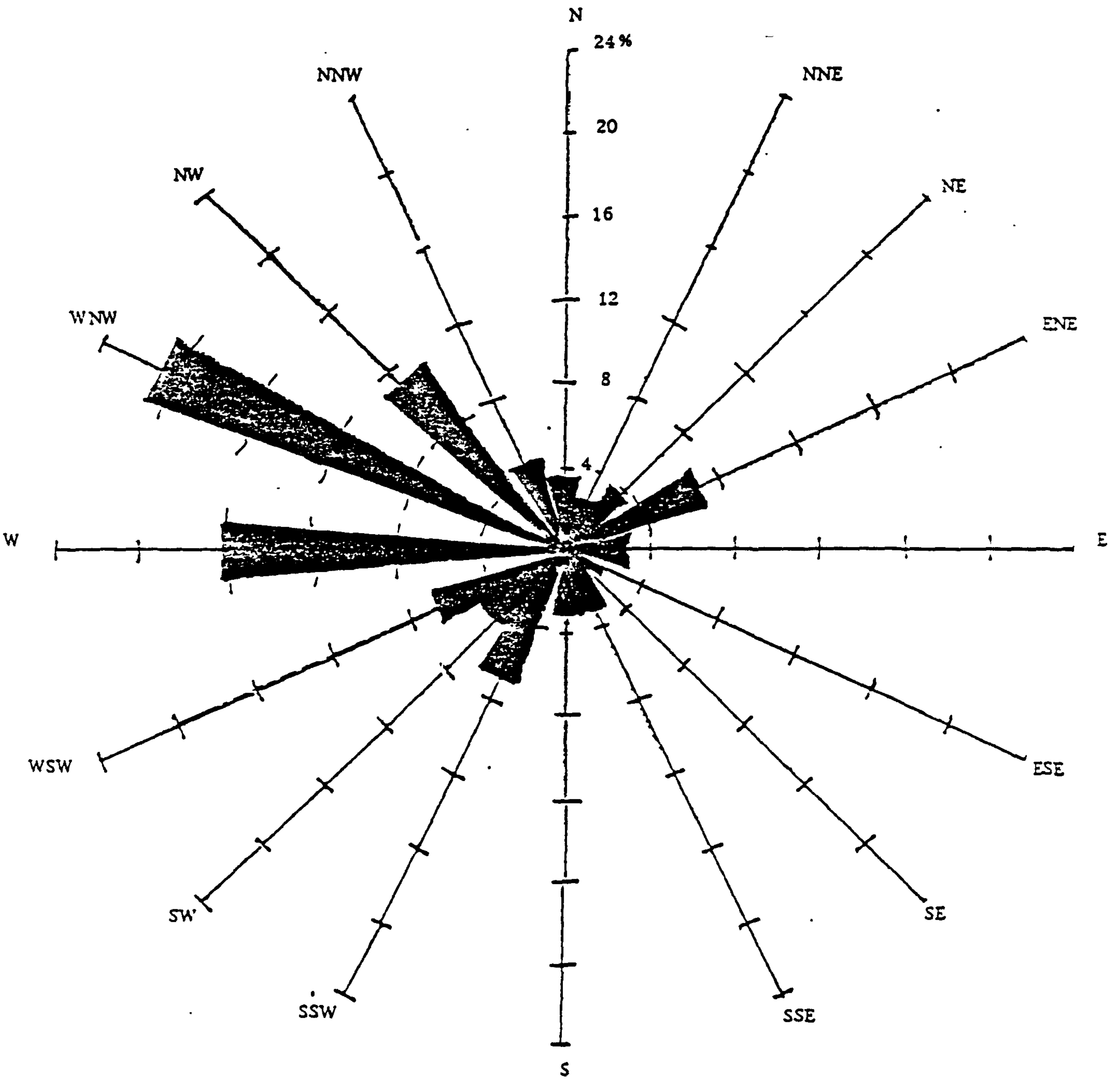


Figure 35. Wind persistence rose for Baltimore-Washington International Airport for 1973-1977 (wind persistence index greater than 0.85) (Pickering et al. 1979).

The preceding discussion describes the development of PM_{10} monitoring network requirements where there is adequate TSP monitoring data to define the shape of the expected pattern of PM_{10} concentrations. In this situation, modeling is not necessary. The subsequent selection of specific monitoring placements require onsite inspection of potential sites and the criteria described in Section 5.

SECTION 7

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APPENDIX A

METEOROLOGICAL DATA TABULATIONS FOR CDM PROGRAM

Cities for which Stability Array (STAR) data tabulations are available are listed alphabetically by date and by city within a state. This list was compiled by Changery, Hodge, and Ramsdell (1977). Additional tabulations may be available since this compilation, and others may be ordered. For assistance on orders contact:

Director
National Climatic Center
Federal Building
Asheville, North Carolina 28801

A-1. EXPLANATION OF ENTRIES

CITY is the city or town name for the location at which the original observations were taken. It may also be the name of a military installation.

NAME-TYPE is usually the airport or field name and/or service which operated the station. If these had changed during the period summarized, the name and/or service valid for the longest portion of the summary is used. A few stations may have no identifying information.

Under NAME, commonly used abbreviations are:

APT	-	Airport
ATL	-	Air Terminal
BD	-	Building
CAP	-	County Airport
CO	-	County
FLD	-	Field
GEN	-	General
GTR	-	Greater
INL	-	International
MAP	-	Municipal Airport
MEM	-	Memorial
METRO	-	Metropolitan
MN	-	Municipal
RGL	-	Regional
TERM	-	Terminal

Under TYPE, commonly used abbreviations are:

AAB	-	Army Air Base
AAF	-	Army Air Field
AAFB	-	Auxiliary Air Force Base
AEPG	-	Army Energy Proving Ground
AF	-	Air Force
AFB	-	Air Force Base
AFS	-	Air Force Station
ANGB	-	Air National Guard Base
ASC	-	Army Signal Corp
CAA	-	Civil Aeronautics Administration
FAA	-	Federal Aviation Administration
FSS	-	Flight Service Station
LAWR	-	Limited Airways Weather Reporting (Station)
MCAF	-	Marine Corps Air Facility
MCAS	-	Marine Corps Air Station
NAAF	-	Naval Auxiliary Air Facility
NAAS	-	Naval Auxiliary Air Station
NAF	-	Naval Air Facility
NAS	-	Naval Air Station
NAU	-	Naval Air Unit
NF	-	Naval Facility
NS	-	Naval Station
PG	-	Proving Ground
SAWR	-	Supplementary Airways Weather Reporting (Station)
WBAS	-	Weather Bureau Airport Station
WBO	-	Weather Bureau Office

ST is a two-letter code identifying each of the fifty states.

WBAN # refers to the five-digit number identifying stations operated by United States Weather Services (civilian and military) currently or in the past. A few stations have had no number assigned.

WMO # refers to the five-digit block and station numbers assigned to U. S. stations as authorized by the World Meteorological Organization. Many stations with a WBAN # will have no corresponding WMO number.

LAT, LONG are the latitude and longitude of the station in degrees and minutes. If the station changed coordinates during the period summarized, the location reflects the site with the longest record.

ELEV is the elevation (above sea level) of the station in meters. Reported station elevation was used if the barometric height above sea level was not available. If an elevation change occurred during the period summarized, the elevation reflects the station height for the longest period of record.

PERIOD OF RECORD is the first and last month-year of the summarized period. As an example, 01 38 - 12 44 is read as January 1938 through December 1944.

SUMMARY TYPE identifies each summary according to its format. Each format is similar to one of the 16 types presented in detail beginning on page I-13.

SUMM FREQ is the summary frequency or the time period in which the summarized data are presented. Abbreviations used are:

M - Monthly. Data for each calendar month combined and presented on a monthly basis.

S - Seasonal. Data for the months December through February of the period of record are combined into a winter season, summarized and presented on a seasonal basis. The months March-May, June-August, and September-November are similarly summarized.

A - Annual. All data for the period summarized together.

MA - Monthly and Annual.

SA - Seasonal and Annual.

MS - Monthly and Seasonal.

MSA - Monthly, Seasonal, and Annual.

IYM - Individual Year-Month. Data are presented for individual months of record.

SP - Special Period. The special period presented is described further in the given summary's Tab #/Remarks column.

TAB #/REMARKS column contains additional identifying or explanatory information. Many of the summaries produced by the Climatic Center and Air Weather Service for a specific project are identified by a tabulation number. A "T" followed by a 4 or 5 digit number identifies a summary produced by the NCC. Similarly, a "TCL" with a number indicates an AWS summary. Not all summaries can be so identified. This number is provided as an aid in requesting a specific tabulation.

Numbers following or in place of a tabulation number refer to remarks listed beginning on page I-9. These remarks are provided if additional information describing a summary is necessary. Examples are summaries with data for hourly or 3-hour periods, specified hours only, combined stations, etc.

A-2. REMARKS

This is a list of descriptive remarks coded by number in the Tab #/Remark column of the index. Numbers missing were not used.

1. Broken period
2. 3-hourly groups
3. Day-night
4. 0600-1800 LST only
5. 10-12 observations per day, all daylight hours
6. By hours 00, 03, 06, 09, 12, 15, 18, 21 LST
7. See microfilm for broken periods and format
8. Includes flying weather conditions
9. Part "C" only
10. Hours 0600-1200 LST only
11. May-November only
12. Broken period - pre-11/45 data from Point Hope (Stn #26601)
13. Broken period by hourly groups
14. Less 12/59
15. Pre-1939 data from Tin City (Stn #26634)
16. Less 12/70
17. 0500-1600 LST only
18. 2-13 observations daily
19. 0700-1900 LST only
20. Combined data for Douglas AAF (Stn #23001) for 11/42-11/45 and Douglas Apt (Stn #93026) for 11/48-12/54
21. Part "A" only by hourly groups - combined data for Kingman CAA (Stn #93167) for 01/34-12/41 and Kingman AAF (Stn #23108) for 03/43-06/45
22. For hours 0800, 1400, 1700 LST only
23. Direction and speed by visibility, relative humidity ≥ 90% and/ precipitation, and relative humidity ≥ 90% and no precipitation August, October, and December only
24. Part "A" only
25. By 2-hourly groups
26. Daylight hours only
27. September-December only
28. By hourly groups
29. For 0900-1600 and 1700-0800 LST
30. Period 01/37-03/38 for Indio (Stn #03105)
31. Precipitation-wind tabulation for April-October
32. By day and night hours on microfilm
33. Periods: July 15-31, August 1-15 for 1000 and 1400 LST
34. No data for 27 months
35. See Edwards AFB
36. Some data from Paso Robles (Stn #23231)
37. All observations by various stability classes
38. See Moffett Field
39. Also contains a contact wind rose
40. Eight directions and calm
41. Includes a percentage graph

42. 1200 LST observations only
43. Some missing data
44. Contains all weather, precipitation, and visibility ≤ 6 miles wind tabulations for day and night hours
45. Also called 94A
46. See Farallon Island SE
47A. 0100-0400 LST
47B. 0700-1000 LST
47C. 1300-1600 LST
47D. 1900-2200 LST
47E. 0600-2200 LST
47F. 0700 LST
47G. 1600 LST
47H. 0600-0900 LST
47I. 1600-1800 LST
47J. 0700-0900 LST
47K. 1900-0600 LST
47L. 1000-1500 LST
47M. 1200-2000 LST
47N. 0800-2100 LST
47P. 1100-1300 LST
48. Also contains bimonthly summaries
49. Located in city file
50. Three speed groups
51. June, July, August - daylight hours only
52. Special tables
53. Pre-1944 data from Bolling AAF (Stn #13710)
54. Also known as Chantilly, VA, FAA (pre-Dulles)
55. See Andrews AFB, MD
56. Data for 01/74 from Herndon Apt (Stn #12841)
57. See also Cape Kennedy AFB
58. Tower data - 8 levels (3-150 m)
59. June-August only
60. Data for 09/42-09/45 from Carlsbad AAF (Stn #23006)
61. Data after 07/53 from Key West NAS (Stn #12850)
62. Data thru 1945 from Marianna AAF (Stn #13851)
63. Contains 14 months of data from Morrison Field (Stn #12865)
64. Contains graphical wind rose
65. Tabulated by temperature and relative humidity intervals
66. Seasonal by day and night hours
67. Closed and instrument weather conditions only
68. Less 01/49
69. 24 observations daily
70. 8 observations daily
71. 1 of 3 parts
72. Tabulation by day and night hours for May 1 - September 30 and October 1 - April 30
73. Tabulated for December-March and April-November
74. Data prior to 10/42 and after 10/45 from Sioux City Apt (Stn #14943)

75. For day - clear and cloudy and night - clear and cloudy conditions
76. Also contains a ceiling-visibility tabulation
77. 0700-1900 LST only
78. All weather and 2 relative humidity classes
79. Summer season only - 1957 missing
80. May, August-November only
81. Includes separate wind rose for WSO
82. Four speed categories
83. Monthly tabulation for 0400 and 1400 LST, seasonal tabulation for all observations
84. Some data from Presque Isle AFB (Stn #14604)
85. Four observations per day
86. Semi-monthly periods
87. 1935 data from Boston WBAS (Stn #14739)
88. VFR, IFR, closed conditions
89. Pre-03/1952 data from Paso Robles (Stn #23231)
90. August 1-15 only for hours 1000 and 1400 LST
91. Partial SMOS
92. June, July only for hours 2200L - 0200L
93. April thru December only
94. Less April 1958 and 1960
95. January, April, July, and October only
96. Winter season only
97. Part "C" and "E" only
98. 36 compass points
99. Less October-December 1945 for a 2-hour period after sunrise
100. November 1951 substituted for November 1955
102. For hour groups 07-09, 10-15, 16-18, and 19-06 LST and all hours combined
103. For hours 0100, 0700, 1300, and 1900 LST (individual and all hours combined)
104. Day and night hours, clear and cloudy conditions
106. Pre-02/33 data from Albuquerque WBO (Stn #23073)
108. Precipitation wind rose tabulation
109. All observations by 6 hourly groups
110. For ceiling less than 600 feet and/or visibility less than 1-1/2 miles - also an annual hourly summary
111. Also summarized by month-hour for hours 0200 and 1400 LST
112. Summarized by days 1-15 and 16 to end of month for day and night hours

115A. 1300 LST
115B. 0400 LST
115C. 1000 LST
115D. 1600 LST
115E. 2200 LST
115F. 0700 LST
115G. 0100 LST
115H. 1900 LST

117. See Covington, Kentucky
118. Pre-04/32 data from Oklahoma City WBO (Stn #93954)
119. May to October only

120. Monthly for 1961-63, individual months 1-4/64
121. Also contains day and night summaries
124. Summary titled Scranton
125. See Wilkes-Barre
126. December-February for 0730 and 1930 LST only
128. Pre-12/44 data from Galveston AAF (Stn #12905)
129. Data for 10/62-12/63 for Greenville-Spartanburg Apt (Stn #03870)
132. February-April and June-September only
133. Pre-03/43 data from English Field (Stn #23047)
134. Post-10/66 data from Fort Wolters
135. Less 6/68
136. For hours 00-23 and 07-22 LST
140. Also contains annual ceiling/visibility tabulation
141. Less 0000 and 0300 LST
142. See Killeen
143. See Dugway PG
144. Data for 1943-49 for Wendover AFB (Stn #24111)
145. 0400-1800 LST
146. See Washington, DC - Dulles International Apt WBAS
147. See Washington, DC - National Apt WBAS
149. 0700-1200 LST
150. Tower data, year-month-level, month-level, and month-level-hour
151. Pre-11/41 data from Paine Field CAA (Stn #24222)
152. 10 observations per day - closed on weekends
153. 10 observations per day - wind speed estimated
155. By 5°F temperature intervals - with and without thunderstorms
157. One speed group - greater than 14 knots
158. Speed classes in Beaufort Force - mean speed by direction in mph
159. Hourly groups for 0600-1600 LST
160. Post-05/55 data from Forest Sherman (Stn #03855)
161. By speed classes and 5°F temperature classes
162. For all hours combined and for hours 0030 and 1230 individually

SUMMARY TYPE: STAR

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAB#/REMARKS
ANNISTON	CALHOUN CO APT CAA	AL	13871		33 35N	085 51W	0183	01 49 - 12 54	STAR	SA	T13272
BIRMINGHAM	MUNICIPAL APT WBAS	AL	13876	72228	33 34N	086 45W	0192	01 50 - 12 54	STAR	MA	T12741
BIRMINGHAM	MUNICIPAL APT WBAS	AL	13876	72228	33 34N	086 45W	0192	01 71 - 12 71	STAR	SA	T13618
BIRMINGHAM	MUNICIPAL APT WBAS	AL	13876	72228	33 34N	086 45W	0192	01 72 - 12 72	STAR	SA	T50979
FORT RUCKER	CAIRNES AAF	AL	03850		31 16N	085 43W	0091	01 65 - 12 58	STAR	SA	T12761
HUNTSVILLE	HUNTSVL-MADISON CAP WBAS	AL	03856	72323	34 42N	086 35W	0185	01 60 - 12 64	STAR	SA	T14716
HUNTSVILLE	HUNTSVL-MADISON CAP WBAS	AL	03856	72323	34 39N	086 46W	0196	01 72 - 12 72	STAR	SA	T50979
MOBILE	BATES FLD WBAS	AL	13894	72223	30 41N	088 15W	0068	01 66 - 12 70	STAR	SA	T12925
MOBILE	BATES FLD WBAS	AL	13894	72223	30 41N	088 15W	0068	01 70 - 12 74	STAR	SA	T52078
MOBILE	BATES FLD WBAS	AL	13894	72223	30 41N	088 15W	0068	01 70 - 12 70	STAR	SA	T12925
MOBILE	BATES FLD WBAS	AL	13894	72223	30 41N	088 15W	0068	01 71 - 12 71	STAR	A	T01772
MOBILE	BATES FLD WBAS	AL	13894	72223	30 41N	088 15W	0068	01 72 - 12 72	STAR	SA	T50979
MONTGOMERY	DANNELLY FLD WBAS	AL	13895	72226	32 18N	086 24W	0081	01 70 - 12 70	STAR	A	T13967
MONTGOMERY	DANNELLY FLD WBAS	AL	13895	72226	32 18N	086 24W	0081	01 72 - 12 72	STAR	SA	T50979
SELMA	CRAIG AFB	AL	12890		32 21N	086 59W	0063	01 54 - 12 58	STAR	SA	T13967
TUSCALOOSA	VAN DE GRAFF APT CAA	AL	93806		33 14N	087 37W	0057	01 48 - 12 54	STAR	A	T51862.3
ANCHORAGE	ELMENDORF AFB	AK	26401	70272	61 15N	149 48W	0054	01 51 - 12 70	STAR	MA	T15332.3
ANCHORAGE	INTERNATIONAL APT WBAS	AK	26451	70273	61 10N	150 01W	0048	01 55 - 12 68	STAR	MA	T13853
BIG DELTA	FAA	AK	26415	70267	64 00N	145 44W	0389	01 60 - 12 64	STAR	SA	T14083
BIG DELTA	FAA	AK	26415	70267	64 00N	145 44W	0389	01 67 - 12 71	STAR	SA	T14083
CORDOVA	MILE 13 APT FAA	AK	26410	70296	60 30N	145 30W	0013	01 58 - 12 62	STAR	SA	T50320
FAIRBANKS	EIELSON AFB	AK	26407	70265	64 39N	147 04W	0168	01 61 - 12 70	STAR	SA	T14703
FAIRBANKS	INTERNATIONAL APT WBAS	AK	26411	70261	64 49N	147 52W	0134	01 51 - 12 70	STAR	SA	T14703
GULKANA	INTERMEDIATE FIELD	AK	26425	70271	62 09N	145 27W	0481	01 67 - 12 71	STAR	SA	T14083
KENAI	MUNICIPAL APT CAA	AK	26523	70259	60 34N	151 15W	0027	01 49 - 12 58	STAR	MA	T15332.3
KENAI	MUNICIPAL APT FAA	AK	26523	70259	60 34N	151 15W	0032	01 66 - 12 70	STAR	SA	T13873
MIDDLETON ISL	AFS	AK	25403	70343	59 28N	146 18W	0013	01 58 - 12 62	STAR	SA	T50320
DOUGLAS	BISBEE-DGLS INL APT WBAS	AZ	93026		31 27N	109 36W	1252	01 50 - 12 54	STAR	SA	T50672.3
DOUGLAS	BISBEE-DGLS INL APT CAA	AZ	93026		31 27N	109 36W	1252	01 50 - 12 54	STAR	SA	T13385
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 55 - 12 64	STAR	MA	T14334
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 67 - 12 71	STAR	MA	T13751
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 68 - 12 73	STAR	SA	T50564.22
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 73 - 12 75	STAR	SA	T52279.3
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 73 - 12 75	STAR	MA	T52362.3
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 75 - 12 75	STAR	SA	T52279.3
PHOENIX	SKY HARBOR MAP WBAS	AZ	23183	72278	33 26N	112 01W	0339	01 75 - 12 75	STAR	MA	T52362.3
PRESCOTT	MUNICIPAL APT WBAS	AZ	23184	72372	34 39N	112 26W	1530	01 67 - 12 71	STAR	SA	T01772
TUCSON	MUNICIPAL APT WBAS	AZ	23160	72274	32 08N	110 57W	0779	01 55 - 12 64	STAR	MA	T14334
TUCSON	MUNICIPAL APT WBAS	AZ	23160	72274	32 08N	110 57W	0779	01 58 - 12 63	STAR	SA	T13111
TUCSON	INL APT WBAS	AZ	23160	72274	32 07N	110 56W	0789	01 67 - 12 71	STAR	MA	T14366
TUCSON	INL APT WBAS	AZ	23160	72274	32 07N	110 56W	0789	01 67 - 12 71	STAR	MSA	T14316
YUMA	INTERNATIONAL APT WBAS	AZ	23195	72280	32 40N	114 36W	0062	01 67 - 12 71	STAR	SA	T13385
EL DORADO	GOODWIN FIELD CAA	AR	93992		33 13N	092 48W	0082	01 50 - 12 54	STAR	SA	T50055
FORT SMITH	MUNICIPAL APT WBAS	AR	13964	72344	35 20N	094 22W	0141	01 55 - 12 74	STAR	MA	T51827.3
FORT SMITH	MUNICIPAL APT WBAS	AR	13964	72344	35 20N	094 22W	0141	01 68 - 12 72	STAR	MSA	T14655
LITTLE ROCK	ADAMS FIELD MAP WBAS	AR	13963	72340	34 44N	092 14W	0084	01 55 - 12 64	STAR	SA	T14644
LITTLE ROCK	ADAMS FIELD MAP WBAS	AR	13963	72340	34 44N	092 14W	0084	01 66 - 12 70	STAR	SA	T13028
LITTLE ROCK	ADAMS FIELD MAP WBAS	AR	13963	72340	34 44N	092 14W	0084	01 68 - 12 73	STAR	SA	T51048.3
LITTLE ROCK	ADAMS FIELD MAP WBAS	AR	13963	72340	34 44N	092 14W	0084	08 71 - 07 72	STAR	SA	T11153
LITTLE ROCK	ADAMS FIELD MAP WBAS	AR	13963	72340	34 44N	092 14W	0084	02 72 - 02 73	STAR	SA	T01772
ALAMEDA	NAS	CA	23239	74506	37 47N	122 19W	0009	01 60 - 12 64	STAR	MA	T14289
ARCATA	FAA	CA	24283		40 59N	124 06W	0068	01 68 - 12 72	STAR	MA	T14360
BAKERSFIELD	MEADOWS FIELD WBAS	CA	23155	72384	35 25N	119 03W	0151	01 60 - 12 64	STAR	A	T52395
BAKERSFIELD	MEADOWS FIELD WBAS	CA	23155	72384	35 25N	119 03W	0151	01 64 - 12 73	STAR	MA	T50715.3
BAKERSFIELD	MEADOWS FIELD WBAS	CA	23155	72384	35 25N	119 03W	0151	01 67 - 12 71	STAR	MA	T14331
BISHOP	WBAS	CA	23157	72480	37 22N	118 22W	1253	01 60 - 12 64	STAR	MA	T15358.47N
BLYTHE	RIVERSIDE COUNTY APT FAA	CA	23158		33 37N	114 43W	0120	01 49 - 12 54	STAR	SA	T14358
BLYTHE	RIVERSIDE COUNTY APT FAA	CA	23158		33 37N	114 43W	0119	09 69 - 08 74	STAR	SA	T15211
BURBANK	HOLLYWD-BURBANK APT WBAS	CA	23152	72288	34 12N	118 22W	0221	01 60 - 12 64	STAR	MA	T13257
CHINA LAKE	NAS	CA	93104		35 41N	117 41W	0680	01 54 - 12 58	STAR	[illegible]	T15276
CHINA LAKE	NAS	CA	93104		35 41N	117 41W	0682	01 58 - 12 63	STAR	[illegible]	T15276
DAGGETT	SAN BERNARDINO CAP FAA	CA	23161		34 52N	116 47W	0588	01 55 - 12 64	STAR	SA	T13284
DAGGETT	SAN BERNARDINO CAP FAA	CA	23161		34 52N	116 47W	0588	01 55 - 12 64	STAR	MA	T13284
EDWARDS	AFB MUROC	CA	23114	72381	34 55N	117 54W	0706	01 56 - 12 70	STAR	MA	T51145
FAIRFIELD	TRAVIS AFB	CA	23202	74516	38 16N	121 56W	0018	01 60 - 12 64	STAR	MA	T14239
FRESNO	AIR TERMINAL WBAS	CA	93193	72389	36 47N	119 42W	0103	01 60 - 12 64	STAR	A	T52395
FRESNO	AIR TERMINAL WBAS	CA	93193	72389	36 47N	119 42W	0103	01 60 - 12 64	STAR	MA	T15358.3
LONG BEACH	MUNICIPAL APT WBAS	CA	23129	72297	33 49N	118 09W	0021	01 49 - 12 64	STAR	MA	T15332.3
LONG BEACH	MUNICIPAL APT WBAS	CA	23129	72297	33 49N	118 09W	0021	01 60 - 12 64	STAR	MA	T13257
LONG BEACH	MUNICIPAL APT WBAS	CA	23129	72297	33 49N	118 09W	0017	01 65 - 12 74	STAR	MA	T15332.3
LONG BEACH	MUNICIPAL APT WBAS	CA	23129	72297	33 49N	118 09W	0008	01 69 - 12 73	STAR	A	T50819.3
LOS ALAMITOS	NAS	CA	93108		33 48N	118 03W	0008	01 65 - 12 69	STAR	MA	T13257
LOS ANGELES	INTERNATIONAL APT WBAS	CA	23174	72295	33 56N	118 23W	0037	01 55 - 12 64	STAR	MA	T50246
LOS ANGELES	INTERNATIONAL APT WBAS	CA	23174	72295	33 56N	118 23W	0037	01 60 - 12 61	STAR	MA	T14069
LOS ANGELES	INTERNATIONAL APT WBAS	CA	23174	72295	33 56N	118 23W	0037	05 64 - 04 69	STAR	MA	T13257
LOS ANGELES	INTERNATIONAL APT WBAS	CA	23174	72295	33 56N	118 23W	0037	01 65 - 12 66	STAR	SA	T14069
LOS ANGELES	INTERNATIONAL APT WBAS	CA	23174	72295	33 56N	118 23W	0037	01 70 - 12 71	STAR	SA	T14069
MOFFETT FIELD	NAS SUNNYVALE	CA	23244	74509	37 25N	122 03W	0012	01 50 - 12 64	STAR	MA	T14289
NEEDLES	MUNICIPAL APT CAA	CA	23179	72380	34 46N	114 37W	0280	01 49 - 12 54	STAR	SA	T13029
NEEDLES	MUNICIPAL APT CAA	CA	23179	72380	34 46N	114 37W	0280	01 55 - 12 64	STAR	SA	T13790
NEEDLES	MUNICIPAL APT FAA	CA	23179	72380	34 46N	114 37W	0280	09 69 - 08 74	STAR	SA	T15211
OAKLAND	INTERNATIONAL APT WBAS	CA	23230	72493	37 44N	122 22W	0005	01 50 - 12 64	STAR	MA	T14289
OXNARD	AFB	CA	23136		34 13N	119 04W	0025	01 60 - 12 64	STAR	MA	T50818
POINT MUGU	NF	CA	93111	72391	34 07N	119 07W	0004	03 52 - 02 72	STAR	MA	T15332.3
POINT MUGU	NF	CA	93111	72391	34 07N	119 07W	0006	01 50 - 12 54	STAR	MA	T50818
RIVERSIDE	MARCH AFB	CA	23119	72286	33 53N	117 15W	0461	01 56 - 12 70	STAR	A	T50819.3
RIVERSIDE	MARCH AFB	CA	23119	72286	33 53N	117 15W	0461	01 56 - 12 70	STAR	MA	T14331
SACRAMENTO	MUNICIPAL APT WBAS	CA	23232	72483	38 31N	121 30W	0013	01 58 - 12 70	STAR	SA	T01772

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAB#/REM
SACRAMENTO	EXECUTIVE APT WBAS	CA	23232	72483	38 31N	121 30W	0008	01 58 - 12 73	STAR	SA	T50504.47
SACRAMENTO	EXECUTIVE APT WBAS	CA	23232	72483	38 31N	121 30W	0008	01 68 - 12 73	STAR	SA	T50504.47
SAN DIEGO	LINDBERGH INL APT WBAS	CA	23188	72290	32 44N	117 10W	0011	01 55 - 12 54	STAR	MA	T50246
SAN DIEGO	LINDBERGH INL APT WBAS	CA	23188	72290	32 44N	117 10W	0011	01 50 - 12 54	STAR	SA	T12989
SAN DIEGO	LINDBERGH INL APT WBAS	CA	23188	72290	32 44N	117 10W	0011	01 58 - 12 72	STAR	MA	T01772
SAN DIEGO	NAS NORTH ISLAND	CA	93112		32 42N	117 12W	0015	01 57 - 12 71	STAR	MA	T75000
SAN FRANCISCO	INTERNATIONAL APT WBAS	CA	23234	72494	37 37N	122 23W	0027	01 50 - 12 64	STAR	MA	T14259
SAN FRANCISCO	INTERNATIONAL APT WBAS	CA	23234	72494	37 37N	122 23W	0002	01 58 - 12 73	STAR	SA	T50879.47I
SAN FRANCISCO	INTERNATIONAL APT WBAS	CA	23234	72494	37 37N	122 23W	0002	01 58 - 12 73	STAR	SA	T50879.47I
SAN FRANCISCO	INTERNATIONAL APT WBAS	CA	23234	72494	37 37N	122 23W	0002	01 58 - 12 73	STAR	SA	T50879.47I
SAN FRANCISCO	INTERNATIONAL APT WBAS	CA	23234	72494	37 37N	122 23W	0002	01 58 - 12 73	STAR	SA	T50879.47I
SAN RAFAEL	HAMILTON AFB	CA	23211		38 04N	122 31W	0004	01 50 - 12 54	STAR	MA	T14289
SAN RAFAEL	HAMILTON AFB *	CA	23211		38 04N	122 31W	0004	01 56 - 12 70	STAR	SA	T14158
SANTA BARBARA	MUNICIPAL APT FAA	CA	23190		34 26N	119 50W	0004	01 60 - 12 54	STAR	MA	T12329
SANTA MARIA	WBAS	CA	23236	72394	34 56N	120 25W	0071	01 49 - 12 53	STAR	MA	T50740
SANTA MARIA	WBAS	CA	23273	72394	34 54N	120 27W	0073	01 65 - 12 74	STAR	MA	T52110.3
UKIAH	MUNICIPAL APT FAA	CA	23275		39 08N	123 12W	0192	01 55 - 12 54	STAR	MA	T50173
VANDENBERG	CAMP COOKE AFB	CA	93214	72393	34 43N	120 34W	0116	01 58 - 12 72	STAR	MA	T15332.3
VANDENBERG	CAMP COOKE AFB	CA	93214	72393	34 43N	120 34W	0118	01 61 - 12 70	STAR	MA	T15029
VANDENBERG	CAMP COOKE AFB	CA	93214	72393	34 43N	120 34W	0118	01 66 - 12 70	STAR	MA	T50998.47E
VANDENBERG	CAMP COOKE AFB SURF	CA	93214	72393	34 43N	120 34W	0118	01 70 - 12 70	STAR	SA	T01772
VICTORVILLE	GEORGE AFB	CA	23131		34 35N	117 23W	0880	01 58 - 12 67	STAR	MA	T13284
VICTORVILLE	GEORGE AFB	CA	23131		34 35N	117 23W	0880	01 58 - 12 67	STAR	SA	T13284
AKRON	WASHINGTON COUNTY APT CAA	CO	24015		40 07N	103 10W	1399	01 50 - 12 54	STAR	MA	T15038
COLORADO SPGS	PETERSON FIELD WBAS	CO	93037	72466	38 49N	104 43W	1857	01 58 - 12 73	STAR	MA	T50235
COLORADO SPGS	PETERSON FIELD WBAS	CO	93037	72466	38 49N	104 43W	1857	01 74 - 12 74	STAR	A	T51947.3
DENVER	STAPLETON INT APT WBAS	CO	23062	72469	39 46N	104 53W	1615	01 60 - 12 64	STAR	MA	T50313
DENVER	STAPLETON INT APT WBAS	CO	23062	72469	39 46N	104 53W	1615	07 68 - 02 69	STAR	A	T12211
DENVER	STAPLETON INL APT WBAS	CO	23062	72469	39 46N	104 53W	1615	01 74 - 12 74	STAR	SA	T51959.3
GRAND JUNCTION	MUNICIPAL APT WBAS	CO	23066	72476	39 07N	108 32W	1474	01 60 - 12 54	STAR	SA	T14518
PUEBLO	MEMORIAL APT WBAS	CO	93058	72464	38 17N	104 31W	1415	01 50 - 12 64	STAR	MA	T50907
PUEBLO	MEMORIAL APT WBAS	CO	93058	72464	38 17N	104 31W	1415	01 66 - 12 70	STAR	SA	T50098
PUEBLO	MEMORIAL APT WBAS	CO	93058	72464	38 17N	104 31W	1439	01 73 - 12 74	STAR	A	T15405
PUEBLO	MEMORIAL APT WBAS	CO	93058	72464	38 17N	104 31W	1439	01 74 - 12 74	STAR	A	T51947.3
BRIDGEPORT	MUNICIPAL APT WBAS	CT	94702	72504	41 10N	073 08W	0009	01 64 - 12 64	STAR	A	T12243
BRIDGEPORT	MUNICIPAL APT WBAS	CT	94702	72504	41 10N	073 08W	0009	01 55 - 12 69	STAR	SA	T14793
HARTFORD	BRAINARD FIELD WBAS	CT	14752		41 44N	072 39W	0006	01 49 - 12 52	STAR	MA	T14204
WINDSOR LOCKS	BRADLEY FIELD WBAS	CT	14740	72508	41 56N	072 41W	0061	01 58 - 12 72	STAR	SA	T14793
WINDSOR LOCKS	BRADLEY FIELD WBAS	CT	14740	72508	41 56N	072 41W	0061	05 73 - 04 74	STAR	A	T50465
WINDSOR LOCKS	BRADLEY FIELD WBAS	CT	14740	72508	41 56N	072 41W	0061	01 74 - 04 75	STAR	MA	T51792
WINDSOR LOCKS	BRADLEY FIELD WBAS	CT	14740	72508	41 56N	072 41W	0061	05 74 - 10 74	STAR	A	T52449.52
DOVER	AFB	DE	13707		39 08N	075 28W	0011	01 63 - 12 67	STAR	A	T11749
DOVER	AFB	DE	13707		39 08N	075 28W	0011	01 66 - 12 70	STAR	MA	T50495.3
DOVER	AFB	DE	13707		39 08N	075 28W	0011	07 74 - 08 75	STAR	A	T52367
WILMINGTON	GTR WIL NEW CAS APT WBAS	DE	13781		39 40N	075 36W	0029	01 60 - 12 54	STAR	MA	T13187
WILMINGTON	GTR WIL NEW CAS APT WBAS	DE	13781		39 40N	075 36W	0024	01 50 - 12 54	STAR	SA	T15634
WILMINGTON	GTR WIL NEW CAS APT WBAS	DE	13781		39 40N	075 36W	0029	01 57 - 12 57	STAR	SA	T01776
WILMINGTON	GTR WIL NEW CAS APT WBAS	DE	13781		39 40N	075 36W	0024	01 68 - 12 73	STAR	MA	T50495
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 50 - 12 54	STAR	A	T14151.47K
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 50 - 12 54	STAR	A	T14151.47I
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 50 - 12 54	STAR	A	T14151.47L
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 50 - 12 54	STAR	A	T13371
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 60 - 12 54	STAR	A	T14151.47J
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 68 - 12 72	STAR	MA	T50766.47J
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 58 - 12 72	STAR	MA	T14737
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 58 - 12 73	STAR	A	T51800.3
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 59 - 12 59	STAR	MSA	T13770
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 70 - 12 70	STAR	MSA	T13770
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	05 70 - 12 70	STAR	MA	T01772
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 71 - 12 71	STAR	MSA	T13770
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 72 - 12 72	STAR	MSA	T14175
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	11 72 - 12 72	STAR	MA	T01772
WASHINGTON	NATIONAL APT WBAS	DC	13743	72405	38 51N	077 02W	0023	01 73 - 12 73	STAR	A	T51800.3
WASHINGTON	DULLES INL APT WBAS	DC	93738	72403	38 57N	077 27W	0094	01 66 - 12 70	STAR	SA	T13303
WASHINGTON	DULLES INL APT WBAS	DC	93738	72403	38 57N	077 27W	0094	01 67 - 12 71	STAR	SA	T12872
WASHINGTON	DULLES INL APT WBAS	DC	93738	72403	38 57N	077 27W	0094	01 70 - 12 71	STAR	SA	T14565
WASHINGTON	DULLES INL APT WBAS	DC	93738	72403	38 57N	077 27W	0094	01 71 - 12 71	STAR	MSA	T14175
WASHINGTON	DULLES INL APT WBAS	DC	93738	72403	38 57N	077 27W	0094	01 72 - 12 72	STAR	MSA	T14175
DAYTONA BEACH	MUNICIPAL APT WBAS	FL	12834		29 11N	081 03W	0015	01 67 - 12 71	STAR	SA	T50033
FORT MEYERS	PAGE FIELD WBAS	FL	12835	72210	26 35N	081 52W	0004	01 59 - 12 73	STAR	A	T50872
JACKSONVILLE	IMESON APT WBAS		13889	72206	30 25N	081 39W	0012	01 66 - 12 56	STAR	SA	T12856
JACKSONVILLE	IMESON APT WBAS	FL	13889	72206	30 25N	081 39W	0012	01 70 - 12 70	STAR	SA	T12856
JACKSONVILLE	IMESON APT WBAS	FL	13889	72206	30 25N	081 39W	0012	01 72 - 12 72	STAR	SA	T01772
JACKSONVILLE	IMESON APT WBAS	FL	[illegible]	72206	30 25N	081 39W	0012	01 73 - 12 73	STAR	SA	T50163
JACKSONVILLE	IMESON APT WBAS		[illegible]	72206	30 25N	081 39W	0009	01 75 - 12 75	STAR	A	T52247
MIAMI	INTERNATIONAL APT W		12839	72202	25 48N	080 16W	0004	01 67 - 12 71	STAR	MA	T13861
MIAMI	INTERNATIONAL APT		12839	72202	25 48N	080 16W	0004	01 70 - 12 74	STAR	A	T52115.3
MIAMI	INTERNATIONAL AP		12839	72202	25 48N	080 16W	0004	01 71 - 12 71	STAR	MA	T13861
MIAMI	INTERNATIONAL AP		12839	72202	25 48N	080 16W	0004	01 72 - 12 72	STAR	MA	T01772
MIAMI	INTERNATIONAL	FL	12839	72202	25 48N	080 16W	0004	01 73 - 12 73	STAR	MA	T50183
MIAMI	INTERNATIONAL	FL	12839	72202	25 48N	080 16W	0017	01 74 - 12 74	STAR	A	T52115.3
MIAMI	INTERNATIONA	FL	12839	72202	25 48N	080 16W	0017	09 74 - 09 75	STAR	MA	T51924.3
MIAMI	INTERNATIO	FL	12839	72202	25 48N	080 16W	0017	03 75 - 09 75	STAR	A	T51924.3
MILTON	WHITING F	FL	93841		30 43N	087 01W	0054	01 52 - 12 71	STAR	SA	T14557
ORLANDO	MCCOY	FL	12815		28 27N	081 18W	0032	01 56 - 12 57	STAR	SA	T01772
ORLANDO	MCCOY	FL	12815		28 27N	081 18W	0032	01 70 - 12 70	STAR	SA	T01772
ORLANDO	MCCOY	FL	12815		28 27N	081 18W	0032	01 74 - 12 74	STAR	A	T51046.56

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAB#/REF
ORLANDO	HERNDON APT WBAS	FL	12841	72205	28 33N	081 20W	0037	01 50 - 12 54	STAR	A	T11749
ORLANDO	HERNDON APT WBAS	FL	12841	72205	28 33N	081 20W	0037	01 50 - 12 54	STAR	MA	T50590
ORLANDO	HERNDON APT WBAS	FL	12841	72205	28 33N	081 20W	0037	01 60 - 12 64	STAR	MA	T14655
ORLANDO	HERNDON APT WBAS	FL	12841	72205	28 33N	081 20W	0037	01 71 - 12 71	STAR	SA	T01772
ORLANDO	HERNDON APT WBAS	FL	12841	72205	28 33N	081 20W	0037	01 73 - 12 73	STAR	MA	T50241
PANAMA CITY	TYNDALL AFB	FL	13846	74775	30 04N	085 35W	0007	01 66 - 12 70	STAR	SA	T14171
PENSACOLA	FOREST SHERMAN NAS	FL	03855	72222	30 21N	087 19W	0010	01 67 - 12 71	STAR	T14	087
PENSACOLA	FOREST SHERMAN NAS	FL	03855	72222	30 21N	087 19W	0010	01 74 - 12 74	STAR	A	T52115.3
TALLAHASSEE	MUNICIPAL APT WBAS	FL	93805	72214	30 23N	084 22W	0021	01 50 - 12 54	STAR	MA	T50590
TALLAHASSEE	MUNICIPAL APT WBAS	FL	93805	72214	30 23N	084 22W	0021	01 58 - 12 73	STAR	SA	T50413
TALLAHASSEE	MUNICIPAL APT WBAS	FL	93805	72214	30 23N	084 22W	0021	01 72 - 12 72	STAR	MA	T50014
TALLAHASSEE	MUNICIPAL APT WBAS	FL	93805	72214	30 23N	084 22W	0021	01 72 - 12 72	STAR	MA	T50638
TAMPA	MACDILL AFB	FL	12810	74788	27 51N	082 30W	0008	01 65 - 12 68	STAR	SA	T12957
TAMPA	MACDILL AFB	FL	12810	74788	27 51N	082 30W	0008	01 70 - 12 70	STAR	SA	T12957
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 50 - 12 54	STAR	MA	T50590
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 55 - 12 68	STAR	SA	T12926
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 68 - 12 73	STAR	A	T15377
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 71 - 12 71	STAR	SA	T14113
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 72 - 12 72	STAR	SA	T14346
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 72 - 12 72	STAR	SA	T13367
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 72 - 12 72	STAR	MA	T50638
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0003	01 73 - 12 73	STAR	A	T50487.3
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0010	01 73 - 12 73	STAR	SA	T50413
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0003	01 74 - 12 74	STAR	A	T51046
TAMPA	INTERNATIONAL APT WBAS	FL	12842	72211	27 58N	082 32W	0003	01 74 - 12 74	STAR	A	T51184
WEST PALM BEACH	INTERNATIONAL APT WBAS	FL	12844	72203	26 41N	080 06W	0008	01 70 - 12 70	STAR	SA	T01772
ALBANY	TURNER AFB	GA	13815		31 35N	084 05W	0058	01 62 - 12 66	STAR	SA	T14372
ALBANY	NAS	GA	13815		31 35N	084 05W	0065	01 68 - 12 73	STAR	SA	T15175.3
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 68 - 12 68	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 68 - 04 74	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 70 - 12 70	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 70 - 12 70	STAR	SA	T13252
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 71 - 12 71	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	084 05W	0085	01 72 - 12 72	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	081 12W	0065	01 73 - 12 73	STAR	MA	T50690.3
ALBANY	NAS	GA	13815		31 35N	081 12W	0065	01 74 - 04 74	STAR	MA	T50690.3
ALMA	BACON COUNTY APT CAA	GA	13870		31 32N	082 31W	0062	01 54 - 12 58	STAR	SA	T15175.3
ATHENS	BEN EPPS FIELD WBAS	GA	13873	72311	33 57N	083 19W	0247	01 68 - 12 73	STAR	SA	T15175.3
ATHENS	BEN EPPS FIELD WBAS	GA	13873	72311	33 57N	083 19W	0245	01 70 - 12 70	STAR	SA	T13252
ATLANTA	WBAS	GA	13874	72219	33 39N	084 25W	0302	01 58 - 12 63	STAR	SA	T12698
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0311	01 67 - 12 71	STAR	SA	T01772
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0315	01 68 - 12 73	STAR	SA	T15175.3
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0311	01 70 - 12 70	STAR	SA	T01772
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0311	01 70 - 12 70	STAR	SA	T13494
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0311	01 72 - 12 72	STAR	MA	T14399
ATLANTA	WBAS	GA	13874	72219	33 39N	084 26W	0315	07 73 - 06 74	STAR	A	T51136
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 55 - 12 55	STAR	SA	T01371
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 67 - 12 71	STAR	SA	T14010
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 68 - 12 73	STAR	SA	T15175.3
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 70 - 12 70	STAR	SA	T13252
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 72 - 12 72	STAR	MA	T14399
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 75 - 12 75	STAR	MA	T15602
AUGUSTA	BUSH FIELD WBAS	GA	03820	72218	33 22N	081 58W	0045	01 76 - 03 76	STAR	MA	T15673.52
BRUNSWICK	GLYNCO NAS	GA	93836		31 15N	081 28W	0010	01 67 - 12 71	STAR	SA	T14372
BRUNSWICK	GLYNCO NAS	GA	93836		31 15N	081 28W	0010	01 68 - 12 73	STAR	SA	T15175.3
BRUNSWICK	GLYNCO NAS	GA	93836		31 15N	081 28W	0010	01 70 - 12 70	STAR	SA	T13252
COLUMBUS	METROPOLITAN APT WBAS	GA	93842		32 31N	084 56W	0123	01 67 - 12 71	STAR	SA	T14065
COLUMBUS	METROPOLITAN APT WBAS	GA	93842		32 31N	084 56W	0118	01 68 - 12 73	STAR	SA	T15175.3
COLUMBUS	METROPOLITAN APT WBAS	GA	93842		32 31N	084 56W	0123	01 70 - 12 70	STAR	A	T14041
MACON	LEWIS B WILSON APT WBAS	GA	03813	72217	32 42N	083 39W	0110	01 67 - 12 71	STAR	SA	T14372
MACON	LEWIS B WILSON APT WBAS	GA	03813	72217	32 42N	083 39W	0110	01 68 - 12 73	STAR	SA	T15175.3
MACON	LEWIS B WILSON APT WBAS	GA	03813	72217	32 42N	083 39W	0110	01 70 - 12 70	STAR	SA	T13252
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 66 - 12 70	STAR	SA	T13050
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 67 - 12 71	STAR	SA	T14065
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 68 - 12 73	STAR	SA	T15175.3
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 70 - 12 70	STAR	SA	T01772
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 70 - 12 70	STAR	SA	T01772
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 72 - 12 72	STAR	MA	T14399
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	07 73 - 06 74	STAR	SA	T50649
SAVANNAH	TRAVIS FLD MAP WBAS	GA	03822	72207	32 08N	081 12W	0016	01 75 - 12 75	STAR	A	T52184
SAVANNAH	HUNTER AFB	GA	13824		32 01N	081 08W	0018	01 66 - 12 70	STAR	SA	T15175.3
BARBERS POINT	NAS	HI	22514	91178	21 19N	158 04W	0015	01 52 - 12 72	STAR	MA	T50709
BARBERS POINT	NAS	HI	22514	91178	21 19N	158 04W	0015	01 67 - 12 71	STAR	MA	T50121
HILO	LYMAN FIELD WBAS	HI	21504	91285	19 43N	155 04W	0010	08 62 - 07 67	STAR	MA	T13223
HONOLULU	JOHN ROGERS INL APT WBAS	HI	22521	91182	21 21N	157 56W	0012	01 60 - 12 64	STAR	MA	T50121
KAHULUI	NAS	HI	22516	91190	20 54N	156 26W	0015	01 66 - 12 70	STAR	SA	T13335
PUUNENE	CAA	HI	22525		20 50N	156 28W	0040	01 53 - 12 57	STAR	SA	T13204
BOISE	MUNICIPAL APT WBAS	ID	24131	72681	43 34N	116 13W	0870	01 60 - 12 64	STAR	MA	T50544
IDAHO FALLS	FANNING FIELD FAA	ID	24145		43 31N	112 04W	1448	01 55 - 12 64	STAR	MA	T51224.3
MALAD CITY	CAA	ID	24151		42 10N	112 19W	1366	01 48 - 12 54	STAR	MA	T51224.3
MOUNTAIN HOME	AFB	ID	24106		43 03N	115 52W	0912	01 55 - 12 68	STAR	MA	T50544
POCATELLO	MUNICIPAL APT WBAS	ID	24156	72578	42 55N	112 36W	1356	01 55 - 12 54	STAR	MA	T51224.3.69
POCATELLO	MUNICIPAL APT WBAS	ID	24156	72578	42 55N	112 36W	1356	01 58 - 12 62	STAR	SA	T13870
POCATELLO	MUNICIPAL APT WBAS	ID	24156	72578	42 55N	112 36W	1365	01 65 - 12 74	STAR	MA	T51224.3.70
BELLEVILLE	SCOTT AFB	IL	13802		38 33N	089 51W	0135	01 61 - 12 70	STAR	SA	T51003.3
CHICAGO	MIDWAY APT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 54 - 12 73	STAR	SA	T50458
CHICAGO	MIDWAY APT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 54 - 12 73	STAR	SA	T50404
CHICAGO	MIDWAY APT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 57 - 12 57	STAR	SA	T11930

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TABS/REMARKS
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 58 - 12 58	STAR	A	T14943
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 70 - 12 70	STAR	SA	T01772
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0190	01 71 - 12 73	STAR	A	T51204
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 71 - 12 71	STAR	SA	T01772
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	01 72 - 12 72	STAR	A	T14943
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	12 72 - 11 73	STAR	SA	T50404
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0187	12 72 - 11 73	STAR	SA	T50456
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0190	01 73 - 12 73	STAR	A	T50549.3
CHICAGO*	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0190	01 74 - 12 74	STAR	SA	T51207.3
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0190	01 75 - 12 75	STAR	A	T52403.3
CHICAGO	MIDWAY ARPT WBAS	IL	14819	72534	41 47N	087 45W	0190	01 75 - 12 75	STAR	A	T52344.3
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 58N	087 54W	0211	01 63 - 12 65	STAR	A	T11860
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 58N	087 54W	0211	01 63 - 12 63	STAR	A	T11860
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 58N	087 54W	0211	01 65 - 12 69	STAR	SA	T12761
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 59N	087 54W	0211	01 66 - 12 66	STAR	A	T11860
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 58N	087 54W	0211	01 67 - 12 67	STAR	A	T11860
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 59N	087 54W	0211	01 60 - 12 64	STAR	SA	T51955.3
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 59N	087 54W	0211	01 69 - 12 69	STAR	A	T11860
CHICAGO	O'HARE INTL ARPT WBAS	IL	94846	72530	41 59N	087 54W	0211	06 71 - 11 71	STAR	MA	T13303
CHICAGO	MEIGS FIELD LAWR	IL	94866		41 52N	087 37W	0179	01 66 - 06 70	STAR	MA	T14901
GLENVIEW	NAS	IL	14855		42 05N	087 50W	0196	01 60 - 12 64	STAR	MA	T50259
GLENVIEW	NAS	IL	14855		42 05N	087 50W	0196	01 74 - 12 74	STAR	A	T51888.3
MOLINE	QUAD-CITY ARPT WBAS	IL	14923	72544	41 27N	090 31W	0184	01 67 - 12 71	STAR	SA	T13553
MOLINE	QUAD-CITY ARPT WBAS	IL	14923	72544	41 27N	090 31W	0181	01 70 - 12 74	STAR	SA	T51153.3
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 64 - 12 73	STAR	SA	T14842
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 65 - 12 69	STAR	SA	T12089
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 65 - 12 69	STAR	SA	T50660.3
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 65 - 12 69	STAR	SA	T51209.3
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 70 - 12 70	STAR	SA	T12787
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 72 - 12 72	STAR	MA	T50443
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 73 - 12 73	STAR	SA	T14842
PEORIA	GREATER PEORIA ARPT WBAS	IL	14842	72532	40 40N	089 41W	0202	01 73 - 12 73	STAR	MA	T50443
QUINCY	BALDWIN FIELD CAA	IL	93989		39 56N	091 12W	0233	01 50 - 12 54	STAR	A	T13709
RANTOUL	CHANUTE AFB	IL	14806	72531	40 18N	088 09W	0230	01 58 - 12 62	STAR	MA	T14464
RANTOUL	CHANUTE AFB	IL	14806	72531	40 18N	088 09W	0230	01 63 - 12 67	STAR	SA	T01772
ROCKFORD	GREATER ROCKFORD ARPT WBAS	IL	94822	72543	42 12N	089 06W	0223	01 66 - 12 70	STAR	MA	T13357
ROCKFORD	GREATER ROCKFORD ARPT WBAS	IL	94822	72543	42 12N	089 06W	0223	01 70 - 12 70	STAR	MA	T14923
ROCKFORD	GREATER ROCKFORD ARPT WBAS	IL	94822	72543	42 12N	089 06W	0226	01 70 - 12 74	STAR	SA	T51153.3
SPRINGFIELD	CAPITAL ARPT WBAS	IL	93822	72439	39 50N	089 40W	0183	01 67 - 12 71	STAR	SA	T13344
SPRINGFIELD	CAPITAL ARPT WBAS	IL	93822	72439	39 50N	089 40W	0183	01 67 - 12 71	STAR	MA	T13563
SPRINGFIELD	CAPITAL ARPT WBAS	IL	93822	72439	39 50N	089 40W	0187	01 70 - 12 74	STAR	SA	T51153.3
EVANSVILLE	DRESS MEMORIAL ARPT WBAS	IN	93817	72432	38 03N	087 32W	0122	01 50 - 12 64	STAR	SA	T11898
EVANSVILLE	DRESS MEMORIAL ARPT WBAS	IN	93817	72432	38 03N	087 32W	0122	01 54 - 12 64	STAR	A	T50423
EVANSVILLE	DRESS MEMORIAL ARPT WBAS	IN	93817	72432	38 03N	087 32W	0122	01 66 - 12 70	STAR	SA	T12881
EVANSVILLE	DRESS MEMORIAL ARPT WBAS	IN	93817	72432	38 03N	087 32W	0122	01 66 - 12 70	STAR	SA	T50020
EVANSVILLE	DRESS MEMORIAL ARPT WBAS	IN	93817	72432	38 03N	087 32W	0122	01 72 - 12 72	STAR	SA	T15207
FORT WAYNE	BAER FIELD	IN	14827	72533	41 00N	085 12W	0252	01 60 - 12 64	STAR	SA	T52128.3
FORT WAYNE	BAER FIELD	IN	14827	72533	41 00N	085 12W	0252	01 70 - 12 74	STAR	SA	T15675.3
FORT WAYNE	BAER FIELD	IN	14827	72533	41 00N	085 12W	0252	01 70 - 12 74	STAR	SA	T15675.3
FORT WAYNE	BAER FIELD	IN	14827	72533	41 00N	085 12W	0252	01 75 - 12 75	STAR	SA	T52409.3
INDIANAPOLIS	WEIR COOK MAP WBAS	IN	93819	72438	39 44N	086 16W	0246	01 55 - 12 74	STAR	MA	T51827
INDIANAPOLIS	WEIR COOK MAP WBAS	IN	93819	72438	39 44N	086 16W	0247	01 68 - 12 71	STAR	SA	T50282
SOUTH BEND	ST JOSEPH COUNTY ARPT WBAS	IN	14848	72535	41 42N	086 19W	0238	01 67 - 12 71	STAR	A	T13709
SOUTH BEND	ST JOSEPH COUNTY ARPT WBAS	IN	14848	72535	41 42N	086 19W	0238	01 70 - 12 70	STAR	A	T13534
SOUTH BEND	ST JOSEPH COUNTY ARPT WBAS	IN	14848	72535	41 42N	086 19W	0238	01 71 - 12 71	STAR	A	T13534
TERRE HAUTE	HULMAN FIELD CAA	IN	93823	72437	39 27N	087 18W	0181	01 50 - 12 54	STAR	A	T13709
BURLINGTON	MUNICIPAL ARPT WBAS	IA	14931		40 47N	091 07W	0212	01 67 - 12 71	STAR	A	T13709
DES MOINES	MUNICIPAL ARPT WBAS	IA	14933	72546	41 32N	093 39W	0290	01 72 - 12 72	STAR	A	T15196
MASON CITY	MUNICIPAL ARPT FAA	IA	14940		43 10N	093 20W	0373	01 70 - 12 74	STAR	A	T51799
SIOUX CITY	MUNICIPAL ARPT WBAS	IA	14943	72557	42 24N	096 23W	0339	01 70 - 12 74	STAR	A	T51799
WATERLOO	MUNICIPAL ARPT SAWR	IA	94910	72548	42 33N	092 24W	0270	01 60 - 12 64	STAR	SA	T50709.3
FT LEAVENWORTH	SHERMAN FIELD AAF	KS	13921		39 22N	094 55W	0238	01 62 - 12 70	STAR	MA	T50127
GARDEN CITY	MUNICIPAL ARPT CAA	KS	23064		37 56N	100 43W	0878	01 50 - 12 54	STAR	MA	T50974.3
GOODLAND	RENNER FIELD WBAS	KS	23065	72465	39 22N	101 42W	1112	01 54 - 12 58	STAR	MA	T15038
GOODLAND	RENNER FIELD WBAS	KS	23065	72465	39 22N	101 42W	1112	01 58 - 12 73	STAR	SA	T15169
TOPEKA	BILLARD MAP WBAS	KS	13996	72456	39 04N	095 38W	0269	01 53 - 12 72	STAR	MA	T14659
TOPEKA	BILLARD MAP WBAS	KS	13996	72456	39 04N	095 38W	0269	01 72 - 12 72	STAR	MA	T01772
WICHITA	MUNICIPAL ARPT WBAS	KS	03928	72450	37 39N	097 25W	0403	01 53 - 12 72	STAR	MA	T50300
WICHITA	MUNICIPAL ARPT WBAS	KS	03928	72450	37 39N	097 25W	0408	01 70 - 12 74	STAR	MA	T51200.3
WICHITA	MUNICIPAL ARPT WBAS	KS	03928	72450	37 39N	097 25W	0408	01 73 - 12 73	STAR	MA	T50300
BOWLING GREEN	CITY-COUNTY ARPT CAA	KY	93808		36 58N	086 26W	0164	01 50 - 12 54	STAR	SA	T11898
CORBIN	CAA	KY	03814		36 58N	084 08W	0358	10 48 - 09 54	STAR	SA	T11898
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 04N	084 40W	0270	01 58 - 12 62	STAR	SA	T11898
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 04N	084 40W	0270	01 64 - 12 64	STAR	A	T50064
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 03N	084 40W	0265	01 69 - 12 73	STAR	SA	T15172
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 03N	084 40W	0265	01 70 - 12 74	STAR	SA	T15675.3
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 04N	084 40W	0265	01 70 - 12 74	STAR	SA	T15675.3
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 03N	084 40W	0265	01 72 - 12 72	STAR	SA	T15207
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 03N	084 40W	0265	01 73 - 12 73	STAR	SA	T51144.3
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 03N	084 40W	0265	04 74 - 07 74	STAR	A	T50329
COVINGTON	GTR CINCINNATI ARPT WBAS	KY	93814	72421	39 04N	084 40W	0271	01 75 - 12 75	STAR	SA	T52409.3
FORT CAMPBELL	CAMPBELL AFB	KY	13806	74671	36 40N	087 30W	0172	01 58 - 12 62	STAR	SA	T11898
FORT KNOX	GODMAN AAF	KY	13807	72423	37 54N	085 58W	0239	01 54 - 12 58	STAR	SA	T11898
LEXINGTON	BLUE GRASS FIELD WBAS	KY	93820	72422	38 02N	084 36W	0299	01 50 - 12 64	STAR	SA	T11898
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 50 - 12 54	STAR	SA	T11898
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 64 - 12 64	STAR	A	T52099
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 56 - 12 70	STAR	SA	T12981
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 67 - 12 71	STAR	MSA	T14316

CITY	NAME - TYPE	ST	NOAA #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAPE #
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 70 - 12 70	STAR	SA	T1227
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 72 - 12 72	STAR	A	T1517
LOUISVILLE	STANDIFORD FIELD WBAS	KY	93821	72423	38 11N	085 44W	0149	01 73 - 12 73	STAR	SA	T5022
PADUCAH	BARKLEY APT CAA	KY	03816		37 04N	088 46W	0121	01 50 - 12 54	STAR	SA	T1189
PADUCAH	BARKLEY APT FSS	KY	03816		37 04N	088 46W	0121	01 55 - 12 54	STAR	[illegible]	T1303
PADUCAH	BARKLEY APT FSS	KY	03816		37 04N	088 46W	0121	01 50 - 12 54	STAR	MA	T1452
ALEXANDRIA	ESLER FIELD	LA	13935		31 23N	092 18W	0036	01 70 - 12 73	STAR	SA	T5056
ALEXANDRIA	ESLER FIELD	LA	13935		31 23N	092 18W	0036	01 70 - 12 74	STAR	SA	T5125
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0024	01 55 - 12 54	STAR	MA	T14291
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0024	01 56 - 12 70	STAR	A	T13080
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0023	01 70 - 12 74	STAR	SA	T51256
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0024	01 70 - 12 70	STAR	A	T13080
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0024	01 72 - 12 72	STAR	MA	T14339
BATON ROUGE	RYAN FIELD MAP WBAS	LA	13970		30 32N	091 09W	0023	01 73 - 12 73	STAR	A	T51096
LAFAYETTE	MUNICIPAL APT CAA	LA	13976		30 12N	091 59W	0013	01 54 - 12 58	STAR	SA	T50753
LAKE CHARLES	MUNICIPAL APT WBAS	LA	03937	72240	30 07N	093 13W	0005	01 66 - 12 70	STAR	A	T50866
LAKE CHARLES	MUNICIPAL APT WBAS	LA	03937	72240	30 07N	093 13W	0005	01 56 - 12 70	STAR	A	T13080
LAKE CHARLES	MUNICIPAL APT WBAS	LA	03937	72240	30 07N	093 13W	0005	01 70 - 12 70	STAR	A	T13080
LAKE CHARLES	MUNICIPAL APT WBAS	LA	03937	72240	30 07N	093 13W	0005	01 70 - 12 74	STAR	SA	T51256
LAKE CHARLES	WBAS	LA	13941	72240	30 13N	093 09W	0005	01 58 - 12 62	STAR	MA	T50749
LAKE CHARLES	CHENNAULT AFB	LA	13941	72240	30 13N	093 09W	0005	01 58 - 12 62	STAR	SA	T51092
MONROE	SELMAN FIELD CAA	LA	13942		32 31N	092 03W	0028	01 54 - 12 58	STAR	SA	T51265
MONROE	SELMAN FIELD CAA	LA	13942		32 31N	092 03W	0028	01 54 - 12 58	STAR	SA	T50555
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 60 - 12 54	STAR	MA	T13267
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 66 - 12 70	STAR	A	T13080
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 67 - 12 71	STAR	MA	T13574
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0001	01 68 - 12 73	STAR	SA	T50827
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 68 - 12 73	STAR	MA	T50308
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 70 - 12 70	STAR	A	T13080
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 74 - 12 74	STAR	MA	T52214.
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 75 - 12 75	STAR	MA	T52214.
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	10 75 - 12 75	STAR	MA	T52221
NEW ORLEANS	MOISANT INL APT WBAS	LA	12916	72231	29 59N	090 15W	0006	01 76 - 05 76	STAR	MA	T52221
NEW ORLEANS	CALLENDER NAS	LA	12958		29 50N	090 01W	0001	01 67 - 12 71	STAR	SA	T51018
NEW ORLEANS	CALLENDER NAS	LA	12958		29 50N	090 01W	0001	01 70 - 12 74	STAR	SA	T51904.
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 60 - 12 54	STAR	A	T13121
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 67 - 12 71	STAR	SA	T14024
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 70 - 12 74	STAR	SA	T51256.
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 71 - 12 75	STAR	SA	T52296.
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 71 - 12 75	STAR	SA	T52296.
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 72 - 12 72	STAR	SA	T14339
SHREVEPORT	MUNICIPAL APT WBAS	LA	13957	72248	32 28N	093 49W	0081	01 75 - 12 75	STAR	MA	T52445
AUGUSTA	STATE APT CAA	ME	14605		44 19N	069 48W	0108	01 50 - 12 54	STAR	SA	T50831.
AUGUSTA	STATE APT CAA	ME	14605		44 19N	069 48W	0108	01 50 - 12 54	STAR	MSA	T50394
AUGUSTA	STATE APT CAA	ME	14605		44 19N	069 48W	0108	01 50 - 12 54	STAR	SA	T50452
AUGUSTA	STATE APT CAA	ME	14605		44 19N	069 48W	0108	01 50 - 12 54	STAR	SA	T50831.4
BRUNSWICK	NAS	ME	14611	74392	43 53N	069 56W	0024	01 50 - 12 59	STAR	SA	T13786
CARIBOU	MUNICIPAL APT WBAS	ME	14607	72712	46 52N	068 01W	0191	01 53 - 12 52	STAR	SA	T13786
OLD TOWN	FAA	ME	14622		44 57N	068 40W	0041	01 50 - 12 54	STAR	MA	T50949
PORTLAND	INTERNATIONAL APT WBAS	ME	14764	72606	43 39N	070 19W	0024	01 55 - 12 54	STAR	SA	T13786
PORTLAND	INTERNATIONAL APT WBAS	ME	14764	72606	43 39N	070 19W	0024	01 50 - 12 54	STAR	SA	T13941
PORTLAND	INTERNATIONAL APT WBAS	ME	14764	72606	43 39N	070 19W	0024	10 73 - 09 74	STAR	MA	T51269.3
ABERDEEN	PHILLIPS FIELD AAF	MD	13701		39 28N	076 10W	0018	01 55 - 12 57	STAR	MA	T13818
ANDREWS AFB	WASHINGTON DC	MD	13705	72403	38 49N	076 53W	0086	01 66 - 12 70	STAR	MA	T50028
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 50 - 12 64	STAR	SA	T14479.4
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 50 - 12 54	STAR	A	T14635.4
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 60 - 12 54	STAR	SA	T14479.4
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 60 - 12 64	STAR	SA	T14479.4
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 50 - 12 64	STAR	SA	T14479.4
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 64 - 12 54	STAR	SA	T11978
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 68 - 12 58	STAR	SA	T11978
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 69 - 12 73	STAR	MA	T50651
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 69 - 12 69	STAR	MSA	T13770
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 70 - 12 70	STAR	MSA	T13770
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 71 - 12 71	STAR	MSA	T13770
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 72 - 12 72	STAR	MSA	T14175
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0060	01 73 - 12 73	STAR	SA	T50282
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0047	01 74 - 12 74	STAR	MSA	T15290
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0047	01 74 - 12 74	STAR	MA	T51155
BALTIMORE	FRIENDSHIP INL APT WBAS	MD	93721	72406	39 11N	076 40W	0047	01 75 - 12 75	STAR	A	T52259.3
CAMP DETRICK	AF	MD	13749		39 26N	077 27W	0101	01 49 - 12 52	STAR	SA	T50767.3
FORT MEADE	TIPTON AAF	MD	93733		39 05N	076 46W	0043	01 50 - 12 64	STAR	SA	T14479.47
FORT MEADE	TIPTON AAF	MD	93733		39 05N	076 46W	0043	01 50 - 12 64	STAR	SA	T52371
FORT MEADE	TIPTON AAF	MD	93733		39 05N	076 46W	0043	01 60 - 12 54	STAR	SA	T14479.47
FORT MEADE	TIPTON AAF	MD	93733		39 05N	076 46W	0043	01 60 - 12 64	STAR	SA	T14479.47
FORT MEADE	TIPTON AAF	MD	93733		39 05N	076 46W	0043	01 60 - 12 64	STAR	SA	T14479.47
HAGERSTOWN	MUNICIPAL APT SAWR	MD	93706		39 42N	077 43W	0215	01 74 - 12 74	STAR	MSA	T15290.36
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 53 - 12 72	STAR	MA	T14830
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 67 - 12 71	STAR	MA	T50230
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 69 - 12 69	STAR	MSA	T13770
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 70 - 12 70	STAR	MA	T13456
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 71 - 12 71	STAR	MSA	T13770
PATUXENT RIVER	NAS	MD	13721	72404	38 18N	076 25W	0014	01 72 - 12 72	STAR	MSA	T14175
SALISBURY	WICOMICO COUNTY APT CAA	MD	93720		38 20N	075 30W	0021	01 49 - 12 58	STAR	MA	T14830
SALISBURY	WICOMICO COUNTY APT CAA	MD	93720		38 20N	075 30W	0018	01 74 - 12 74	STAR	MSA	T15290
BEDFORD	L G HANSCOM FIELD AFB	MA	14702	74490	42 48N	071 17W	0045	01 53 - 12 67	STAR	SA	T01772
BOSTON	LOGAN INL APT WBAS	MA	14739	72509	42 22N	071 02W	0009	01 56 - 12 70	STAR	SA	T13333
BOSTON	LOGAN INL APT WBAS	MA	14739	72509	42 22N	071 02W	0009	01 57 - 12 71	STAR	SA	T01772

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAPE/REMARKS
BOSTON	LOGAN INL APT WBAS	MA	14739	72509	42 22N	071 02W	0009	01 72 - 12 72	STAR	SA	T50855
CHICOPEE FALLS	WESTOVER AFB	MA	14703	74491	42 12N	072 32W	0075	01 60 - 12 64	STAR	SA	T13722
CHICOPEE FALLS	WESTOVER AFB	MA	14703	74491	42 12N	072 32W	0075	01 59 - 12 59	STAR	SA	T50572
FALMOUTH	OTIS AFB	MA	14704		41 39N	070 31W	0042	01 50 - 12 54	STAR	SA	T50421
PITTSFIELD	MUNICIPAL APT CAA	MA	14763		42 26N	073 18W	0358	01 46 - 12 56	STAR	SA	T14019
SOUTH WEYMOUTH	NAS	MA	14790		42 09N	070 56W	0051	01 70 - 12 74	STAR	SA	T52034.3
WORCESTER	MUNICIPAL APT WBAS	MA	94746		42 16N	071 52W	0305	01 65 - 12 59	STAR	S	T11927
WORCESTER	MUNICIPAL APT WBAS	MA	94746		42 16N	071 52W	0310	01 72 - 12 72	STAR	SA	T50555
WORCESTER	MUNICIPAL APT WBAS	MA	94746		42 16N	071 52W	0310	05 74 - 04 75	STAR	SA	T51792
BENTON HARBOR	ROSS FIELD	MI	94871		42 08N	086 28W	0191	01 74 - 12 74	STAR	SA	T51045.47N
DETROIT	CITY APT WBAS	MI	14822		42 25N	083 01W	0191	01 69 - 12 73	STAR	A	T15016
DETROIT	CITY APT WBAS	MI	14822		42 25N	083 01W	0191	01 72 - 12 72	STAR	SA	T50049
DETROIT	CITY APT WBAS	MI	14822		42 25N	083 01W	0191	01 73 - 12 73	STAR	SA	T50208
DETROIT	CITY APT WBAS	MI	14822		42 25N	083 01W	0191	01 74 - 12 74	STAR	SA	T51021
DETROIT	CITY APT WBAS	MI	14822		42 25N	083 01W	0191	01 75 - 12 75	STAR	SA	T52135
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0197	01 71 - 12 71	STAR	SA	T01772
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0197	01 72 - 12 72	STAR	SA	T50049
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0197	01 73 - 12 73	STAR	SA	T50208
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0202	01 74 - 12 74	STAR	MA	T52442
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0202	01 74 - 12 74	STAR	SA	T51021
DETROIT	METRO-WAYNE CAP WBAS	MI	94847	72537	42 14N	083 20W	0202	01 75 - 12 75	STAR	SA	T52135
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0235	01 60 - 12 64	STAR	MA	T50440
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0235	01 65 - 12 68	STAR	SA	T11972
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	01 56 - 12 75	STAR	MA	T52408
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	01 72 - 12 72	STAR	SA	T01772
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	01 73 - 12 73	STAR	SA	T50512
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	01 74 - 12 74	STAR	SA	T51021
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	01 75 - 12 75	STAR	SA	T52135
FLINT	BISHOP APT WBAS	MI	14826	72637	42 58N	083 44W	0233	03 75 - 02 76	STAR	MA	T52408
GWINN	KI SAWYER AFB	MI	94836		46 21N	087 24W	0377	01 63 - 12 67	STAR	SA	T50829.3
GWINN	KI SAWYER AFB	MI	94836		46 21N	087 24W	0377	01 65 - 12 70	STAR	MA	T50922
LANSING	CAPITAL CITY APT WBAS	MI	14836	72539	42 47N	084 36W	0266	01 69 - 12 73	STAR	A	T15016
MUSKEGON	MUSKEGON COUNTY APT WBAS	MI	14840	72636	43 10N	086 14W	0192	01 67 - 12 71	STAR	SA	T13900
SAGINAW	TRI-CITY APT CAA	MI	14845		43 32N	084 05W	0183	01 40 - 12 54	STAR	SA	T13890
SAGINAW	TRI-CITY APT CAA	MI	14845		43 32N	084 05W	0203	01 46 - 12 54	STAR	MA	T52383.3
SAGINAW	TRI-CITY APT CAA	MI	14845		43 32N	084 05W	0204	01 50 - 12 54	STAR	SA	T14238
SAGINAW	TRI-CITY APT CAA	MI	14845		43 32N	084 05W	0204	01 50 - 12 54	STAR	MA	T13839
TRAVERSE CITY	CHERRY CAP CAA	MI	14850		44 44N	085 35W	0192	01 74 - 12 74	STAR	MSA	T15290
YPSILANTI	WILLOW RUN APT WBAS	MI	14853		42 14N	083 32W	0237	10 63 - 09 68	STAR	A	T15016
YPSILANTI	WILLOW RUN APT WBAS	MI	14853		42 14N	083 32W	0237	10 63 - 09 68	STAR	SA	T52125.3
ALEXANDRIA	MUNICIPAL APT CAA	MN	14910		45 52N	095 23W	0435	01 52 - 12 54	STAR	SA	T13083
DULUTH	INTERNATIONAL APT WBAS	MN	14913	72745	46 50N	092 11W	0434	01 67 - 12 71	STAR	SA	T14008
DULUTH	INTERNATIONAL APT WBAS	MN	14913	72745	46 50N	092 11W	0434	01 70 - 12 74	STAR	SA	T15660.3
DULUTH	INTERNATIONAL APT WBAS	MN	14913	72745	46 50N	092 11W	0434	01 70 - 12 70	STAR	SA	T12751
MINNEAPOLIS	INTERNATIONAL APT WBAS	MN	14922	72658	44 53N	093 13W	0262	01 58 - 12 72	STAR	MSA	T50097
MINNEAPOLIS	INTERNATIONAL APT WBAS	MN	14922	72658	44 53N	093 13W	0262	01 60 - 12 64	STAR	MA	T50219
MINNEAPOLIS	INTERNATIONAL APT WBAS	MN	14922	72658	44 53N	093 13W	0262	01 55 - 12 74	STAR	MA	T52351.3
MINNEAPOLIS	INTERNATIONAL APT WBAS	MN	14922	72658	44 53N	093 13W	0262	01 67 - 12 71	STAR	SA	T14008
MINNEAPOLIS	INTERNATIONAL APT WBAS	MN	14922	72658	44 53N	093 13W	0262	01 70 - 12 70	STAR	SA	T12751
ROCHESTER	MUNICIPAL APT WBAS	MN	14925	72644	43 55N	092 30W	0402	01 59 - 12 73	STAR	MA	T51085
BILOXI	KEESLER AFB	MS	13820		30 24N	088 55W	0008	01 60 - 12 64	STAR	MA	T50775
BILOXI	KEESLER AFB	MS	13820		30 24N	088 55W	0008	01 50 - 12 54	STAR	A	T50010
COLUMBUS	AFB	MS	13825		33 39N	088 27W	0065	01 66 - 12 74	STAR	SA	T50475
COLUMBUS	AFB	MS	13825		33 39N	088 27W	0068	01 56 - 12 70	STAR	SA	T50636
GREENVILLE	AFB	MS	13839	72238	33 31N	091 00W	0042	11 55 - 10 60	STAR	SA	T14354
JACKSON	THOMPSON MAP WBAS	MS	03940	72235	32 19N	090 05W	0110	01 55 - 12 64	STAR	A	T52191
JACKSON	THOMPSON MAP WBAS	MS	03940	72235	32 19N	090 05W	0110	01 65 - 12 69	STAR	MSA	T14408
JACKSON	THOMPSON MAP WBAS	MS	03940	72235	32 19N	090 05W	0110	01 55 - 12 69	STAR	SA	T11873
JACKSON	THOMPSON MAP WBAS	MS	03940	72235	32 19N	090 05W	0110	01 66 - 12 70	STAR	SA	T12925
JACKSON	THOMPSON MAP WBAS	MS	03940	72235	32 19N	090 05W	0110	01 70 - 12 70	STAR	SA	T12925
JACKSON	HAWKINS FIELD WBAS	MS	13956	72235	32 20N	090 13W	0096	01 60 - 12 54	STAR	MSA	T14408
JACKSON	HAWKINS FIELD WBAS	MS	13956	72235	32 20N	090 13W	0096	01 50 - 12 64	STAR	MA	T13267
JACKSON	HAWKINS FIELD WBAS	MS	13956	72235	32 20N	090 13W	0096	01 50 - 12 54	STAR	MA	T13930
MCCOMB	PIKE COUNTY CAA	MS	93919		31 15N	090 28W	0141	01 49 - 12 49	STAR	SA	T51036
MERIDIAN	KEY FIELD WBAS	MS	13865	72234	32 20N	088 45W	0090	01 66 - 12 70	STAR	SA	T12925
MERIDIAN	KEY FIELD WBAS	MS	13865	72234	32 20N	088 45W	0090	01 70 - 12 70	STAR	SA	T12925
COLUMBIA	REGIONAL APT WBAS	MO	03945	72445	38 49N	092 13W	0272	01 73 - 12 73	STAR	MA	T50300
COLUMBIA	MUNICIPAL APT WBAS	MO	13983	72445	38 58N	092 22W	0238	01 54 - 12 56	STAR	A	T13746
KANSAS CITY	MUNICIPAL APT WBAS	MO	03947	72446	39 18N	094 33W	0315	01 59 - 12 74	STAR	MA	T52323
KANSAS CITY	MUNICIPAL APT WBAS	MO	13988	72446	39 07N	094 36W	0241	01 54 - 12 54	STAR	A	T50692.3
KANSAS CITY	MUNICIPAL APT WBAS	MO	13988	72446	39 07N	094 36W	0228	01 57 - 12 71	STAR	A	T13785
KANSAS CITY	MUNICIPAL APT WBAS	MO	13988	72446	39 07N	094 36W	0228	01 58 - 09 72	STAR	SA	T50635
KANSAS CITY	MUNICIPAL APT WBAS	MO	13988	72446	39 07N	094 36W	0228	01 59 - 12 59	STAR	SA	T12061
KIRKSVILLE	CANNON MEMORIAL APT	MO	14938		40 06N	092 33W	0294	01 50 - 12 54	STAR	A	T51867
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 50 - 12 64	STAR	MA	T50284
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 64 - 12 58	STAR	SA	T11930.96
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 55 - 12 69	STAR	SA	T12039.2
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 58 - 12 72	STAR	SA	T50123
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 59 - 12 69	STAR	A	T12084
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	01 70 - 12 74	STAR	SA	T51153.3
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	10 70 - 09 71	STAR	A	T13157
SAINT LOUIS	LAMBERT FIELD WBAS	MO	13994	72434	38 45N	090 23W	0172	12 70 - 02 71	STAR	S	T11930
SPRINGFIELD	MUNICIPAL APT WBAS	MO	13995	72440	37 14N	093 23W	0388	01 56 - 12 70	STAR	SA	T13192
BILLINGS	LOGAN FIELD WBAS	MT	24033	72677	45 48N	108 32W	1092	01 57 - 12 71	STAR	SA	T14135
BUTTE	SILVER BOW COUNTY APT CAA	MT	24135	72679	45 57N	112 30W	1690	01 56 - 12 50	STAR	SA	T13365
CUSTER	CAA	MT	24040		46 07N	107 31W	0878	01 46 - 05 50	STAR	MA	T14527
CUT BANK	MUNICIPAL APT CAA	MT	24137		48 36N	112 22W	1174	01 49 - 12 58	STAR	MA	T50298

CITY	NAME - TYPE	ST	#	#	LAT	LONG	ELEV	RECORD	TYPE	FREQ	TAPE/REF
GLASGOW	INTERNATIONAL APT WBAS	MT	94008	72768	48 13N	106 37W	2696	01 55 - 12 58	STAR	SA	T51080.4
GLASGOW	INTERNATIONAL APT WBAS	MT	94008	72768	48 13N	106 37W	2696	01 57 - 12 71	STAR	T14	527
HAVRE	CITY-COUNTY APT WBAS	MT	94012	72770	48 33N	109 46W	2598	01 57 - 12 71	STAR	MA	T14627
HELENA	WBAS	MT	24144	72772	46 36N	112 00W	1188	01 58 - 12 52	STAR	SA	T13835
HELENA	WBAS	MT	24144	72772	46 36N	112 00W	1188	01 55 - 10 74	STAR	MA	T15236
KALISPELL	GLACIER PARK INL APT WBAS	MT	24146	72779	48 18N	114 16W	2908	01 50 - 12 52	STAR	SA	T15081
KALISPELL	GLACIER PARK INL APT WBAS	MT	24146	72779	48 18N	114 16W	2908	01 63 - 12 72	STAR	SA	T14723
LEWISTOWN	MUNICIPAL APT FAA	MT	24036		47 33N	109 27W	1263	01 67 - 12 71	STAR	MA	T14627
MILES CITY	MUNICIPAL APT FAA	MT	24037		46 25N	105 52W	2602	01 57 - 12 71	STAR	MA	T14135
MISSOULA	JOHNSON-BELL FIELD WBAS	MT	24153	72773	46 55N	114 05W	3960	01 67 - 12 71	STAR	MA	T14627
LINCOLN	AFB	NE	14904	72551	40 51N	096 45W	0358	01 58 - 12 63	STAR	A	T52091
NORTH PLATTE	LEE BIRD FIELD WBAS	NE	24023	72562	41 08N	100 41W	0848	01 50 - 12 54	STAR	MA	T14312
NORTH PLATTE	LEE BIRD FIELD WBAS	NE	24023	72562	41 08N	100 41W	0848	01 69 - 12 73	STAR	SA	T15169
NORTH PLATTE	LEE BIRD FIELD WBAS	NE	24023	72562	41 08N	100 41W	0848	05 73 - 04 75	STAR	MA	T52016.3
OMAHA	EPPLEY FIELD WBAS	NE	14942	72553	41 18N	095 54W	0303	01 54 - 12 54	STAR	A	T51832
OMAHA	EPPLEY FIELD WBAS	NE	14942	72553	41 18N	095 54W	0304	01 64 - 12 73	STAR	A	T51298
OMAHA	EPPLEY FIELD WBAS	NE	14942	72553	41 18N	095 54W	0303	08 67 - 12 73	STAR	MA	T52008
OMAHA	EPPLEY FIELD WBAS	NE	14942	72553	41 18N	095 54W	0298	01 69 - 12 73	STAR	A	T01776
OMAHA	EPPLEY FIELD WBAS	NE	14942	72553	41 18N	095 54W	0299	01 73 - 12 73	STAR	A	T51020
OMAHA	OFFUTT AFB	NE	14949	72554	41 07N	095 55W	0314	01 60 - 12 64	STAR	MA	T14312
SCOTTSBLUFF	MUNICIPAL APT WBAS	NE	24028	72566	41 52N	103 36W	1204	01 67 - 12 71	STAR	MA	T50663.3
SCOTTSBLUFF	MUNICIPAL APT WBAS	NE	24028	72566	41 52N	103 36W	1204	01 67 - 12 71	STAR	MA	T14842
SCOTTSBLUFF	MUNICIPAL APT WBAS	NE	24028	72566	41 52N	103 36W	1204	01 68 - 12 72	STAR	SA	T50256
ELKO	MUNICIPAL APT FAA	NV	24121	72582	40 50N	115 47W	1547	01 69 - 12 73	STAR	SA	T51029
ELY	YELLAND FIELD WBAS	NV	23154	72486	39 17N	114 51W	1907	01 67 - 12 71	STAR	SA	T13365
LAS VEGAS	NELLIS AFB	NV	23112		36 15N	115 02W	0573	01 58 - 12 67	STAR	MA	T15029
LAS VEGAS	MCCARRAN INL APT WBAS	NV	23169	72386	36 05N	115 10W	0664	01 69 - 12 73	STAR	SA	T50529.47
LAS VEGAS	MCCARRAN INL APT WBAS	NV	23169	72386	36 05N	115 10W	0664	01 68 - 12 73	STAR	SA	T50529.47
LOVELOCK	DERBY APT FAA	NV	24172		40 04N	118 33W	1190	01 69 - 12 73	STAR	SA	T51029
RENO	STEAD AFB	NV	23118	72488	39 40N	119 52W	1531	01 56 - 12 65	STAR	MA	T15029
RENO	INTERNATIONAL APT WBAS	NV	23185	72488	39 30N	119 47W	1343	01 50 - 12 64	STAR	A	T52240
RENO	INTERNATIONAL APT WBAS	NV	23185	72488	39 30N	119 47W	1343	01 60 - 12 80	STAR	MA	T50678
WINNEMUCCA	MUNICIPAL APT WBAS	NV	24128	72583	40 54N	117 48W	1322	01 59 - 12 73	STAR	SA	T51028
CONCORD	MUNICIPAL APT WBAS	NH	14745	72605	43 12N	071 30W	0104	01 50 - 12 64	STAR	A	T15140.10
CONCORD	MUNICIPAL APT WBAS	NH	14745	72605	43 12N	071 30W	0104	01 50 - 12 54	STAR	MA	T50303
CONCORD	MUNICIPAL APT WBAS	NH	14745	72605	43 12N	071 30W	0105	01 70 - 12 70	STAR	SA	T12926
PORTSMOUTH	PEASE AFB	NH	04743		43 05N	070 49W	0039	01 68 - 12 59	STAR	SA	T12926
ATLANTIC CITY	WBAS	NJ	93730	72407	39 27N	074 35W	0020	01 64 - 12 54	STAR	A	T52113
ATLANTIC CITY	WBAS	NJ	93730	72407	39 27N	074 35W	0020	01 64 - 12 54	STAR	MA	T13831
ATLANTIC CITY	WBAS	NJ	93730	72407	39 27N	074 35W	0020	01 68 - 12 72	STAR	MA	T14622
ATLANTIC CITY	WBAS	NJ	93730	72407	39 27N	074 35W	0020	01 70 - 12 74	STAR	A	T52035
BELMAR	ASC	NJ	04738		40 11N	074 04W	0026	01 55 - 12 58	STAR	MA	T13381
LAKEHURST	NAS	NJ	14780	72409	40 02N	074 19W	0036	01 68 - 12 72	STAR	SA	T14630
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 55 - 12 64	STAR	SA	T128 2
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 60 - 12 64	STAR	SA	T14947.47L
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 60 - 12 54	STAR	SA	T14947.47I
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 60 - 12 64	STAR	SA	T14947.47K
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 50 - 12 64	STAR	SA	T14947.47J
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 66 - 12 .0	STAR	MA	T12910
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 70 - 12 70	STAR	SA	T12892
NEWARK	WBAS	NJ	14734	72502	40 42N	074 10W	0009	01 71 - 12 71	STAR	SA	T50200
TETERBORO	SAWR	NJ	94741		40 51N	074 03W	0002	01 52 - 12 56	STAR	MA	T12910
WRIGHTSTOWN	MCGUIRE AFB	NJ	14706		40 00N	074 36W	0045	01 66 - 12 70	STAR	SA	T15100
ALBUQUERQUE	SUN-KIRTLAND INL APT WBAS	NM	23050	72365	35 03N	106 37W	1619	01 60 - 12 64	STAR	MA	T14164
ALBUQUERQUE	SUN-KIRTLAND INL APT WBAS	NM	23050	72365	35 03N	106 37W	1619	01 75 - 12 75	STAR	MA	T52113
FARMINGTON	MUNICIPAL APT CAA	NM	23090		36 45N	108 14W	1677	01 54 - 12 58	STAR	SA	T13029
FARMINGTON	MUNICIPAL APT FAA	NM	23090		36 45N	108 14W	1677	09 63 - 04 68	STAR	MA	T12160
GALLUP	SENATOR CLARKE FIELD SAWR	NM	23081		35 31N	108 47W	1970	01 73 - 12 75	STAR	SA	T52176
HOBBS	LEA COUNTY APT CAA	NM	93034		32 41N	103 12W	1117	01 49 - 12 49	STAR	SA	T52339
HOBBS	LEA COUNTY APT CAA	NM	93034		32 41N	103 12W	1117	01 48 - 12 54	STAR	MA	T14040
HOBBS	LEA COUNTY APT CAA	NM	93034		32 41N	103 12W	1117	01 53 - 12 54	STAR	SA	T52339
LAS CRUCES	WHITE SANDS AF	NM	23039	72269	32 22N	106 29W	1291	01 51 - 12 55	STAR	MA	T52246
SANTA FE	CAA	NM	23049		35 37N	106 05W	1925	01 50 - 12 54	STAR	MA	T52246
ZUNI	INTERMEDIATE FIELD FSS	NM	93044		35 06N	108 48W	1965	01 67 - 12 71	STAR	SA	T14358
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0088	01 50 - 12 54	STAR	SA	T14613
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 66 - 12 70	STAR	MA	T12910
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 57 - 12 71	STAR	SA	T14364.115G
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 57 - 12 71	STAR	SA	T14364.47G
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 67 - 12 71	STAR	SA	T14364.115A
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 57 - 12 71	STAR	SA	T14364.115C
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 67 - 12 71	STAR	SA	T14364.115H
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 67 - 12 71	STAR	SA	T14364.47F
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 67 - 12 71	STAR	SA	T14364.115B
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 67 - 12 71	STAR	SA	T14364.115E
ALBANY	MUNICIPAL APT WBAS	NY	14735	72518	42 45N	073 48W	0090	01 72 - 12 72	STAR	SA	T50655
BINGHAMTON	BROOME COUNTY APT WBAS	NY	04725	72515	42 13N	075 59W	0493	01 50 - 12 64	STAR	SA	T14640
BINGHAMTON	BROOME COUNTY APT WBAS	NY	04725	72515	42 13N	075 59W	0493	01 64 - 12 54	STAR	SA	T01772
BINGHAMTON	BROOME COUNTY APT WBAS	NY	04725	72515	42 13N	075 59W	0493	01 64 - 12 54	STAR	SA	T50408
BINGHAMTON	TRI-CITIES APT WBAS	NY	14738		42 05N	076 06W	0254	01 50 - 12 50	STAR	SA	T50408
BUFFALO	GTR BUFFALO INL APT WBAS	NY	14733	72528	42 56N	078 44W	0218	01 54 - 12 73	STAR	MA	T50366
BUFFALO	GTR BUFFALO INL APT WBAS	NY	14733	72528	42 56N	078 44W	0218	01 67 - 12 71	STAR	SA	T01772
BUFFALO	GTR BUFFALO INL APT WBAS	NY	14733	72528	42 56N	078 44W	0218	01 57 - 12 71	STAR	MA	T14452
BUFFALO	GTR BUFFALO INL APT WBAS	NY	14733	72528	42 56N	078 44W	0218	01 73 - 12 73	STAR	MA	T50847.3
ELMIRA	CHEMUNG COUNTY APT CAA	NY	14748	72516	42 10N	076 54W	0289	01 50 - 12 54	STAR	MA	T51195.3
GLENS FALLS	WARREN COUNTY APT CAA	NY	14750		43 21N	077 37W	0104	01 50 - 12 54	STAR	MA	T51195.3
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 52W	0015	01 51 - 12 50	STAR	A	T14022

					LAT	LONG	ELEV	RECORD	TYPE	FREQ	TAB#/REMARKS
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 50 - 12 51	STAR	SA	T14068
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 65 - 12 70	STAR	A	T12795
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 55 - 12 56	STAR	SA	T14068
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 56 - 12 70	STAR	MA	T12910
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 70 - 12 70	STAR	A	T13860
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 70 - 12 71	STAR	SA	T14068
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 71 - 12 71	STAR	A	T13860
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	12 71 - 11 72	STAR	SA	T14745
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 72 - 12 72	STAR	SA	T50003
NEW YORK	LA GUARDIA APT WBAS	NY	14732	72503	40 46N	073 54W	0012	01 74 - 12 74	STAR	SA	T51951.3
NEW YORK	CENTRAL PARK WBO	NY	94728		40 47N	073 58W	0040	01 56 - 12 70	STAR	MSA	T13640.40
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 50 - 12 51	STAR	SA	T14068
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 65 - 12 56	STAR	SA	T12761
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 55 - 12 56	STAR	SA	T14068
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 66 - 12 70	STAR	MA	T12910
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 70 - 12 71	STAR	SA	T14068
NEW YORK	J F KENNEDY INL APT WBAS	NY	94789	74486	40 39N	073 47W	0010	01 74 - 12 74	STAR	SA	T51951.3
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 65 - 12 69	STAR	SA	T50251.115C
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 55 - 12 59	STAR	SA	T50251.115H
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 55 - 12 59	STAR	SA	T50251.115E
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 55 - 12 69	STAR	SA	T50251.115A
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 65 - 12 69	STAR	SA	T50251.115B
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 65 - 12 58	STAR	MA	T12910
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 65 - 12 69	STAR	SA	T50251.47F
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 55 - 12 69	STAR	SA	T50251.115G
NEWBURGH	STEWART AFB	NY	14714	74482	41 30N	074 06W	0177	01 65 - 12 58	STAR	SA	T50251.47G
NIAGARA FALLS	MISSILE SITE AF	NY	04724		43 08N	078 57W	0181	01 55 - 12 58	STAR	MA	T51195.3
ONEONTA	MUNICIPAL APT	NY	94731	74484	42 27N	075 00W	0364	01 67 - 12 67	STAR	A	T50428
POUGHKEEPSIE	DUTCHESS COUNTY APT CAA	NY	14757		41 38N	073 53W	0049	01 50 - 12 54	STAR	MA	T12910
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0166	01 55 - 12 64	STAR	MSA	T50221
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 50 - 12 64	STAR	SA	T14580
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115C
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115B
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115E
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.47F
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115G
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115A
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.47G
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 67 - 12 71	STAR	SA	T14237.115H
ROCHESTER	MONROE COUNTY APT WBAS	NY	14768	72529	43 07N	077 40W	0167	01 72 - 12 72	STAR	SA	T50224
ROME	GRIFFISS AFB	NY	14717	72518	43 14N	075 25W	0145	01 66 - 12 70	STAR	SA	T50784
SYRACUSE	C E HANCOCK APT WBAS	NY	14771	72519	43 07N	076 07W	0128	01 55 - 12 64	STAR	MA	T51175.3
SYRACUSE	C E HANCOCK APT WBAS	NY	14771	72519	43 07N	076 07W	0128	01 55 - 12 64	STAR	MA	T51175
SYRACUSE	C E HANCOCK APT WBAS	NY	14771	72519	43 07N	076 07W	0126	01 67 - 12 67	STAR	SA	T12322
SYRACUSE	C E HANCOCK APT WBAS	NY	14771	72519	43 07N	076 07W	0124	01 59 - 12 73	STAR	MA	T50694
WATERTOWN	MUNICIPAL APT FSS	NY	94790		44 00N	076 01W	0101	01 60 - 12 64	STAR	SA	T50784
WHITE PLAINS	WESTCHESTER CAP SAWR	NY	94745		41 04N	073 43W	0122	01 49 - 12 53	STAR	MA	T12910
WHITE PLAINS	WESTCHESTER CAP SAWR	NY	94745		41 04N	073 43W	0135	01 72 - 12 72	STAR	A	T50556
ASHEVILLE	MUNICIPAL APT WBAS	NC	03812	72315	35 26N	082 32W	0656	01 56 - 12 70	STAR	SA	T12761
ASHEVILLE	MUNICIPAL APT WBAS	NC	03812	72315	35 26N	082 32W	0659	01 71 - 12 71	STAR	MA	T13877
CAPE HATTERAS	WBO	NC	93729	72304	35 16N	075 33W	0008	01 56 - 12 70	STAR	SA	T12761
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0226	01 60 - 12 64	STAR	SA	T51661
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0226	01 56 - 12 70	STAR	SA	T12761
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0226	01 59 - 12 73	STAR	SA	T50544
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0226	01 70 - 12 70	STAR	SA	T12761
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0226	10 70 - 10 71	STAR	A	T50464
CHARLOTTE	DOUGLAS MAP WBAS	NC	13881	72314	35 13N	080 56W	0224	01 73 - 12 73	STAR	SA	T50857
CHERRY POINT	MCAS	NC	13754	72308	34 54N	076 53W	0010	01 67 - 12 71	STAR	MA	T14256.
FORT BRAGG	POPE AFB	NC	13714	72303	35 11N	079 01W	0061	01 68 - 12 70	STAR	SA	T14256
GOLDSBORO	SEYMOUR JOHNSON AFB	NC	13713		35 20N	077 58W	0027	01 66 - 12 70	STAR	MA	T14256
GREENSBORO	GREENSBORO HI PT APT WBAS	NC	13723	72317	36 05N	079 57W	0275	01 66 - 12 70	STAR	SA	T12761
GREENSBORO	GREENSBORO HI PT APT WBAS	NC	13723	72317	36 05N	079 57W	0275	01 68 - 12 72	STAR	SA	T14587
GREENSBORO	GREENSBORO HI PT APT WBAS	NC	13723	72317	36 05N	079 57W	0273	01 73 - 12 73	STAR	SA	T50857
GREENSBORO	GREENSBORO HI PT APT WBAS	NC	13723	72317	36 05N	079 57W	0273	10 73 - 09 74	STAR	SA	T50795
RALEIGH	RALEIGH DURHAM APT WBAS	NC	13722	72306	35 52N	078 47W	0132	01 55 - 12 54	STAR	SA	T12310.108
RALEIGH	RALEIGH DURHAM APT WBAS	NC	13722	72306	35 52N	078 47W	0132	01 55 - 12 54	STAR	SA	T12310
RALEIGH	RALEIGH DURHAM APT WBAS	NC	13722	72306	35 52N	078 47W	0132	01 55 - 12 54	STAR	SA	T12310.108
RALEIGH	RALEIGH DURHAM APT WBAS	NC	13722	72306	35 52N	078 47W	0132	01 66 - 12 70	STAR	SA	T12761
WILMINGTON	NEW HANOVER APT WBAS	NC	13748	72301	34 16N	077 55W	0014	01 66 - 12 70	STAR	SA	T12761
WILMINGTON	NEW HANOVER APT WBAS	NC	13748	72301	34 16N	077 55W	0014	01 57 - 12 67	STAR	SA	T51279.6
WINSTON SALEM	SMITH REYNOLDS APT WBAS	NC	93807	72319	36 08N	080 14W	0303	01 60 - 12 64	STAR	SA	T14587
BISMARCK	MUNICIPAL APT WBAS	ND	24011	72764	46 46N	100 45W	0507	01 67 - 12 71	STAR	SA	T13923
DICKINSON	MUNICIPAL APT FAA	ND	24012		46 47N	102 48W	0792	01 60 - 12 54	STAR	MA	T14627
MINOT	INTERNATIONAL APT FAA	ND	24013		48 16N	101 17W	0526	01 57 - 12 71	STAR	MA	T14627
WILLISTON	SLOULIN FLD INL APT WBAS	ND	94014	72767	48 11N	103 38W	0581	01 57 - 12 71	STAR	MA	T14627
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 60 - 12 64	STAR	SA	T50148
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 64 - 12 73	STAR	SA	T50805.3
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 70 - 12 74	STAR	SA	T15675.3
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 70 - 12 74	STAR	MA	T51253.3
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 73 - 12 73	STAR	SA	T51144.3
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 73 - 12 73	STAR	A	T14900
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 74 - 12 74	STAR	SA	T15675.3
AKRON	AKRON-CANTON APT WBAS	OH	14895	72521	40 55N	081 26W	0379	01 75 - 12 75	STAR	SA	T52409.3
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 54 - 12 54	STAR	A	T50064
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 55 - 12 57	STAR	A	T11936
CLEVELAND	HOPKINS- INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 65 - 12 57	STAR	SA	T11983
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 67 - 12 71	STAR	SA	T01772
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 59 - 12 73	STAR	A	T50959.3
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 59 - 12 59	STAR	SA	T11983

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TABS/REF-NO
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 70 - 12 74	STAR	SA	T52044
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 73 - 12 74	STAR	SA	T15675.3
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 70 - 12 70	STAR	A	T01772
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 70 - 12 70	STAR	A	T14928
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0247	01 72 - 12 72	STAR	A	T14957
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0245	01 73 - 12 73	STAR	A	T50705.3
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0245	01 74 - 12 74	STAR	SA	T15351.3
CLEVELAND	HOPKINS INL APT WBAS	OH	14820	72524	41 24N	081 51W	0245	01 75 - 12 75	STAR	SA	T52409.3
COLUMBUS	PORT COLUMBUS APT WBAS	OH	14821	72428	40 00N	082 53W	0253	01 50 - 12 54	STAR	SA	T51830
COLUMBUS	PORT COLUMBUS APT WBAS	OH	14821	72428	40 00N	082 53W	0253	01 50 - 12 54	STAR	SA	T14132
COLUMBUS	PORT COLUMBUS APT WBAS	OH	14821	72428	40 00N	082 53W	0253	01 70 - 12 74	STAR	SA	T15675.3
COLUMBUS	PORT COLUMBUS APT WBAS	OH	14821	72428	40 00N	082 53W	0253	01 74 - 12 74	STAR	SA	T15675.3
COLUMBUS	PORT COLUMBUS APT WBAS	OH	14821	72428	40 00N	082 53W	0253	01 75 - 12 75	STAR	SA	T52409.3
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0313	01 55 - 12 58	STAR	SA	T11983
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0313	01 58 - 12 58	STAR	SA	T11983
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 69 - 12 73	STAR	A	T50958.3
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 70 - 12 74	STAR	SA	T15675.3
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 73 - 12 73	STAR	A	T15022
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 73 - 12 73	STAR	A	T50958.3
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 74 - 12 74	STAR	A	T51267
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 74 - 12 74	STAR	SA	T15675.3
DAYTON	J M COX-DAYTON MAP WBAS	OH	93815	72429	39 54N	084 13W	0306	01 75 - 12 75	STAR	SA	T52409.3
FINDLAY	CAA	OH	14825		41 01N	083 40W	0244	01 50 - 12 54	STAR	A	T13708
FINDLAY	CAA	OH	14825		41 01N	083 40W	0245	01 50 - 12 54	STAR	A	T50788.3
FINDLAY	CAA	OH	14825		41 01N	083 40W	0244	01 50 - 12 54	STAR	SA	T52126.3
MANSFIELD	LAHM MUNICIPAL APT FAA	OH	14891		40 49N	082 31W	0397	01 70 - 12 74	STAR	SA	T15675.3
MANSFIELD	LAHM MUNICIPAL APT FAA	OH	14891		40 49N	082 31W	0397	01 74 - 12 74	STAR	SA	T15675.3
MANSFIELD	LAHM MUNICIPAL APT FAA	OH	14891		40 49N	082 31W	0397	01 75 - 12 75	STAR	SA	T52409.3
PERRY	CAA	OH	14843		41 47N	081 06W	0211	01 48 - 12 48	STAR	A	T50875.3
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 50 - 12 64	STAR	SA	T52126.3
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 64 - 12 68	STAR	SA	T12221
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	06 68 - 05 70	STAR	SA	T12221
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 70 - 12 74	STAR	SA	T15675.3
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 73 - 12 73	STAR	SA	T51144.3
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 74 - 12 74	STAR	SA	T15675.3
TOLEDO	EXPRESS APT WBAS	OH	94830	72536	41 36N	083 48W	0211	01 75 - 12 75	STAR	SA	T52409.3
YOUNGSTOWN	MUNICIPAL APT WBAS	OH	14852	72525	41 16N	080 40W	0365	01 67 - 12 71	STAR	SA	T01772
YOUNGSTOWN	MUNICIPAL APT WBAS	OH	14852	72525	41 16N	080 40W	0365	01 70 - 12 74	STAR	SA	T15675.3
YOUNGSTOWN	MUNICIPAL APT WBAS	OH	14852	72525	41 16N	080 40W	0365	01 73 - 12 73	STAR	A	T14900
YOUNGSTOWN	MUNICIPAL APT WBAS	OH	14852	72525	41 16N	080 40W	0365	01 74 - 12 74	STAR	SA	T15675.3
YOUNGSTOWN	MUNICIPAL APT WBAS	OH	14852	72525	41 16N	080 40W	0365	01 75 - 12 75	STAR	SA	T52409.3
ENID	VANCE AFB	OK	13909		36 20N	097 54W	0392	01 65 - 12 58	STAR	SA	T12761
MCALESTER		OK	93950		34 53N	095 47W	0227	01 54 - 12 54	STAR	MA	T51827.3
OKLAHOMA CITY	TINKER AFB	OK	13919	72354	35 25N	097 23W	0384	07 65 - 06 70	STAR	SA	T12897
OKLAHOMA CITY	WILL ROGERS APT WBAS	OK	13967	72353	35 24N	097 36W	0395	01 70 - 12 74	STAR	MA	T51200.3
PONCA CITY	MUNICIPAL APT CAA	OK	13969		36 44N	097 06W	0304	01 48 - 12 54	STAR	MA	T51200.3
TULSA	INTERNATIONAL APT WBAS	OK	13968	72356	36 12N	095 54W	0207	01 55 - 12 74	STAR	MA	T51827.3
TULSA	INTERNATIONAL APT WBAS	OK	13968	72356	36 12N	095 54W	0207	01 62 - 12 71	STAR	MA	T01772
TULSA	INTERNATIONAL APT WBAS	OK	13968	72356	36 12N	095 54W	0208	01 70 - 12 70	STAR	MA	T51200.3
TULSA	INTERNATIONAL APT WBAS	OK	13968	72356	36 12N	095 54W	0206	12 73 - 05 74	STAR	MA	T50430.3
TULSA	INTERNATIONAL APT WBAS	OK	13968	72356	36 12N	095 54W	0206	12 73 - 11 74	STAR	MSA	T50987
ASTORIA	CLATSOP COUNTY APT WBAS	OR	94224	72791	46 10N	123 52W	0003	01 60 - 12 64	STAR	MA	T12945
EUGENE	MAHLON-SWEET FIELD WBAS	OR	24221	72693	44 07N	123 13W	0111	01 67 - 12 71	STAR	SA	T14469
KLAMATH FALLS	KINGSLEY FIELD AF	OR	94236		42 09N	121 44W	1246	01 61 - 12 65	STAR	MSA	T12273
KLAMATH FALLS	KINGSLEY FIELD AF	OR	94236		42 09N	121 44W	1246	07 69 - 06 70	STAR	MSA	T12273
MEDFORD	JACKSON COUNTY APT WBAS	OR	24225	72597	42 22N	122 52W	0400	01 70 - 12 74	STAR	A	T52143.3
MEDFORD	JACKSON COUNTY APT WBAS	OR	24225	72597	42 22N	122 52W	0400	01 73 - 12 73	STAR	SA	T52143.3
MEDFORD	JACKSON COUNTY APT WBAS	OR	24225	72597	42 22N	122 52W	0400	01 73 - 12 74	STAR	A	T52143.3
PENDLETON	PENDLETON FIELD WBAS	OR	24155	72688	45 41N	118 51W	0459	01 55 - 12 64	STAR	MA	T14634
PORTLAND	INTERNATIONAL APT WBAS	OR	24229	72698	45 36N	122 36W	0008	01 67 - 12 71	STAR	SA	T13530
PORTLAND	INTERNATIONAL APT WBAS	OR	24229	72698	45 36N	122 36W	0008	01 58 - 12 73	STAR	A	T50372
REDMOND	ROBERTS FIELD CAA	OR	24230		44 16N	121 09W	0934	01 55 - 12 54	STAR	MA	T14634
SALEM	MCNARY FIELD WBAS	OR	24232	72694	44 55N	123 01W	0061	01 67 - 12 71	STAR	SA	T14469
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0117	01 60 - 12 64	STAR	SA	T13645
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0117	01 54 - 12 73	STAR	SA	T15347.3
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0117	01 55 - 12 69	STAR	SA	T13540
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0117	01 59 - 12 73	STAR	SA	T15347.3
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0117	01 73 - 12 73	STAR	SA	T15347.3
ALLENTOWN	BETHLEHEM EST APT WBAS	PA	14737	72517	40 39N	075 26W	0116	01 74 - 12 74	STAR	SA	T51938.3
ALTOONA	BLAIR CAP PCT MEM FLD CAA	PA	14736		40 18N	078 19W	0447	10 48 - 09 54	STAR	SA	T14015
BRADFORD	REGIONAL APT FSS	PA	04751		41 48N	078 38W	0647	01 50 - 12 54	STAR	MA	T13909
BRADFORD	REGIONAL APT FSS	PA	04751		41 48N	078 38W	0647	01 60 - 12 54	STAR	SA	T13909
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 64 - 12 73	STAR	MA	T50368
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 54 - 12 73	STAR	SA	T15347.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 59 - 12 73	STAR	SA	T15347.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 70 - 12 74	STAR	SA	T15675.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 73 - 12 73	STAR	SA	T15347.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 74 - 12 74	STAR	SA	T15675.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 74 - 12 74	STAR	SA	T51938.3
ERIE	INTERNATIONAL APT WBAS	PA	14860	72526	42 05N	080 11W	0225	01 75 - 12 75	STAR	SA	T52409.3
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0107	01 64 - 12 64	STAR	A	T50461
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0107	01 54 - 12 73	STAR	SA	T15347.3
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0107	01 65 - 12 69	STAR	SA	T13432
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0102	01 58 - 12 74	STAR	A	T50819.3
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0107	11 70 - 10 71	STAR	SA	T01772
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0107	01 73 - 12 73	STAR	SA	T15347.3
HARRISBURG	STATE APT WBAS	PA	14751	72511	40 13N	076 51W	0102	01 74 - 12 74	STAR	SA	T51938.3
MARTINS CREEK		PA	94768		40 48N	075 07W	0106	01 38 - 03 38	STAR	MA	T12746.52
MARTINS CREEK		PA	94768		40 48N	075 07W	0108	01 38 - 03 38	STAR	SA	T12746.52

STATION	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TABS/REMARKS
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 50 - 12 54	STAR	SA	T14623.47I
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 50 - 12 54	STAR	SA	T14623.47J
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 50 - 12 54	STAR	SA	T14623.47P
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 50 - 12 54	STAR	M	T13167
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 50 - 12 54	STAR	A	T14635.47M
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 59 - 12 73	STAR	M	T50412
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 70 - 12 70	STAR	A	T14252
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 71 - 12 71	STAR	A	T14252
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 71 - 12 71	STAR	SA	T01772
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 72 - 12 72	STAR	A	T50884
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 72 - 12 72	STAR	A	T01772
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 73 - 12 73	STAR	SA	T50983
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 74 - 12 74	STAR	A	T52217
PHILADELPHIA	INTERNATIONAL APT WBAS	PA	13739	72408	39 53N	075 15W	0009	01 74 - 12 74	STAR	SA	T51938.3
PHILIPSBURG	MID STATE APT CAA	PA	14781	72512	40 53N	078 05W	0566	01 50 - 12 54	STAR	SA	T14019
PITTSBURGH	ALLEGHENY COUNTY APT	PA	14762		40 21N	079 56W	0388	01 74 - 12 75	STAR	SA	T52345.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 53 - 12 55	STAR	A	T14407
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 54 - 12 73	STAR	SA	T15347.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 55 - 12 69	STAR	SA	T12089
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 66 - 12 66	STAR	A	T14407
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 67 - 12 67	STAR	A	T14407
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 68 - 12 68	STAR	A	T14407
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 68 - 12 68	STAR	M	T11902
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 69 - 12 73	STAR	SA	T15347.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 69 - 12 73	STAR	A	T50956
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 70 - 12 70	STAR	M	T13680
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 70 - 12 74	STAR	SA	T15675.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 71 - 12 71	STAR	M	T13680
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 72 - 12 72	STAR	A	T01772
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 72 - 12 72	STAR	A	T01772
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 72 - 06 72	STAR	M	T01772
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 73 - 12 73	STAR	A	T50956
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 73 - 12 73	STAR	SA	T15347.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 74 - 12 74	STAR	SA	T15675.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 74 - 12 74	STAR	SA	T51938.3
PITTSBURGH	GTR PITTSBURGH APT WBAS	PA	94823	72520	40 30N	080 13W	0373	01 75 - 12 75	STAR	SA	T52409.3
READING	GEN SPAATZ FLD MAP AAF	PA	14712	72510	40 23N	075 58W	0096	01 49 - 12 49	STAR	SA	T13365
READING	GEN SPAATZ FLD MAP AAF	PA	14712	72510	40 23N	075 58W	0096	01 49 - 12 49	STAR	SA	T13521
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0292	01 60 - 12 64	STAR	SA	T14643
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0289	01 64 - 12 73	STAR	SA	T15347.3
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0289	01 69 - 12 73	STAR	SA	T15347.3
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0289	01 71 - 12 75	STAR	M	T51940
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0289	01 73 - 12 73	STAR	SA	T15347.3
WILKES-BARRE	WBAS SCRANTON	PA	14777	72513	41 20N	075 44W	0289	01 74 - 12 74	STAR	SA	T51936.3
WILLIAMSPORT	LYCOMING COUNTY APT WBAS	PA	14778	72514	41 15N	076 55W	0160	01 54 - 12 73	STAR	SA	T15347.3
WILLIAMSPORT	LYCOMING COUNTY APT WBAS	PA	14778	72514	41 15N	076 55W	0160	01 69 - 12 73	STAR	SA	T15347.3
WILLIAMSPORT	LYCOMING COUNTY APT WBAS	PA	14778	72514	41 15N	076 55W	0160	01 73 - 12 73	STAR	SA	T15347.3
WILLOW GROVE	NAS	PA	14793		40 12N	075 09W	0102	01 70 - 12 70	STAR	A	T14252
WILLOW GROVE	NAS	PA	14793		40 12N	075 09W	0102	01 71 - 12 71	STAR	A	T14252
WILLOW GROVE	NAS	PA	14793		40 12N	075 09W	0102	01 74 - 12 74	STAR	SA	T51936.3
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0018	01 60 - 12 64	STAR	SA	T14116
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0018	01 64 - 12 73	STAR	M	T50379
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0018	01 58 - 12 72	STAR	SA	T14793
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	01 72 - 12 72	STAR	SA	T50855
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	01 72 - 12 72	STAR	M	T13902
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	08 72 - 09 72	STAR	M	T50726
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	01 74 - 12 74	STAR	A	T52449
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	01 74 - 12 74	STAR	SA	T51176.3
PROVIDENCE	T F GREEN APT WBAS	RI	14765	72507	41 44N	071 26W	0019	05 74 - 10 74	STAR	A	T52449.52
ANDERSON	ANDERSON COUNTY APT CAA	SC	93846		34 30N	082 43W	0233	01 54 - 12 58	STAR	SA	T13686
CHARLESTON	MUNICIPAL APT WBAS	SC	13880	72208	32 54N	080 02W	0018	01 60 - 12 64	STAR	SA	T12919
CHARLESTON	MUNICIPAL APT WBAS	SC	13880	72208	32 54N	080 02W	0018	01 68 - 12 72	STAR	M	T14415
CHARLESTON	MUNICIPAL APT WBAS	SC	13880	72208	32 54N	080 02W	0018	01 70 - 12 70	STAR	SA	T12919
CHARLESTON	MUNICIPAL APT WBAS	SC	13880	72208	32 54N	080 02W	0018	01 72 - 12 72	STAR	M	T14415
COLUMBIA	METROPOLITAN APT WBAS	SC	13883	72310	33 57N	081 07W	0075	01 57 - 12 68	STAR	SA	T14140
COLUMBIA	METROPOLITAN APT WBAS	SC	13883	72310	33 57N	081 07W	0075	01 67 - 12 71	STAR	SA	T14140
COLUMBIA	METROPOLITAN APT WBAS	SC	13883	72310	33 57N	081 07W	0075	01 69 - 12 71	STAR	SA	T14140
COLUMBIA	METROPOLITAN APT WBAS	SC	13883	72310	33 57N	081 07W	0066	01 70 - 12 74	STAR	SA	T51979
COLUMBIA	METROPOLITAN APT WBAS	SC	13883	72310	33 57N	081 07W	0066	08 72 - 07 73	STAR	SA	T15164
FLORENCE	GILBERT FIELD MAP WBAS	SC	13744		34 11N	079 43W	0046	01 50 - 12 54	STAR	SA	T50266
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 53 - 12 57	STAR	SA	T12919
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 58 - 12 72	STAR	SA	T14587
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 58 - 12 72	STAR	A	T14542
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 58 - 12 72	STAR	M	T14413
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 70 - 12 70	STAR	SA	T12919
GREENVILLE	GREEN-SPART APT WBAS	SC	03870	72312	34 54N	082 13W	0290	01 72 - 12 72	STAR	M	T14413
SPARTANBURG	MEMORIAL APT WBAS	SC	93804	72313	34 55N	081 57W	0248	01 57 - 12 61	STAR	SA	T14587
PIERRE	MUNICIPAL APT FSS	SD	24025		44 23N	100 17W	0526	01 67 - 12 71	STAR	M	T14316
RAPID CITY	MUNICIPAL APT WBAS	SD	24090	72662	44 03N	103 04W	0966	01 67 - 12 71	STAR	M	T14122
SIOUX FALLS	FOSS FIELD WBAS	SD	14944	72651	43 34N	096 44W	0433	01 58 - 12 72	STAR	M	T14676
SIOUX FALLS	FOSS FIELD WBAS	SD	14944	72651	43 34N	096 44W	0435	01 74 - 12 74	STAR	A	T52157.3
BRISTOL	TRI-CITY APT WBAS	TN	13877	72318	36 29N	082 24W	0475	01 50 - 12 54	STAR	SA	T51955.3
BRISTOL	TRI-CITY APT WBAS	TN	13877	72318	36 29N	082 24W	0475	01 56 - 12 70	STAR	SA	T13054
BRISTOL	TRI-CITY APT WBAS	TN	13877	72318	36 29N	082 24W	0475	01 74 - 12 74	STAR	A	T51543
CHATTANOOGA	LOVELL FIELD WBAS	TN	13882	72324	35 02N	085 12W	0210	01 50 - 12 54	STAR	SA	T50242.47W
CHATTANOOGA	LOVELL FIELD WBAS	TN	13882	72324	35 02N	085 12W	0210	01 50 - 12 54	STAR	SA	T51955.3
CHATTANOOGA	LOVELL FIELD WBAS	TN	13882	72324	35 02N	085 12W	0210	01 57 - 12 71	STAR	SA	T14372
CHATTANOOGA	LOVELL FIELD WBAS	TN	13882	72324	35 02N	085 12W	0210	01 68 - 12 73	STAR	SA	T50621

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAPE/REMARKS
CHATTANOOGA	LOVELL FIELD WBAS	TN	13882	72324	35 02N	085 12W	0210	01 70 - 12 70	STAR	SA	T13252
JACKSON	MCKELLER	TN	03811		35 36N	088 55W	0129	01 48 - 12 54	STAR	MA	T52438
KNOXVILLE	MCGHEE TYSON APT WBAS	TN	13891	72326	35 49N	083 59W	0297	01 58 - 12 70	STAR	SA	T13054
KNOXVILLE	MCGHEE TYSON APT WBAS	TN	13891	72326	35 49N	083 59W	0298	01 58 - 12 73	STAR	SA	T50621
MEMPHIS	INTERNATIONAL APT WBAS	TN	13893	72334	35 03N	089 59W	0086	01 57 - 12 71	STAR	SA	T13479
NASHVILLE	BERRY FIELD MAP WBAS	TN	13897	72327	36 07N	086 41W	0177	01 50 - 12 54	STAR	A	T14424,47
NASHVILLE	BERRY FIELD MAP WBAS	TN	13897	72327	36 07N	086 41W	0183	01 58 - 12 70	STAR	SA	T12881
NASHVILLE	BERRY FIELD MAP WBAS	TN	13897	72327	36 07N	086 41W	0183	01 70 - 12 70	STAR	A	T12751
NASHVILLE	BERRY FIELD MAP WBAS	TN	13897	72327	36 07N	086 41W	0184	01 71 - 12 75	STAR	MA	T52420.3
NASHVILLE	BERRY FIELD MAP WBAS	TN	13897	72327	36 07N	086 41W	0184	01 73 - 12 73	STAR	SA	T50828
ABILENE	MUNICIPAL APT WBAS	TX	13962	72266	32 26N	099 41W	0537	01 67 - 12 71	STAR	SA	T01772
ABILENE	MUNICIPAL APT WBAS	TX	13962	72266	32 26N	099 41W	0537	10 72 - 10 73	STAR	MSA	T50308
AMARILLO	ENGLISH FLD MAP WBAS	TX	23047	72363	35 14N	101 42W	1098	01 55 - 12 54	STAR	SA	T50360
AUSTIN	MUELLER MAP WBAS	TX	13958	72254	30 18N	097 42W	0189	01 57 - 12 71	STAR	MA	T14284
AUSTIN	MUELLER MAP WBAS	TX	13958	72254	30 18N	097 42W	0189	01 58 - 12 73	STAR	MA	T51101
BEEVILLE	CHASE FIELD NAAS	TX	12925		28 22N	097 40W	0060	01 65 - 12 59	STAR	SA	T50893
BEEVILLE	CHASE FIELD NAAS	TX	12925		28 22N	097 40W	0060	01 56 - 12 70	STAR	A	T13121
CORPUS CHRISTI	NAS	TX	12926		27 41N	097 17W	0006	01 65 - 12 58	STAR	SA	T12761
COTULLA	MUNICIPAL APT CAA	TX	12947		28 26N	099 13W	0141	01 50 - 12 54	STAR	SA	T50893
DALLAS	LOVE FIELD WBAS	TX	13960	72258	32 51N	096 51W	0158	01 50 - 12 54	STAR	SA	T13080
DALLAS	LOVE FIELD WBAS	TX	13960	72258	32 51N	096 51W	0158	01 57 - 12 71	STAR	MA	T14191
DALLAS	LOVE FIELD WBAS	TX	13960	72258	32 51N	096 51W	0158	05 72 - 04 73	STAR	A	T14569
DALLAS	LOVE FIELD WBAS	TX	13960	72258	32 51N	096 51W	0158	05 72 - 12 72	STAR	A	T01772
DEL RIO	LAUGHLIN AFB	TX	22001	72261	29 22N	100 47W	0327	01 65 - 12 58	STAR	SA	T12761
EL PASO	INTERNATIONAL APT WBAS	TX	23044	72270	31 48N	106 24W	1200	01 50 - 12 64	STAR	SA	T14562
EL PASO	INTERNATIONAL APT WBAS	TX	23044	72270	31 48N	106 24W	1198	01 72 - 12 72	STAR	SA	T01772
FORT WORTH	GREATER SW INL APT WBAS	TX	03927	72258	32 50N	097 03W	0175	01 57 - 12 71	STAR	MA	T52415
FORT WORTH	GREATER SW INL APT WBAS	TX	03927	72258	32 50N	097 03W	0175	01 57 - 12 71	STAR	SA	T14024
FORT WORTH	GREATER SW INL APT WBAS	TX	03927	72258	32 50N	097 03W	0175	05 72 - 04 74	STAR	MA	T52415
FORT WORTH	MEACHAM FLD WBAS	TX	13961		32 49N	097 21W	0215	01 48 - 12 52	STAR	SA	T52393.3
GALVESTON	SCHOLES FIELD WBAS	TX	12923	72242	29 18N	094 51W	0008	01 56 - 12 50	STAR	SA	T14432
GALVESTON	SCHOLES FIELD WBAS	TX	12923	72242	29 18N	094 51W	0008	01 58 - 12 52	STAR	A	T14356
HOUSTON	ELLINGTON AFB	TX	12906		29 37N	095 10W	0012	01 68 - 12 70	STAR	MA	T50955.3
HOUSTON	ELLINGTON AFB	TX	12906		29 37N	095 10W	0012	01 69 - 12 59	STAR	SA	T12243
HOUSTON	HOBBY INL APT WBAS	TX	12918	72243	29 39N	095 17W	0016	01 64 - 12 58	STAR	SA	T13874
HOUSTON	HOBBY INL APT WBAS	TX	12918	72243	29 39N	095 17W	0016	01 65 - 12 57	STAR	SA	T13425
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	08 69 - 12 71	STAR	MA	T14191
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	08 69 - 07 73	STAR	A	T14569
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	09 69 - 12 71	STAR	SA	T12813
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	09 71 - 12 73	STAR	ITM	T50174
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	08 72 - 12 72	STAR	A	T01772
HOUSTON	INTERCONTINENTAL APT WBAS	TX	12960	72243	29 58N	095 22W	0033	08 72 - 07 73	STAR	A	T14568
LAREDO	AFB	TX	12907	72252	27 32N	099 28W	0154	04 65 - 03 70	STAR	SA	T12761
LUFKIN	ANGELINA COUNTY APT FSS	TX	93987		31 14N	094 45W	0089	01 57 - 12 71	STAR	MA	T14443
MIDLAND	MID-ODESSA RGL ATL WBAS	TX	23023	72265	31 56N	102 12W	0875	01 60 - 12 64	STAR	SA	T13931
MIDLAND	MID-ODESSA RGL ATL WBAS	TX	23023	72265	31 56N	102 12W	0875	01 71 - 12 71	STAR	MA	T01772
PORT ARTHUR	JEFFERSON COUNTY APT WBAS	TX	12917	72241	29 57N	094 01W	0009	01 57 - 12 71	STAR	SA	T01772,141
SAN ANGELO	MATHIS FIELD WBAS	TX	23034	72263	31 22N	100 30W	0585	01 50 - 12 54	STAR	SA	T13931
SAN ANTONIO	INTERNATIONAL APT WBAS	TX	12921	72253	29 32N	098 28W	0243	01 60 - 12 64	STAR	SA	T13931
TYLER	POUNDS FIELD CAA	TX	13972		32 22N	095 24W	0173	01 50 - 12 54	STAR	SA	T51272
VICTORIA	FOSTER AFB	TX	12912	72255	28 51N	096 55W	0031	01 55 - 12 74	STAR	SA	T52254
WACO	MUNICIPAL APT WBAS	TX	13959	72256	31 37N	097 13W	0155	01 68 - 12 73	STAR	MA	T51101
BRYCE CANYON	CAA	UT	23159		37 42N	112 09W	2317	01 48 - 12 54	STAR	SA	T13029
DELTA	MUNICIPAL APT CAA	UT	23162	72479	39 23N	112 31W	1462	01 50 - 12 54	STAR	SA	T12781
HANKSVILLE	CAA	UT	23170	72473	38 25N	110 42W	1360	01 48 - 12 54	STAR	SA	T13029
MILFORD	MUNICIPAL APT CAA	UT	23176	72475	38 25N	113 01W	1534	07 47 - 12 51	STAR	MA	T51121
OGDEN	HILL AFB	UT	24101	72575	41 07N	111 58W	1459	01 65 - 12 59	STAR	SA	T12908
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 48 - 12 48	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 49 - 12 49	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 50 - 12 50	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 51 - 12 51	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 52 - 12 52	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1298	01 53 - 12 53	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 54 - 12 54	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 55 - 12 55	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 56 - 12 56	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 57 - 12 57	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 58 - 12 58	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 59 - 12 59	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 50 - 12 50	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 51 - 12 51	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 52 - 12 52	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 63 - 12 63	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 64 - 12 54	STAR	A	T13858
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 56 - 12 70	STAR	SA	T12745
SALT LAKE CITY	INTERNATIONAL APT WBAS	UT	24127	72572	40 46N	111 58W	1287	01 70 - 12 72	STAR	SA	T01772
BURLINGTON	INTERNATIONAL APT WBAS	VT	14742	72617	44 28N	073 09W	0106	01 65 - 12 69	STAR	MA	T12179
BURLINGTON	INTERNATIONAL APT WBAS	VT	14742	72617	44 28N	073 09W	0104	01 70 - 12 74	STAR	SA	T52031.3
BURLINGTON	INTERNATIONAL APT WBAS	VT	14742	72617	44 28N	073 09W	0104	01 70 - 12 74	STAR	SA	T15370
DANVILLE	MUNICIPAL APT CAA	VA	13728		36 34N	079 20W	0180	01 50 - 12 54	STAR	MA	T50970
GORDONSVILLE	CAA	VA	13732		38 04N	078 09W	0135	01 56 - 12 50	STAR	MA	T50970
LYNCHBURG	MUNICIPAL APT WBAS	VA	13733	72410	37 20N	079 12W	0296	01 69 - 12 73	STAR	SA	T50447
NORFOLK	REGIONAL APT WBAS	VA	13737	72308	36 54N	076 12W	0013	01 55 - 12 54	STAR	SA	T14008
NORFOLK	REGIONAL APT WBAS	VA	13737	72308	36 54N	076 12W	0013	01 73 - 12 73	STAR	SA	T11703
NORFOLK	NAS	VA	13750		36 57N	076 17W	0010	12 58 - 12 71	STAR	SA	T13599
PULASKI	NEW RIVER APT CAA	VA	13868		37 05N	080 47W	0688	01 50 - 12 54	STAR	SA	T51955
QUANTICO	MCAS	VA	13773		38 30N	077 18W	0004	01 55 - 12 59	STAR	MSA	T14427
QUANTICO	MCAS	VA	13773		38 30N	077 18W	0004	05 72 - 05 73	STAR	MA	T13590

CITY	NAME - TYPE	ST	WBAN #	WMO #	LAT	LONG	ELEV	PERIOD OF RECORD	SUMMARY TYPE	SUMM FREQ	TAPE/REMARKS
RICHMOND	BYRD FIELD WBAS	VA	13740	72401	37 30N	077 20W	0054	01 54 - 12 73	STAR	SA	T50633
RICHMOND	BYRD FIELD WBAS	VA	13740	72401	37 30N	077 20W	0055	01 71 - 12 71	STAR	MA	T01772
RICHMOND	BYRD FIELD WBAS	VA	13740	72401	37 30N	077 20W	0055	01 72 - 12 72	STAR	MA	T14226
RICHMOND	BYRD FIELD WBAS	VA	13740	72401	37 30N	077 20W	0054	01 74 - 12 74	STAR	A	T52083.3
ROANOKE	WOODRUM FIELD MAP WBAS	VA	13741	72411	37 19N	079 58W	0364	01 68 - 12 72	STAR	MA	T14656
WALLOPS ISLAND	WBO	VA	93739	72402	37 51N	075 29W	0004	01 57 - 12 72	STAR	MA	T14630
WALLOPS ISLAND	WBO	VA	93739	72402	37 51N	075 29W	0004	01 69 - 12 73	STAR	MA	T50495.3
BELLINGHAM	MUNICIPAL APT CAA	WA	24217		48 48N	122 32W	0047	01 48 - 12 58	STAR	MA	T50951
BELLINGHAM	MUNICIPAL APT CAA	WA	24217		48 48N	122 32W	0048	01 56 - 12 58	STAR	MA	T14112
DALLESPORT		WA	24218		45 37N	121 09W	0072	01 64 - 12 64	STAR	SA	T52306
ELLENSBURG	CAA	WA	24220		47 02N	120 31W	0527	01 50 - 12 54	STAR	A	T14578
EPHRATA	MUNICIPAL APT CAA	WA	24141		47 18N	119 32W	0387	01 50 - 12 54	STAR	A	T14578
EVERETT	PAINE FIELD AFB	WA	24203		47 54N	122 17W	0182	01 63 - 12 67	STAR	A	T14578
HOQUIAM	BOWERMAN APT CAA	WA	94225		46 58N	123 56W	0008	01 54 - 12 58	STAR	A	T14578
MOSES LAKE	LARSON AFB	WA	24110		47 11N	119 20W	0361	01 61 - 12 65	STAR	A	T14578
OLYMPIA	WBAS	WA	24227	72792	46 58N	122 54W	0066	01 60 - 12 64	STAR	A	T14578
PORT ANGELES	WBAS	WA	24228	74201	48 08N	123 24W	0005	01 48 - 12 53	STAR	MA	T14411
SEATTLE	SEA-TAC INL APT WBAS	WA	24233	72793	47 27N	122 18W	0137	01 48 - 12 53	STAR	SA	T14411
SEATTLE	SEA-TAC INL APT WBAS	WA	24233	72793	47 27N	122 18W	0137	01 67 - 12 71	STAR	MA	T11170
SEATTLE	BOEING FIELD MAP WBAS	WA	24234		47 32N	122 18W	0010	01 60 - 12 64	STAR	A	T14578
SPOKANE	GEIGER FIELD INL APT WBAS	WA	24157	72785	47 38N	117 32W	0721	01 67 - 12 71	STAR	SA	T13365
TACOMA	MCCHORD AFB	WA	24207	74208	47 09N	122 29W	0088	01 66 - 12 70	STAR	MA	T14411
TOLEDO	WINLOCK APT CAA	WA	24241		46 29N	122 48W	0109	01 50 - 12 54	STAR	A	T14578
WALLA WALLA	CITY-COUNTY APT CAA	WA	24160		46 06N	118 17W	0363	01 50 - 12 54	STAR	A	T14578
WHIDBEY ISLAND	NAS	WA	24296		48 21N	122 40W	0010	01 67 - 12 71	STAR	MA	T14411
YAKIMA	MUNICIPAL APT WBAS	WA	24243	72781	46 34N	120 32W	0324	01 60 - 12 64	STAR	A	T14578
CHARLESTON	KANAWHA APT WBAS	WV	13866	72414	38 22N	081 36W	0301	01 58 - 12 73	STAR	MA	T50556.3
HUNTINGTON	TRI-STATE APT WBAS	WV	03860	72425	38 22N	082 33W	0258	01 67 - 12 71	STAR	SA	T13828
HUNTINGTON	TRI-STATE APT WBAS	WV	03860	72425	38 22N	082 33W	0258	01 70 - 12 74	STAR	SA	T15675.3
HUNTINGTON	TRI-STATE APT WBAS	WV	03860	72425	38 22N	082 33W	0258	01 74 - 12 74	STAR	SA	T15675.3
HUNTINGTON	TRI-STATE APT WBAS	WV	03860	72425	38 22N	082 33W	0258	01 75 - 12 75	STAR	SA	T52409.3
HUNTINGTON	CHESAPEAKE APT CAA	WV	03818	72425	38 25N	082 30W	0173	01 50 - 12 54	STAR	SA	T11898
MARTINSBURG	MUNICIPAL APT CAA	WV	13734		39 24N	077 59W	0166	01 60 - 12 64	STAR	MA	T50833
MORGANTOWN	MUNICIPAL APT CAA	WV	13736		39 39N	079 55W	0380	01 50 - 12 54	STAR	A	T50886
PARKERSBURG	WBO	WV	13867		39 16N	081 34W	0205	01 50 - 12 54	STAR	SA	T13824
EAU CLAIRE	MUNICIPAL APT FSS	WI	14991		44 52N	091 29W	0273	01 69 - 12 73	STAR	SA	T50648
GREEN BAY	AUSTIN STRAUBEL APT WBAS	WI	14898	72645	44 29N	088 08W	0212	01 64 - 12 73	STAR	SA	T15137
GREEN BAY	AUSTIN STRAUBEL APT WBAS	WI	14898	72645	44 29N	088 08W	0212	01 67 - 12 71	STAR	SA	T14008
GREEN BAY	AUSTIN STRAUBEL APT WBAS	WI	14898	72645	44 29N	088 08W	0212	01 69 - 12 73	STAR	SA	T50648
GREEN BAY	AUSTIN STRAUBEL APT WBAS	WI	14898	72645	44 29N	088 08W	0212	01 73 - 12 73	STAR	SA	T15137
LA CROSSE	MUNICIPAL APT WBAS	WI	14920	72643	43 52N	091 15W	0201	01 48 - 12 53	STAR	SA	T01772
LA CROSSE	MUNICIPAL APT WBAS	WI	14920	72643	43 52N	091 15W	0201	01 67 - 12 71	STAR	SA	T14006
MADISON	TRUAX FIELD WBAS	WI	14837	72641	43 08N	089 20W	0265	01 54 - 12 73	STAR	SA	T15137
MADISON	TRUAX FIELD WBAS	WI	14837	72641	43 08N	089 20W	0265	01 67 - 12 71	STAR	SA	T13399
MADISON	TRUAX FIELD WBAS	WI	14837	72641	43 08N	089 20W	0265	01 71 - 12 71	STAR	SA	T01772
MADISON	TRUAX FIELD WBAS	WI	14837	72641	43 08N	089 20W	0262	01 73 - 12 73	STAR	SA	T15137
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0215	01 50 - 12 54	STAR	MA	T50259
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0215	01 60 - 12 64	STAR	SA	T50685
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0215	01 64 - 12 73	STAR	SA	T15137
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0215	01 56 - 12 70	STAR	SA	T13174
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0211	01 67 - 12 71	STAR	SA	T14006
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0211	01 58 - 12 72	STAR	MA	T14462
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0211	01 70 - 07 70	STAR	A	T11873
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0205	01 73 - 12 73	STAR	SA	T15137
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0205	07 73 - 06 74	STAR	SA	T50873
MILWAUKEE	MITCHELL FIELD WBAS	WI	14839	72640	42 57N	087 54W	0205	01 74 - 12 74	STAR	A	T52042
MILWAUKEE	L J TIMMERMAN APT FAA	WI	94869		43 07N	088 02W	0227	01 68 - 12 72	STAR	MA	T14637
CASPER	AIR TERMINAL WBAS	WY	24089	72569	42 55N	106 28W	1622	01 66 - 12 75	STAR	SA	T52227.3
CASPER	AIR TERMINAL WBAS	WY	24089	72569	42 55N	106 28W	1622	01 57 - 12 71	STAR	MA	T14235
CASPER	AIR TERMINAL WBAS	WY	24089	72569	42 55N	106 28W	1622	01 67 - 12 71	STAR	MA	T50663.3
CHEYENNE	MUNICIPAL APT WBAS	WY	24018	72564	41 09N	104 49W	1871	01 60 - 12 64	STAR	MA	T50313
CHEYENNE	MUNICIPAL APT WBAS	WY	24018	72564	41 09N	104 49W	1871	01 67 - 12 71	STAR	MA	T50663.3
CHEYENNE	MUNICIPAL APT WBAS	WY	24018	72564	41 09N	104 49W	1871	01 67 - 12 71	STAR	MSA	T14318
CHEYENNE	MUNICIPAL APT WBAS	WY	24018	72564	41 09N	104 49W	1871	01 74 - 12 74	STAR	A	T51947.3
LANDER	HUNT APT WBAS	WY	24021	72576	42 49N	108 44W	1698	01 70 - 12 74	STAR	A	T51819.3
MOORCROFT		WY	24088	72563	44 16N	104 57W	1305	01 50 - 07 52	STAR	MA	T14235
ROCK SPRINGS	MUNICIPAL APT WBAS	WY	24027	72574	41 36N	109 04W	2056	01 60 - 12 64	STAR	SA	T14293
ROCK SPRINGS	MUNICIPAL APT WBAS	WY	24027	72574	41 36N	109 04W	2056	01 67 - 12 71	STAR	SA	T01772
ROCK SPRINGS	MUNICIPAL APT WBAS	WY	24027	72574	41 36N	109 04W	2057	01 71 - 12 75	STAR	SA	T52211.3
SHERIDAN	SHERIDAN CAP WBAS	WY	24029	72666	44 46N	106 58W	1202	01 49 - 12 53	STAR	SA	T14135

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/4-87-009	2.	3. RECIPIENT'S ACCESSION NO.
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16. ABSTRACT

This report presents procedures and criteria for selecting appropriate locations for particulate matter (PM_{10}) monitoring stations. Background on sources of particulate matter, monitoring objectives, spatial relationships and various meteorological considerations used in site selection are provided.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
particulate matter site exposure criteria site selection monitoring objectives air pollution		

18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED	21. NO. OF PAGES 132
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