by 1982. The net reduction by 1982 is 45 percent, although the real effect on oxidant reduction could be larger. All of the strategies are transportation related and would reduce the 6:00 to 9:00 a.m. peak in a greater proportion than 45 percent. Computer modeling is needed to see if the effects of the high early morning hydrocarbon concentration do, indeed, contribute significantly to the oxidant level when relatively high dilution rates are present after that time.

Maricopa County already has an inspection and maintenance program, and other controls will be recommended for implementation in 1978. Given the limited historical record and the high population growth rate of the area, it is difficult to say if these controls will be enough.

ACKNOWLEDGMENTS

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# Monitoring and Modeling of Resuspended Roadway Dust Near Urban Arterials

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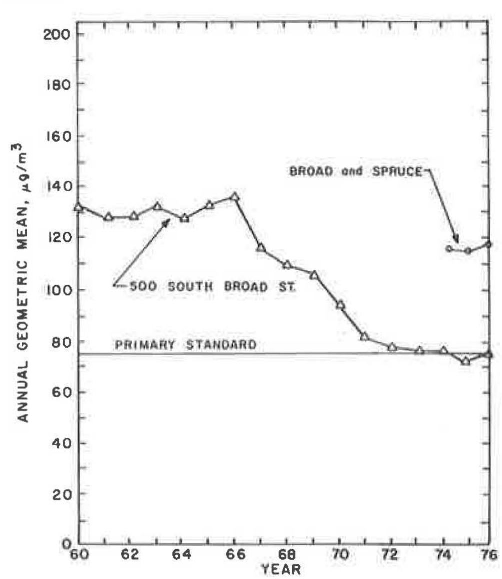
**The probability that resuspended roadway dust plays a predominant role in many violations of the ambient particulate standards is now widely accepted. Quantification of this effect is needed before control strategies are developed. In addition, there is increasing concern that strategies should, for reasons of health, also address the respirable fraction of total particulates. This paper describes a twofold approach to the problem of identifying the sources of particulates within the city of Philadelphia and presents selected results from the study. One approach used a sampling program designed to investigate the contribution of traffic-related emissions. Measurements were made using conventional high-volume air samplers at four heights near an intersection and at rooftop level on either side of the main street. The U.S. Environmental Protection Agency dichotomous sampler and the GCA ambient particulate monitor were used to discriminate between respirable and nonrespirable particulates. The second approach used diffusion modeling techniques to calculate the contribution of source categories. Also, a test was conducted to**

measure the effectiveness of street washing in reducing ambient particulate levels. The results suggest that about one-fourth of the particulates measured at the roof of the Health building were vehicle related, but approximately one-half of the particulates measured at the top of a trailer at a busy intersection were from these sources. Based on a comparison of data from the dichotomous sampler and the high-volume sampler, only about one-fourth of the particulates measured by the high-volume sampler at the trailer were respirable. Ambient particulate levels increased dramatically immediately after street washing.

This paper describes the design and operation of a sampling program to investigate the contribution of traffic-related emissions to total suspended particulate concentrations. The program was part of a general project designed to increase understanding of the principal sources of particulates within a major urban area, their dispersion, and the feasibility of their control. To help define the spatial impact of traffic-related emissions, measurements were made with conventional high-volume air samples at three heights on a 12.2-m tower adjacent to an intersection and at roof-top level (about 11 m) on either side of the main street at distances of 15 to 60 m.

Two highly specialized instruments were used to discriminate between respirable and nonrespirable particles. One, the U.S. Environmental Protection Agency (EPA) dichotomous sampler, also allows for detailed chemical analysis of the collected particles without the serious interferences normally encountered with glass fiber filters. The other, the GCA ambient particulate monitor (APM), determines the short-term (e.g., hourly) changes in both the respirable and total particulate loadings. A fractionating head high-volume sample was used to provide additional data on particle size distributions. Concentration measurements as a function of wind direction were made by a National Aeronautics and Space Administration (NASA) Air Scout at one of the rooftop locations. Automatic traffic counters provided continuous data throughout the two sampling periods. Selected filters were analyzed by sophisticated techniques to determine particle characteristics under various sampling conditions. The experiment was run for two 2-week periods, in February 1977 and in June 1977. The latter sampling period included a 3-d period when the city of Philadelphia conducted intensive street washing to test its effectiveness in reducing ambient particulate levels.

Figure 1. Annual mean TSP concentrations at two sites.




In a second part of the project, numerical diffusion modeling techniques and an upgraded emissions inventory for particulates were used to calculate the contribution of each major source category to the total suspended particles (TSP) loadings at the various city monitoring sites. The results of the field measurement program provided a basis for selecting an appropriate emission factor for reentrained dust for use in the model calculations.

The underlying problem is illustrated in Figure 1. Over a period of years the control of major industrial and fuel combustion sources has caused a striking decrease in particulate levels, but the national standards are still not uniformly met. In the case illustrated, the decrease in annual mean TSP levels at 500 South Broad Street is evident, especially after 1966. This site is located on a flat roof at an elevation 11 m above ground and 30 m back from the street. The data from the site at the corner of Broad and Spruce streets demonstrate that significant differences in TSP observations can occur within a distance of only two blocks. The high-volume air sampler at the Broad and Spruce street location is on top of the air monitoring trailer, 4 m above ground and only 9 m back from South Broad Street.

Observations such as this as well as other high TSP measurements near such areas as unpaved parking lots, dirt roads, and storage piles have led many observers to question the presumption that sufficient reduction of major point source emissions will result in the uniform attainment of the standards. This situation is obviously not limited to Philadelphia; it calls for a careful assessment of precisely where the measured particulate matter is coming from.

## NETWORK DESIGN

As noted earlier, recent observations identified the area in the vicinity of the 500 South Broad Street site and the intersection of South Broad and Spruce streets as a promising one for a detailed study of the spatial impact of traffic-related particulates. Here, within a distance of approximately 275 m, the rooftop location at 500 South Broad Street has an annual mean concentration of pollutants nearly equal to the primary standard, and the trailer-top location near the intersection of Broad and Spruce streets experiences an annual mean concentration 50 percent higher. The only obvious differences between the sites is the proximity to vehicular traffic. In spite of the complicating effects of the surrounding building structures, we decided to perform the field study at this location, where the problem was known to exist. Figures 2 and 3 show the building heights and streets in the vicinity of the two sites.

A 12.2-m self-supporting tower was erected on the corner of Broad and Spruce streets next to the Air Management Services air monitoring trailer, as shown in Figure 2. The tower was outfitted at three heights with six high-volume air samplers. This allowed operation of the high-volume sampler on a 24-h basis without requiring the presence of the operator at midnight to change filters. The effective heights of the high-volume samplers were 11.2, 9.1, and 6.1 m. The vertical profile was completed by a pair of high-volume samplers at an elevation of 4.0 m on the trailer rooftop. In addition, the EPA dichotomous sampler, the GCA APM, and the fractionating head high-volume sampler were operated on the roof of the trailer to provide particle size information and short-term concentration data. Traffic counts were automatically recorded every 15 min at four locations on Broad and Spruce streets.

Figure 2. Local neighborhood at Broad and Spruce streets.

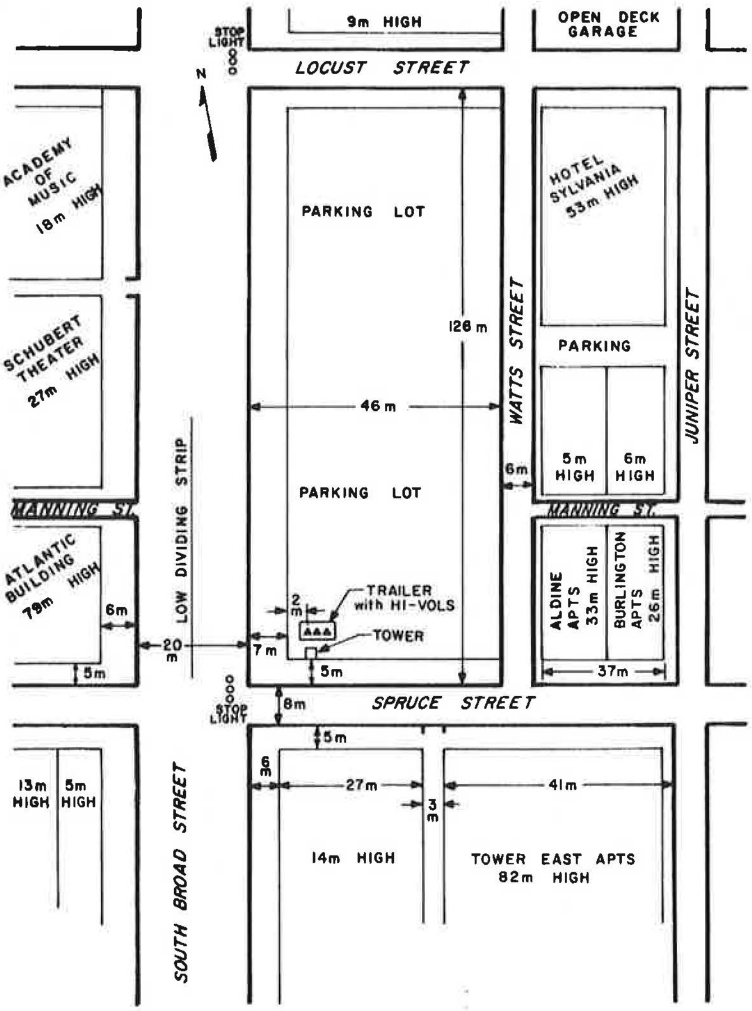
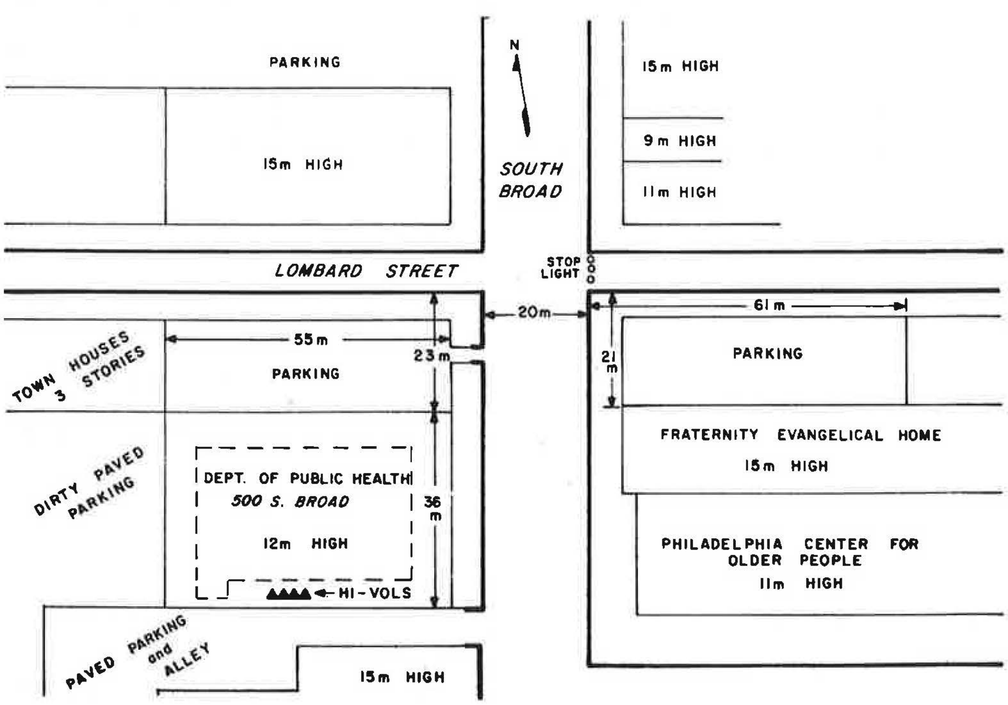



Figure 3. Local neighborhood at 500 South Broad Street.

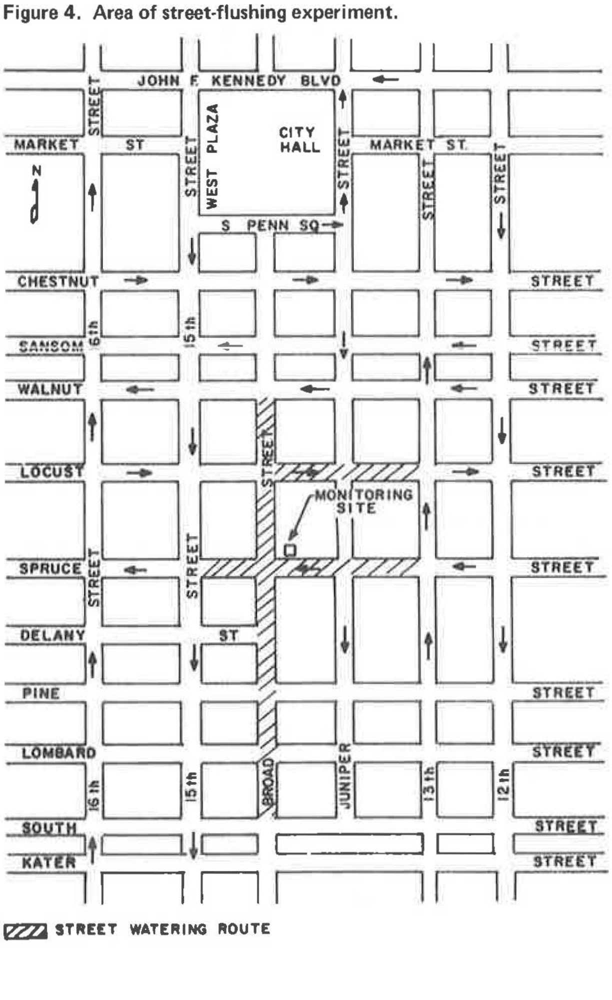


At 500 South Broad Street, the existing Air Management Services high-volume samplers were supplemented by a high-volume sampler on the front edge of the roof near Broad Street and a high-volume sampler on the back edge of the roof away from Broad Street. Meteorological instrumentation to record wind speed and direction was positioned on an elevated portion of the roof near the back of the building. Directly across the street from 500 South Broad Street, on the roof of the Philadelphia Center for Older People, two additional sites for high-volume samplers were established. One was on the front edge near Broad Street and the other on the back edge away from Broad Street. This resulted in a horizontal array of five high-volume sampler sites at nearly the same elevation above Broad Street. The three on the 500 South Broad Street roof were on the west side of Broad Street, at distances of approximately 9, 30, and 58 m from the street. The high-volume samplers on the east side of Broad Street on the Philadelphia Center for Older People were approximately 9 and 34 m from the street. In addition, during the February sampling period a NASA Air Scout directional sampler with its meteorological sensors was operated on the Broad Street edge of the 500 South Broad Street roof.

## Sampling Schedule

The basic high-volume sampler network (the vertical array at the tower site and the horizontal array at rooftop level approximately 275 m to the south) was operated from February 4 to 20, 1977, and from June 7 to 20, 1977. These observations were supplemented by APM and dichotomous sampler data from the roof of the trailer during the 2-week sampling period in February; at the end of this period, the dichotomous sampler was moved to the rooftop at 500 South Broad Street and operated for an additional 2-week period. Intensive street washing took place on June 15, 16, and 17, 1977. The streets washed during this period are shown in Figure 4. At the end of the third day of street washing, the high-volume samplers at Broad and Spruce streets were operated on a 4-h schedule, which continued until 8:00 p.m. on June 19.

Figure 4. Area of street-flushing experiment.




## EPA Dichotomous Sampler

The dichotomous sampler utilizes virtual impaction to separate the respirable and nonrespirable fractions. Air is drawn into the inlet at a relatively high flow rate to ensure collection of particles up to 20-$\mu$m aerodynamic diameter. The inlet has a deflector rim on the bottom of a rain shield to direct particles into the sampler during high wind conditions. At the bottom of the inlet a portion of the total sample flow is isokinetically sampled at a rate of 14 L/min and transported to the two-stage virtual impactor. A servo system and pump maintain a flow rate of 13.6 L/min to the fine-particle collector and 0.4 L/min to the large-particle collector. This results in particles in the range of 3.5 to 20 $\mu$m aerodynamic diameter being collected on one membrane filter and particles less than 3.5 $\mu$m aerodynamic diameter being collected on another membrane filter. At the conclusion of the sampling period, which is typically 24 h, the filters are removed and the concentrations of the respirable and nonrespirable fractions are determined gravimetrically. The membrane filters are then available for chemical analysis free from the interferences inherent with glass fiber filters.

## GCA APM

The APM also utilizes a high flow rate at the inlet of the instrument and a configuration such that the conditions are similar to that of a high-volume sampler. The APM uses beta attenuation sensing for mass determination and, since the sensitivity depends on small-area collection, a flow rate of 9 L/min is isokinetically withdrawn via two probes. One probe has a cyclone that removes the nonrespirable fraction (i.e., greater than 3.5 $\mu$m) and the other probe collects the total particulate. The flow rates into the two probes are kept constant either by means of a specially designed sonic venturi nozzle or by an active feedback mass flow control system.

The aerosol to be measured is collected on a reinforced glass fiber filter tape and analyzed by beta radiation. In practice, an area of the tape is tared by a beta source-detector pair, the tape is indexed by a stepping motor to the collection port where the sample is collected, and, after the selected sampling period, is indexed to a second beta source-detector pair where the transmitted beta radiation is again measured. The appropriate calculations are performed by a microprocessor and the TSP concentration for each fraction is printed on a tape. The sensitivity of the system allows collection times much shorter than the conventional high-volume sampler without seriously affecting the measurement error. During this study, sampling periods of about 1 h were used.

## NASA Air Scout

The Air Scout was developed by scientists at the NASA Lewis Research Center to permit collection of airborne particulate samples as a function of wind direction. It includes a system for recording wind speed and direction, and the wind direction is also fed to the circuitry of the sampling device.

Eight individual electrically actuated poppet valves, positioned in a circular pattern in a housing above a high-volume sampler, control air flow through the ports. Each port represents one of the eight directions of the compass. A solenoid actuates each valve and is connected electrically to a set of contacts in the wind vane corresponding to the direction assigned to the valve. Thus each valve, when open, permits collecting a particulate sample in a discrete location on a filter slide when it is in sampling position over the housing. The sample thus collected represents particulates in the air coming from a 45° arc of the compass. The central hole in the housing does not have a control valve. It is open continuously so that the sample collected on the filter slide can provide a measure of the TSP. The solenoids opening the valves have sufficient force to overcome the suction of the high-volume sampler that runs continuously during the sampling period.

## SELECTED RESULTS

Data collected by the dichotomous sampler and by high-volume samplers during the February and early March sampling period are compared in Table 1. The observations were not taken concurrently, but have been assembled to present a composite picture of the spatial distribution of particulates during the period. Specifically, only one dichotomous sampler was used to provide the breakout of fine and coarse particulates at the two heights. It was operated approximately every other day for about 2 weeks on the roof of the trailer at Broad and Spruce streets and then moved to the roof of the Health building at 500 South Broad Street for a similar period. Also, although the data from the trailer top and rooftop high-volume samplers contain observations spread over the entire period during which the dichotomous sampler was operated, the concentration entered for the top of the tower was established on the basis of the average decrease in concentration as a function of height that was observed during the shorter 2-week tower experiment. With these limitations, the following three-dimensional picture emerges:

1. Turbulent mixing created by the passage of motor vehicles, the release of hot exhaust gases, and buildings of varying heights and sizes results in a nearly uniform mix of particulates over the height of the tower.
2. Rooftop concentrations average about 27 percent lower than concentrations at a corresponding height at the exposed intersection location.
3. Assuming a cutoff of 20 μm by the dichotomous sampler, approximately 62 percent of the particulate mass collected by the high-volume sampler at the trailer top location was composed of particles of aerodynamic diameter greater than 20 μm. At the rooftop location, this percentage dropped to approximately 55 percent.
4. About 70 percent of the particulates captured by the dichotomous sampler were respirable at the rooftop location, but only 60 percent were respirable at the trailer top location.
5. Using the dichotomous sampler to define the respirable fraction, 32 percent of the particulates captured by the high-volume sampler were respirable at the rooftop location, but only 23 percent were respirable at the trailer top location.

**Table 1. Comparison of dichotomous and high-volume sampler results.**

| Location | Height (m) | Concentration by Sampler (μg/m³) | | | |
|---|---|---|---|---|---|
| | | Dichotomous Sampler | | | High-Volume Sampler |
| | | Fine | Coarse | Total | |
| Top of tower | 11 | - | - | - | 130 |
| Rooftop | 11 | 30 | 13 | 43 | 95 |
| Trailertop | 4 | 34 | 23 | 57 | 149 |

### Elemental Concentrations

Table 2 lists the six elements found to have the highest concentrations in the dichotomous samples and the most probable major source of each. Tabulated concentrations are based on the totals found in the two size fractions. The bottom line was obtained from the total mass of particulates collected by the dichotomous sampler.

Of these six elements, S has the highest concentration; and when expressed as sulfate ($SO_4$), it makes up approximately 19 and 25 percent respectively of the particulate mass measured by the dichotomous sampler at the Broad and Spruce streets and 500 South Broad Street locations. There is little decrease in average concentration with height, which indicates the thorough mixing and transport from nonlocal sources.

Si, Ca, Fe, and Al are presumed to be primarily of mineral origin, are most abundant in the coarser particles, and with the exception of Ca, decrease substantially in concentration between the trailer top location at Broad and Spruce streets and the rooftop location at 500 South Broad Street, which indicates strong contributions from local fugitive dust sources. Pb is the third most common element at Broad and Spruce streets and the fourth most common at 500 South Broad Street. Pb, like S, is found predominantly in the fine particulates, but unlike S, it shows a rapid decrease in concentration with height, in agreement with the hypothesis that motor vehicles are its principal source.

### Comparison of Observed and Calculated Street-Level Contributions

Although the Broad and Spruce streets site appears to be typical of urban intersections, it is not at all obvious that conventional modeling procedures can be of great use in evaluating source contributions and control strategies at such locations. As can be seen from Figure 2, the physical configuration of buildings in the vicinity of this site bears no resemblance to that of the ideal sites used in the development and validation of line source models. Further complications in modeling street-level particulate emissions in downtown areas arise from the difficulty of either measuring or estimating reliably background concentrations, and in assigning appropriate emission factors. For these reasons, a number of ex-

**Table 2. Six highest elemental concentrations and probable sources.**

| Element | Major Source | Concentration by Location (μg/m³) | | Average Fine (%) | Reduction With Height (%) |
|---|---|---|---|---|---|
| | | Broad and Spruce | 500 South Broad | | |
| Sulfur | Fuel combustion | 3.65 | 3.58 | 87 | 2 |
| Silicon | Crustal material | 2.71 | 1.50 | 12 | 45 |
| Calcium | Crustal material | 1.15 | 1.08 | 14 | 6 |
| Lead | Motor vehicles | 1.36 | 0.86 | 85 | 37 |
| Iron | Crustal material | 1.22 | 0.63 | 24 | 48 |
| Aluminum | Crustal material | 0.87 | 0.56 | 8 | 36 |
| TSP | | 56.4 | 42.8 | 64 | 24 |

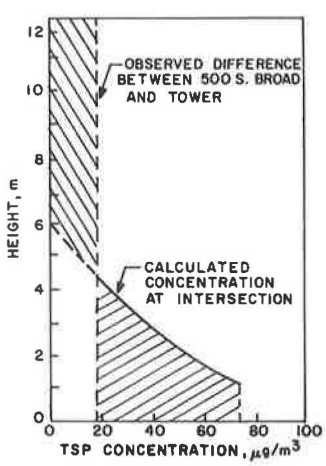
ploratory calculations were carried out prior to making the final model calculations used in assessing the Philadelphia particulate problem.

The approach taken was to assume that the street contribution to concentrations measured at the tower is simply the difference between the tower concentrations and the rooftop concentration measured at 500 South Broad Street. The street contribution was further assumed to come from both Broad and Spruce streets and that emissions were directly proportional to traffic volume. Current information was judged to be insufficient to warrant making adjustments in the emission rates of either reentrained street dust or tailpipe particulate emissions according to vehicle speed or operating mode. The exploratory calculations at the Broad and Spruce street intersection included the application of a Gaussian line source model and a box model for a 24-h period, and the use of the STAR model meteorological summary with the Gaussian model for a 1-year period. The cut-section submodel of HIWAY (highway air pollution model) was used to calculate the average annual impact of reentrained dust at rooftop level at 500 South Broad Street and at the Philadelphia Center for Older People.

February 8, 1977, a day with westerly winds and the requisite hourly traffic and meteorological data, was chosen for the initial exploratory calculations. An emission rate of 0.42 g/km for each vehicle [developed from data in a draft report by Midwest Research Institute (1)] was used for reentrained dust. EPA emission factors of 0.21 and 0.12 g/km for each vehicle were used respectively for tailpipe exhaust and tire wear (2). It was assumed that the source height of these emissions was 1.0 m above street level and that the standard deviation of the vertical concentration of the model ($\sigma_z$) was equal to 1.5 m at the source. An adaptation of the HIWAY model (Intersection-Midblock model) was run for each hour of the day for four receptor heights on the tower and the results were averaged over the 24-h period. The solid curve in Figure 5 is the result. The rapid decrease in concentration with height is to be expected in view of the assumed vertical dimension at the source and the fact that no adjustment in stability class was made to account for additional turbulence induced by the building structures.

Using Figure 5, a comparison can be made between the calculated amount of traffic-related particulates and the observed amount as indicated by the difference in concentration between the tower and the rooftop at 500 South Broad Street. This concentration difference, estimated to be 18 $\mu g/m^3$ over the height of the tower, is indicated in the figure by the dashed vertical line. The approximate agreement between calculated and observed flux of particulates by the tower is shown by the close equivalence of the two shaded areas.

Figure 5. Comparison of calculated and observed vertical TSP profiles on February 8, 1977.




The thorough vertical mixing that takes place within a layer at least as deep as the tower suggests that conditions near the intersection might be more realistically represented by a box model instead of a Gaussian model. To apply a box model on February 8th, the following assumptions were made:

1. The height of the box is equal to the height of the tower (12 m).
2. The box is flushed by the average rooftop wind speed (2.3 m/s).
3. Traffic-related emissions are contributed at a rate per vehicle of 0.75 g/km by all vehicles entering the intersection of Broad and Spruce streets during the day (39 000 vehicles).

Using these assumptions, the following calculation provides an estimate of the average concentration of traffic-related particulates within the box on this day:

$$\begin{aligned} \text{Concentration} &= \text{mass added/volume} \\ &= [39\,000 \times (750/24) \times 3600]/(12 \times 2.3 \times 1) \\ &= 12\ \mu g/m^3 \end{aligned} \tag{1}$$

which is in agreement with the estimate of 18 $\mu g/m^3$ obtained from the observations.

To obtain some further idea of the suitability of the 0.42 g/km emission rate per vehicle for reentrained dust in combination with the Intersection-Midblock model, the model was applied to the tower site over a 1-year period, arbitrarily using a 2-m receptor height. For this calculation, the STAR meteorological summary for 1974 was used. The STAR summary does not distinguish hour of the day; therefore, the average daily traffic volume was assumed to be distributed evenly over a 24-h period. Also, traffic counts from the February 1977 field program were assumed to represent average travel during the year. The result of these calculations was an annual average concentration of 37 $\mu g/m^3$. This is in agreement with the annual differences of 43 and 44 $\mu g/m^3$, respectively, experienced between the 500 South Broad Street site and the Broad and Spruce street site in 1975 and 1976. However, judging by the concentration profile shown in Figure 5, the calculated 2-m concentration should have exceeded the annual difference by a factor of 2 for good agreement. If tailpipe and tire wear emissions are unchanged, this could be accomplished by increasing the emission factor for resuspended dust by a factor of 3.

This emission rate was also used with the cut-section submodel of HIWAY to calculate the average annual impact of reentrained dust at rooftop level at 500 South Broad Street and the Philadelphia Center for Older People. The resulting concentrations were 2.6 $\mu g/m^3$ at 500 South Broad Street and 9.4 $\mu g/m^3$ at the Philadelphia Center for Older People. The difference in average concentration between the two sides of Broad Street reflects the prevailing westerly winds. Although there are no annual values with which these model estimates can be compared, the estimates are in approximate agreement with the average downwind values experienced during the February field program.

## Source Contributions to Annual Geometric Means

Under a previous EPA contract, GCA updated the TSP point source inventory for the metropolitan Philadelphia Interstate air quality control region (AQCR) and developed a regional TSP area source emission inventory. The use of this emission inventory and the emission factor per vehicle of 0.42 g/km for fugitive dust emissions from paved roads (which was tested at the Broad Street sites) gives the breakdown by source category of annual geometric means for the two sites shown in Figure 6. The 43 μg/m$^3$ attributed to local reentrained dust and vehicular emissions at Broad and Spruce streets is simply the difference in measured concentrations at the two sites. Figure 6 illustrates the use of modeling to provide the basic understanding of the particulate problem needed prior to the development of control strategies.

## CONTROL STRATEGY MONITORING

The major role played by reentrained street dust in violations of the particulate standards in urban areas has now been generally accepted, but the formulation of feasible control strategies is proving to be a formidable task. The use of street washing as a possible control strategy was tested at the Broad and Spruce street site during the June field program. The city of Philadelphia performed washing on three consecutive days between 7:00 a.m. and 6:30 p.m. along the street segments shown in Figure 4. On the third day, washing was delayed for 2 h by a parade. The amount of water used was as follows: June 15 th, 4.3 × 10$^5$ L; June 16 th, 4.2 × 10$^5$ L; and June 17 th, 3.1 × 10$^5$ L. At the end of the third day of street washing, the high-volume samplers at Broad and Spruce streets were operated on a 4-h schedule in an attempt to measure the rate of increase in TSP levels resulting from accumulating street dust. This 4-h schedule continued until 8:00 p.m. on the 19 th. Traffic volume data were taken by automatic counters located on South Broad and Spruce streets.

TSP concentrations preceding, during, and following the washing experiment are plotted in Figure 7. The Broad and Spruce street curve shows the average concentration for the trailer and tower high-volume samplers; the x's indicate average 4-h concentrations at this location. The 500 South Broad Street curve shows the average concentration measured at this rooftop location. The third curve shows the average concentration measured at the two other sites in the city with approximate daily sampling. The periods of intensive street washing are also indicated in the figure.

Several features of Figure 7 deserve comment. First, citywide concentrations, as indicated by the LAB-, S/E-, and rooftop-site monitors, were generally low through the 13 th, increased during the 14 th and 15 th, gradually decreased somewhat during the 16 th and 17 th, and were down to approximately 75 μg/m$^3$ on the 18 th and 19 th. Also, the average concentration at the LAB and S/E sites and the rooftop concentrations followed each other quite closely. Second, the average 24-h concentration at the Broad and Spruce street site did not appear to be affected significantly by the intensive daytime street washing, which took place on the 15 th and 16 th, remaining roughly 40 μg/m$^3$ higher than the average citywide index. On the 17 th, this difference increased somewhat. Third, the concentrations at Broad and Spruce streets increased dramatically to the highest levels observed during the field program immediately following the washing, while the citywide concentrations remained low.

The failure of street washing to reduce TSP concentrations at the intersection and the unusually high concentrations measured there following the washing were both unexpected and at first puzzling results. The most plausible suggestion made to date is that the vigorous, forced washing plus splashing by motor vehicles redistributed particulates that had previously become concentrated adjacent to the curbs. Many of these redistributed particulates probably became airborne as soon as the streets were dry. Also, recall that the washing operation was less extensive on June 17 due to a parade, giving additional time for reentrainment. This hypothesis of reentrainment of the redistributed dried particulates by vehicular traffic is supported by Figure 8, which compares the volume of traffic entering the intersection at Broad and Spruce streets in a 4-h period with the average TSP concentration measured at that site. The correspondence between the two curves is surprisingly close. Calculation of the linear correlation coefficient for the 11 pairs yielded a value of +0.79, which is significant at the 1 percent level.

## SUMMARY

Based on experience gained in performing this work, we offer the following general comments for consideration in the design of similar programs. A number of devices are currently available for monitoring ambient particulates, as illustrated by the wide range of instruments that were deployed in this field program. In contrast to

Figure 6. Source contributions to annual geometric means in 1976.

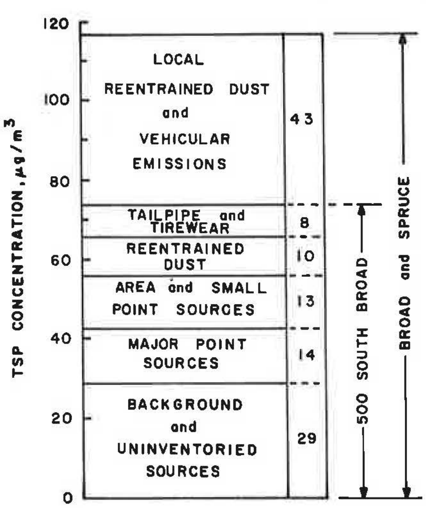



Figure 7. TSP trends during street-flushing experiment.

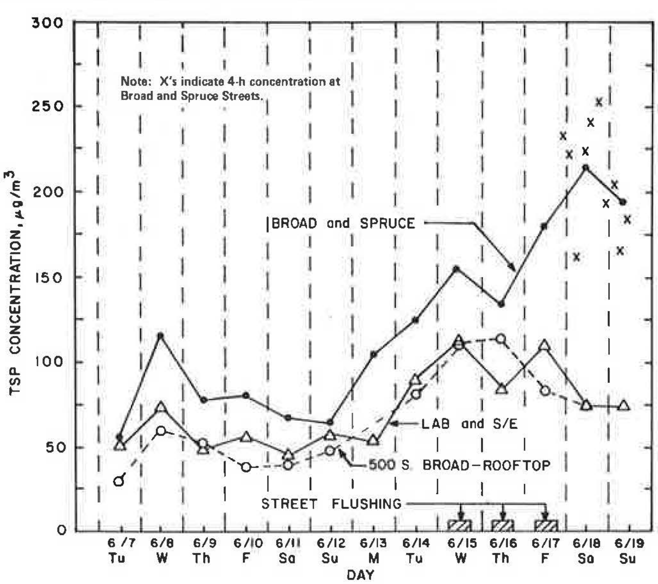
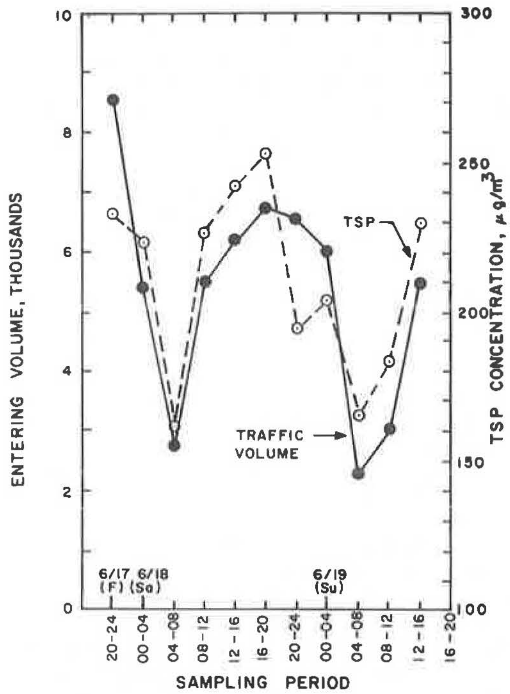


Figure 8. Comparison of TSP concentration and traffic volume following street flushing.




the selection of monitors for gaseous pollutants, the selection of instrumentation for particulate monitoring requires that careful consideration be given to the purposes of the monitoring program and to any special characteristics of the candidate instruments. Although in principle the choice of instruments can be made on the basis of sampling time, particulate size cut, and type of chemical or physical analysis desired, if any, the actual results may be influenced by the particular instrument selected and perhaps by the atmosphere being measured. For example, in a limited comparison of total suspended particulate concentrations made during this program, the APM and the dichotomous sampler yielded concentrations that were roughly 70 and 40 percent, respectively, of the high-volume sampler concentrations. Much of the difference can be explained by differences in inlet configurations, but some of the discrepancy may result from a mass accretion on the high-volume sampler filters as a result of passive particle deposition and chemical reactions between collected particulates and various gaseous species present in the ambient air. The larger discrepancy that occurred with the dichotomous sampler presumably resulted in part from its upper particle size cutoff of 20 μm.

The selection of appropriate emission factors for fugitive and reentrained dust continues to be one of the most perplexing problems associated with particulate modeling. Enough measurements have been made to confirm that roadway emission rates and the size distribution of the emitted particles within an urban area vary widely both spatially and temporally. Generalizing from these measurements frequently leads to unreasonable results. For example, the introduction of emission factors for roadway dust developed for residential areas (1) (using a nonstandard collection inlet configuration) leads, through the use of the air quality display model, to excessively high estimates for the contribution of reentrained dust within the metropolitan Philadelphia AQCR. If these emission factors are, in fact, generally applicable, it would appear that large losses of particulates occur as they move from the roadway to monitoring locations, possibly due to the screening and cleansing effects of vegetation. An approach that holds some promise, and one that was adopted in this project, is to accept an emission factor for general use that yields consistently reasonable results throughout the area for rooftop monitors or for monitors removed from any obvious local particulate source. An attempt is then made to explain deviations from these rooftop model estimates by local sources either by modeling or by the use of empirically derived expressions.

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