MRI REPORT

Fugitive Particulate Matter Emissions

Final Report

For U.S. Environmental Protection Agency
Emission Factor and Inventory Group (MD-14)
Emissions, Modeling, and Analysis Division
Office of Air Quality Planning and Standards
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Preface

This report was prepared by Midwest Research Institute (MRI) for the Emission Factor and Inventory Group of the U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards. Mr. William Kuykendal was the EPA Work Assignment Manager.

The report describes the results of field measurement and other data collection activities that were undertaken to determine PM-10 and PM-2.5 components of fugitive dust emissions from representative paved and unpaved roads at four geographic locations in the United States.

Dr. Chatten Cowherd served as MRI Project Leader for this work and was the principal author of this report. Other MRI staff who contributed to this project included Dr. Gregory Muleski (overall field activity direction), Mr. Gary Garman (field crew chief), and Mrs. Mary Ann Grelinger (special studies at the Kansas City site).

The contributions of EPA personnel who provided colocated data from continuous monitors at the Raleigh paved road test site (Mr. Ron Speer, Mr. Bruce Harris, and Mr. Robert McCrillis) are also acknowledged.

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Introduction

The U.S. Environmental Protection Agency (EPA) is currently considering revisions to the existing particulate matter (PM) National Ambient Air Quality Standard (NAAQS), which is based on particles 10 micrometers and smaller in aerodynamic diameter (≤ 10 µmA). This particle size fraction is referred to as PM-10. The fine particle fraction selected as the basis for proposed revisions to the standard is PM-2.5, i.e., particles ≤ 2.5 µmA.

In order to assess the possible impacts of revisions to the PM NAAQS, EPA needs national emission inventories for both PM-10 and PM-2.5. The existing emission inventories for both particle size fractions are dominated by source categories that emit fugitive particulate matter, such as emissions from unpaved and paved roads, construction activities, and agricultural activities. This assignment directed Midwest Research Institute (MRI) to evaluate, refine, and enhance the PM emission factor equations (USEPA, 1995)[1] currently in use to estimate PM emissions from fugitive dust sources. Particular emphasis is placed on the estimation of the PM-2.5 fraction of the emissions from unpaved and paved roads.

The AP-42 predictive emission factor equation for unpaved roads is as follows:

$$E = k(1.7)\left(\frac{s}{12}\right)\left(\frac{S}{48}\right)\left(\frac{W}{2.7}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \text{ (kilograms [kg]/VKT)}$$

$$E = k(5.9)\left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \text{ (pounds [lb]/VMT)} \qquad (1\text{-}1)$$

[1] This document, entitled, "Compilation of Air Pollution Emission Factors," is also referred to as "AP-42."

where:

- E = emission factor, kilograms per vehicle-kilometer traveled (lbs per vehicle-mile traveled)
- k = particle size multiplier (dimensionless)
- s = Silt content of road surface material (%)
- S = mean vehicle speed, kilometers per hour (km/hr) (miles per hour [mph])
- W = mean vehicle weight, megagrams (Mg) (ton)
- w = mean number of wheels
- p = number of days with at least 0.254 mm (0.01 in.) of precipitation per year (see discussion below about the effect of precipitation.)

The percentage of silt (particles smaller than 75 micrometers (μm) in diameter) in the road surface material is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method.

The particle size multiplier, k, in equation 1-1 varies with aerodynamic particle size range as follows:

Aerodynamic Particle Size Multiplier (k) for Equation 1					
≤ 30 μm[a]	≤ 30 μm	≤ 15 μm	≤ 10 μm	≤ 5 μm	≤ 2.5 μm
1.0	0.80	0.50	0.36	0.20	0.095

[a] Stokes diameter.

Similarly, the AP-42 predictive emission factor equation for paved roads is as follows:

$$E = k\,(sL/2)^{0.65}\,(W/3)^{1.5} \qquad (1\text{-}2)$$

where:

- E = particulate emission factor
- k = base emission factor for particle size range and units of interest (see below)
- sL = road surface silt loading (grams per square meter) (g/m2)
- W = average weight (tons) of the vehicles traveling the road

The particle size multiplier (k) above varies with aerodynamic size range as follows:

Particle Size Multipliers for Paved Road Equation

Size Range[a]	Multiplier k[b]		
	g/VKT	g/VMT	lb/VMT
PM-2.5	2.1	3.3	0.0073
PM-10	4.6	7.3	0.016
PM-15	5.5	9.0	0.020
PM-30[c]	24	38	0.082

a Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.
b Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT).
c PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

To determine particulate emissions for a specific particle size range, use the appropriate value of k above.

The term "silt loading" (sL) refers to the mass of silt-size material (equal to or less than 75 micrometers (μm] in physical diameter) per unit area of the travel surface. The total road surface dust loading consists of loose material that can be collected by broom sweeping and vacuuming of the traveled portion of the paved road. The silt fraction is determined by measuring the proportion of the loose dry surface dust that passes through a 200-mesh screen, using the ASTM-C-136 method. Silt loading is the product of the silt fraction and the total loading. Additional details on the sampling and analysis of such material are provided in AP-42 Appendices C.1 and C.2.

This document presents the results of an extensive testing program that used state-of-the-art plume profiling techniques and particle sizing devices to characterize particulate emissions from representative paved and unpaved roads in four geographic locations. Section 2 presents the background for this work and focuses on prior sources of particle size distribution data for paved and unpaved roads. The experimental plan for the test program is described in Section 3. Sections 4 and 5 document the test results for unpaved and paved roads, respectively. Section 6 contains an overall evaluation of test results, and

Section 7 presents conclusions from the testing program and recommendations, with regard to revisions of the emission factor equations, especially the particle size multipliers for PM-2.5.

Appendix A presents graphs of the upwind/downwind PM-10 concentration profiles obtained from the testing program. Appendix B contains the detailed sampling data from each test site/run. Appendix C presents the chemical analyses of airborne PM and resuspended road surface materials.

Section 2
Background

As an outgrowth of the process of evaluating a revision to the national ambient air quality standards for particulate matter, the National Particulates Inventory (NPI) was prepared by the U.S. Environmental Protection Agency (EPA). It considered both the PM-10 and PM-2.5 components of emissions from each source category including fugitive dust sources. In the estimating process, the NPI utilized in most cases the particle size multipliers contained in the AP-42 predictive emission factor equations for fugitive dust sources. The NPI showed that the national emissions of PM-10 were dominated by fugitive dust sources, led by paved and unpaved roads.

Even the PM-2.5 fugitive dust component of the NPI, although somewhat reduced in magnitude, continued to show a dominance of fugitive dust emissions on the national emission totals. At the same time there seemed to be considerable evidence from ambient PM characterization that the PM-2.5 emissions from fugitive dust sources had been overestimated. This was believed to be due largely to inflated PM-2.5/PM-10 ratios in the particle size multipliers of the AP-42 predictive emission factor equations for fugitive dust sources. As a result of this problem, one task of the subject program was directed to deriving interim adjustment factors for PM-2.5 emissions from fugitive dust sources. These factors were to be expressed as multipliers for the PM-10 predictive emission factor equations presented in AP-42.

Certain source categories were of primary interest because they had been used in the NPI. The source categories are as follows:

Wind erosion—agricultural land
Agricultural crops
Agricultural livestock
Wind erosion—non-agricultural land
Paved roads
Unpaved roads
Construction activities

The review of the literature to assess the validity of the AP-42 particle size multipliers considered studies of area-wide ambient particle size distributions as well as particle size data from source plume characterizations. This dealt with "coarse model aerosol," since fugitive dust consists mostly of particles larger than 2.5 μmA.

2.1 Area-wide Ambient Studies

According to the Lundgren and Burton (1995) analysis of accumulated coarse particle size distribution measurements, typically only about 5 to 10% of the atmospheric PM-10 consists of coarse mode PM-2.5. The data collected in the various cited studies incorporated a range of particle size measurement methods.

In a study of fugitive dust emissions using silicon as a tracker of crustal material components, Desert Research Institute (Watson et al., 1995) estimated "intrusion of coarse-mode crustal particles into the fine fraction" for four geographic areas:

- San Joaquin Valley
- Phoenix, AZ
- Ohio River Valley
- Boise, ID

The ratios of crustal PM-2.5 to PM-10 in these areas fell in the range of 0.05 to 0.1.

2.2 Emission Studies

The Criteria Document for Particulate Matter (USEPA, 1996) indicated a ratio of about 0.15 for construction sites in Fresno. Laboratory resuspension of source material samples as performed by Desert Research Institute (DRI, 1986) showed the following PM-2.5 to PM-10 ratios.

Source Category	PM-2.5/PM-10
Paved Road Dust	0.20
Unpaved Road Dust	0.15
Agricultural Soil	0.20
Sand/Gravel	0.40

A number of field studies also yielded data on PM-2.5 to PM-10 ratios. Data from UC-Davis (UCD) on emissions from agricultural harvesting operations (mostly almonds and cotton) showed that about 12% of the PM-10 was in the PM-2.5 size range (Ashbaugh, 1995). In a 1990 study of unpaved road emissions in three Arizona counties, the Arizona Department of Environmental Quality (AZDEQ, 1990) found a consistent PM-2.5 to PM-10 ratio of about 0.25; this study used dichotomous samplers for the field measurements. The original Pedco-MRI study of fugitive dust sources at western surface coal mines (Axetell and Cowherd, 1981) found a PM-2.5/PM-10 ratio of about 0.15 for unpaved haul roads, based on data from dichotomous samplers with PM-15 inlets. Unpaved road data collected by the Illinois Water Survey (Williams et al., 1988) in support of the 1985 National and Precipitation Assessment Program (NAPAP) emission inventory showed a PM-2.5 to PM-10 mass concentration ratio of about 0.10 using dichotomous samplers, although a few values as high as 0.20 were recorded.

2.3 Interim Adjustment Factors

The proposed interim particle size adjustment factors, as shown in Table 2-1, were issued by MRI on September 25, 1995. They represented a substantial downward adjustment of AP-42 particle size multipliers. At the time of issue, it was projected that some of these ratios would probably be lowered further based on the results of the planned field studies reported herein. However, pending availability of these results, justification for additional reductions could be based only on conclusions drawn from area-wide ambient data.

Table 2-1. Interim Particle Size Adjustment Factors

Source Category	Ratio of PM-2.5 to PM-10: AP-42	Ratio of PM-2.5 to PM-10: Nationwide Emission Inventory[a]	Ratio of PM-2.5 to PM-10: Proposed	Supporting Data
Wind erosion—agricultural land	NA	—	0.15	By analogy to industrial wind erosion
Agricultural crops	0.48 for tilling	—	0.20	DRI dust resuspension studies. UCD finds ~0.12 for harvesting
Agricultural livestock	NA	—	0.15	No data for this relatively insignificant source
Wind erosion—non-agricultural land	0.40	—	0.25	Available MRI wind tunnel data suspect because of probable particle bounce biases due to high substrate loadings
Paved roads	0.46	0.75	0.25	AP-42 ratio includes vehicle exhaust, now suspected to comprise about half of the PM-2.5
Unpaved roads	0.26	0.26	0.15	Results of AZDEQ 1990 dichot data (~0.25) moderated by earlier NAPAP data (~0.10) and corroborated by original Pedco/MRI dichot data from haul roads (0.15) at western surface coal mines
Construction activities	Use blended ratio representing component operations	0.02	0.15	Construction operations dominated by unpaved road emissions. DRI dust resuspension of sand/gravel gives high value (0.40).

[a] Memorandum from William E. Wilson to Christopher A. Knopes, 2/7/95.

Section 3
Experimental Approach

This section describes the field measurement and other data collection activities used in characterizing particulate emissions from paved and unpaved roads. Particular emphasis is given to use of state-of-the-art particle sizing methods with appropriate QA measures at representative paved and unpaved road test sites, for the purpose of determining PM-2.5 and PM-10 components of fugitive dust emissions.

3.1 Site Selection

The following selection criteria were used to evaluate candidate roadway source test locations during pretest site surveys.

1. There should be at least 10 m of flat, open terrain downwind of the road.

2. There should be at least 30 m of flat, open terrain upwind of the road.

3. The height of the nearest downwind obstruction should be less than the distance from the road to the obstruction.

4. The height of the nearest upwind obstruction should be less than one-third the distance from the road to the obstruction.

5. A line drawn perpendicular to the road orientation should form an angle of 0 to 45 degrees with the mean daytime prevailing wind direction during test periods of interest.

6. The mean daytime wind speed should be greater than 4 mph.

7. The test road should have an adequate number of vehicle passes per hour to enable completion of a test in less than 3 h in order that testing can be safely completed during daylight hours and during a period of relatively constant wind direction.

8. The traffic mix during a test should be representative of the type of vehicles that regularly use the road.

9. The testing location should be at least 100 m from a controlled intersection, to provide for freely flowing traffic at the point of sampling.

10. The number of travel lanes should be limited to four; two or three lanes are preferable. One-way traffic is acceptable.

Criterion 5 is most easily met when either of two conditions are satisfied:

a. The test road has a gradual bend of 45 to 90 degrees.

b. Two test roads at right angles are available in the same area (e.g., intersecting roads).

In the case of paved roads, Criterion 7 requires a minimum average daily traffic (ADT) count of several thousand vehicles coupled with a moderate silt loading. This is best satisfied by using an arterial or feeder road with some evidence of visible dust on the road surface. However, the test site should be at least 300 m from any obvious trackout source, such as an active construction site, so that the test road is generally representative of urban road/traffic conditions. Note that in the case of unpaved roads, only about 100 vehicle passes are required, and a captive vehicle can supply this amount in about 90 minutes.

Also, in the case of paved roads, Criterion 10 is most easily met by having a test road that is divided by a median strip that is at least 15 m in width. Operation of plume sampling instruments in the median strip provides for emission characterization of one-half of the roadway, i.e., the one-way lanes that are upwind of the median.

The above siting criteria were used to select test sites in four geographic areas:

- An unpaved road at MRI's Deramus Field Station (DFS) near Kansas City, Missouri

- A paved road and an unpaved road in Raleigh, North Carolina (vicinity of Research Triangle Park).

- Two paved roads in Denver, Colorado, in collaboration with another MRI testing program for the Colorado Department of Transportation (CDOT).

- A paved road and an unpaved road in Reno, Nevada (a western PM-10 non-attainment area, which has an excellent temporal database of silt loading measurements on paved roads).

The following subsections describe the procedures used for plume sample collection, ancillary sample collection, and emission factor calculations.

3.2 Air Sampling Equipment and Techniques

The source-directed field sampling conducted in this study employed an "exposure profiling" approach to characterize near-source particulate mass concentrations and particle size distributions by height. The exposure profiling method was developed by Cowherd et al. (1974).

The exposure profiling technique is based on the profiling concept used in conventional (stack) testing. The passage of target airborne pollutant immediately downwind of the source is measured directly by means of simultaneous, multipoint sampling over the effective cross section of the open dust source plume. This technique, which uses a mass flux measurement scheme similar to EPA Method 5 for stack testing, does not require an indirect emission rate calculation through the application of a generalized atmospheric dispersion model. Further details of the exposure profiling method can be found in earlier technical reports, such as the 1986 EPA collaborative study (Pyle and McCain, 1986).

For measurement of particulate emissions from the paved test roads, multipoint vertical arrays of samplers were positioned just downwind and upwind from the edge of the road. The downwind distance of 5 m is far enough that sampling interference due to traffic-generated turbulence is minimal but close enough to the source that the vertical plume extent can be adequately characterized with a maximum sampling height of about 6 m. In a similar manner, the 10-m distance upwind from the road's edge is far enough from the source that: (a) source turbulence does not affect sampling, and (b) a brief reversal in wind directions will not substantially impact the upwind samplers. The 10-m distance is, however, close enough to the road to provide the representative background concentration values needed to determine the net mass flux (i.e., due to the source).

The various particle sizing devices used in this study and their aerodynamic cutpoints are listed in Table 3-1.

Table 3-1. Particle Sizing Devices

Device	Model No. (Identifier)	Collection Substrate	Particle Size Cutpoints (μmA)[a]
High-volume PM-10 Inlet (40 cfm)	Wedding (W)	Quartz back-up filter	10
Dichotomous Sampler (16.7 Lpm)	Sierra Andersen Model 245 (DT/DQ)	Teflon/quartz filters	10, 2.5
High-volume Cyclone (40 cfm)	Sierra Model 230CP	Glass fiber back-up filter	10
High-volume Cyclone/ Cascade Impactor (20 cfm)	Sierra Model 230CP/235 (C/I)	Quartz impaction substrates and back-up filter	15, 10.2, 4.2, 2.1, 1.4 and 0.73
Aerodynamic Particle Sizer	TSI Model APS3310	[light scattering]	Multiple subranges 20............0.55

[a] Each cutpoint represents a collection stage.

For PM-10 plume sampling, high-volume (hi-vol) air samplers equipped with the Sierra Model 230CP cyclone preseparators were used. At 40 cfm (68 m^3/h), the cyclone exhibits an effective 50% cutoff diameter D_{50} of approximately 10 μmA. The PM-10 is collected on an 8 m-by-10 m glass-fiber back-up filter underneath the cyclone. In most cases, three sampling heights were used at the downwind location.

For particle sizing hi-vol samplers equipped with cyclone preseparators and parallel-slot, five-stage cascade impactors were used. This equipment is consistent with that used to develop the particle size multipliers that accompany the AP-42 predictive emissions factor equations for paved and unpaved roads. The Sierra Model 230CP cyclone preseparator exhibits an effective D_{50} of approximately 15 μmA when operated at a constant flow rate of 20 cfm (34 m^3/h). The corresponding 50% cutoff aerodynamic diameters of the five-stage Sierra Model 235 cascade impactors (with glass fiber impaction substrates) are 0.73 µmA, 1.4 µmA, 2.1 µmA, 4.2 µmA, and 10.2 µmA. A single hi-vol equipped with a Wedding PM-10 inlet and a quartz back-up filter also was operated at the downwind location.

Sierra Anderson Model 245 dichotomous samplers with cutpoints of 10 µmA and 2.5 µmA also were used for particle sizing. Both Teflon and quartz fiber filter media were used to provide for different types of chemical analysis for speciation of the collected particles.

At the test sites in the Raleigh, North Carolina, area, three additional state-of-the-art particle monitoring devices were operated by EPA personnel at the primary downwind distance (5 m):

1. An Amhurst Aerosizer Particle Sizer (unpaved road site)
2. A TSI Aerodynamic Particle Sizer (paved road site).
3. A Climet Laser Particle Counter (paved road site).

In addition, at the unpaved test site in the Kansas City area, a (TSI) DustTrak Aerosol Monitor was operated by MRI personnel at various downwind locations. It was programmed to collect 6-sec average concentrations at 6-sec intervals. This device is a 90° light-scattering instrument with a particle size range from 0.1 to 15 µm, although measurement sensitivity is dependent on particle reflectivity and scattering angle. When a Dorr-Oliver cyclone is placed on the inlet, the device monitors PM-3.5.

Throughout each test, wind speed was monitored by wind odometers mounted downwind at three heights. Horizontal wind direction also was monitored by a continuously recording R.M. Young wind instrument with sensors at a 3-m height.

3.3 Testing Procedures

3.3.1 Preparation of Sample Collection Media

Except for the dichotomous samplers, particulate samples were collected on either Type AH grade glass fiber (impactor substrates and back-up filters), or QM-A microquartz filters (Wedding PM-10 reference sampler). Impactor substrates were greased by spraying with a solution prepared by dissolving 140 g of stopcock grease in 1 L of reagent grade toluene. For the dichotomous samplers, particulate samples were collected on 37-mm Teflon membrane filters and QM-A microquartz filters.

Prior to the initial weighing, the filters were equilibrated for 24 h at constant temperature and humidity in a special weighing room. During weighing, the balance will be checked at frequent intervals with standard (Class S) weights to ensure accuracy. The filters remained in the same controlled environment for a second 24-h period, after which a second analyst will reweigh them as a precision check. If a filter did not pass audit limits, the entire lot was reweighed. Ten percent (10%) of the filters taken to the field were used as blanks. The quality control guidelines pertaining to preparation of sample collection media are presented in Table 3-2.

As indicated in Table 3-2, a minimum of 10% field blanks were collected for QC purposes. This procedure involved handling at least one filter in every 10 in an identical manner as the others to determine systematic weight changes. These changes were then used to mathematically correct the net weight gain determined from gravimetric analysis of the filter samples. During field blank collection, filters were loaded into samplers and then recovered without air actually being passed through the media.

Table 3-2. Quality Control Procedures for Sampling Media

Activity	QC Check/Requirement
Preparation	Inspect and imprint glass fiber media with identification numbers.
Conditioning	Equilibrate media for 24 h in clean controlled room with a relative humidity of 45% (variation of less than ±5%) and with a temperature of 23°C (variation of less than ±1%).
Weighing	Weigh hi-vol filters to nearest 0.1 mg.
Auditing of weights	For tare weights, conduct a 100% audit. Reweigh tare weight of any filters that deviate by more than ±1.0 mg. Independently verify final weights of 10% of filters (at least four from each batch). Reweigh batch if weights of any hi-vol filters deviate by more than ±2.0 mg.
Correction for handling effects[a]	Weigh and handle at least one blank for each 10 filters of each type for each test.
Calibration of balance	Balance to be calibrated once per year by certified manufacturer's representative. Check prior to each use with laboratory Class S weights.

[a] Includes field blanks (see text).

3.3.2 Pretest Procedures/Evaluation of Sampling Procedures

Prior to actual sample collection, a number of decisions were made as to the potential for acceptable source-testing conditions. These decisions were based on forecast information obtained from the local U.S. Weather Service office. If conditions were considered acceptable, the sampling equipment was prepared for testing. Pretest preparations included calibration checks of the various air sampling instruments, insertion of filters, and so forth. The quality control guidelines governing this activity are found in Table 3-3.

Table 3-3. Quality Control Procedures for Sampling Flow Rates

Activity	QC Check/Requirement
Hi-vol air samplers	Single point calibration check using calibration orifice upon arrival at test site for comparison against standard table.
Orifice and electronic calibrator	Calibrate against displaced volume test meter annually.
Warm wire anemometers	Calibrate annually in standard wind tunnel.

Once the source testing equipment was set up and the filters inserted, air sampling was conducted. Information recorded on specially designed reporting forms included:

- Air samples—Start/stop times, filter IDs, approach wind speeds at sampler intakes, sampler flow rates, and wind direction relative to the roadway perpendicular (10-min average). (See Table 3-4 for QC procedures.)

Table 3-4. Quality Control Procedures for Sampling Equipment

Activity	QC Check/Requirement[a]
Maintenance All samplers	Check motors, gaskets, timers, and flow measuring devices prior to testing.
Operations Timing	Start and stop all downwind samplers during time span not exceeding 1 min.
Isokinetic sampling (cyclones)	Adjust sampling intake orientation whenever mean wind direction dictates.
Prevention of static mode deposition	Cap sampler inlets prior to and immediately after sampling.

[a] "Mean" denotes a 5- to 15-min average.

- Traffic count by vehicle type and speed.

- General meteorology—Wind speed, wind direction, temperature, and barometric pressure.

Criteria for suspending or terminating a source test are presented in Table 3-5.

Table 3-5. Criteria for Suspending or Terminating a Test

A test may be suspended or terminated if:
1. Precipitation occurs during equipment setup or when sampling is in progress.
2. Mean[a] wind speed during sampling moves outside the 1.3- to 8.9-m/s (2- to 20-mph) acceptable range for more than 20% of the sampling time.
3. The angle between mean wind direction and the perpendicular to the path of the moving point source during sampling exceeds 45 degrees for two consecutive averaging periods.
4. Daylight is insufficient for safe equipment operation.
5. Source condition deviates from predetermined criteria (e.g., occurrence of wet pavement conditions).

[a] "Mean" denotes a 5- to 15-min average.

3.3.3 Sample Handling and Analysis

To prevent particulate losses, the exposed media were carefully transported in special containers to MRI's main laboratory in Kansas City. In the laboratory, exposed filters were equilibrated under the same conditions as the initial weighing. After reweighing, 10% of the filters were audited to check weighing accuracy.

Following storage in a freezer, selected filters were sent to Desert Research Institute (DRI) for chemical speciation. PM-10 and PM-2.5 fractions from dichotomous samplers were chemically analyzed by DRI using X-ray florescence (XRF) (Teflon filters) and thermal/optical reflectance (TOR) (quartz filters) for elemental and carbon analyses, respectively.

3.4 Ancillary Sample Collection and Analysis

The types of ancillary samples and information collected were divided into two broad categories: roadway surface samples and source activity levels. Each category is described in greater detail below.

3.4.1 Surface Sample Collection and Analysis

In conjunction with the emissions tests, samples of the dust on the test road surface were obtained. These samples were needed to characterize the test roads in terms of their emission potential and their representativeness of roads previously tested as the basis for AP-42 emission factors. The specific procedures used to collect and analyze paved and unpaved road surface samples to determine texture and loading are generally described in AP-42 Appendices C1 and C2.

For chemical characterization of collected road surface materials, two laboratory devices were used to resuspend and collect segregated samples of fine particle components (PM-10 and PM-2.5). The purpose of this work was to develop chemical source fingerprints of "in-place" road dust for comparison with the chemical profiles of ambient air samples of PM-10 and PM-2.5 collected downwind of the same test road.

The first device, which was developed by DRI (Chow et al., 1994), uses a pulsed air jet to entrain and transfer the sub 38 μm component of the road surface sample to an air sampling chamber. In the chamber, PM-10 and PM-2.5 components are collected on Teflon and quartz fiber filters. The sub 38 μm starting material is obtained by separating out the fraction of the original road dust sample that passes a 400 mesh screen upon dry sieving.

The second device, which was developed by MRI (Cowherd et al., 1989), consists of a dustiness test chamber wherein a portion of the collected road dust sample is poured over a 25 cm drop height onto the chamber floor. Immediately after the pour, a size-segregating sampler mounted in the chamber lid collects either the PM-10 or the PM-2.5 component of the resuspended particles.

In either case, samples were collected onto Teflon or quartz fiber filters for chemical analysis of the collected particles by X-ray fluorescence (XRF) or by thermal/optical reflectance (TOR), respectively. XRF provided for analysis of 30+ elements and TOR was used for analysis of elemental and organic carbon.

3.4.2 Source Activity Monitoring

Vehicle-related parameters were obtained using a combination of manual and automated counting techniques. Pneumatic tube axle counters were used to acquire traffic volume data for paved roads. Because these counters only record the number of passing axles, it was also necessary to obtain manual traffic mix information (e.g., number of axles per vehicle) to convert axle counts to the number of vehicle passes. Vehicle mixes were observed visually and also distinguished between diesel- and gasoline-powered vehicles. Comparison of the observed vehicle mix to the pneumatic counter totals allowed the accuracy of the axle counter to be assessed. A radar gun was used during selected tests to determine the average speed of vehicles passing the sampling transect. For unpaved roads with dominantly captive traffic, vehicle passes were recorded by the vehicle operator, and vehicle speed at the sampling location was maintained at 30 mph.

3.5 Calculation Procedure

To calculate emission rates, a conservation of mass approach was used. The passage of airborne particulate (i.e., the quantity of emissions per unit of source activity) is obtained by spatial integration of distributed measurements of exposure (mass/area) over the effective cross section of the plume. Exposure is the point value of the flux (mass/area-time) of airborne particulate integrated over the time of measurement or, equivalently, the net particulate mass passing through a unit area normal to the mean wind direction during the test. The steps in the calculation procedure are described below.

3.5.1 Particulate Concentration/Exposures

The concentration of PM-10 measured by a sampler is given by:

$$C = 10^3 \frac{m}{Qt} \qquad (3\text{-}1)$$

where: C = PM-10 concentration ($\mu g/m^3$)
m = PM-10 sample weight (mg)
Q = sampler flow rate (m^3/min)
t = duration of sampling (min)

To be consistent with the National Ambient Air Quality Standards, all concentrations and flow rates are expressed in standard conditions (25°C and 101 kPa or 77°F and 29.92 inHg).

The isokinetic flow ratio (IFR) is the ratio of a directional (i.e., cyclone) sampler's intake air speed to the mean wind speed approaching the sampler. It is given by:

$$\text{IFR} = \frac{Q}{aU} \tag{3-2}$$

where: Q = sampler flow rate (m^3/min)
a = intake area of sampler (m^2)
U = mean wind speed at height of sampler (m/min)

The above ratio is of interest only in the sampling of total particulate, since isokinetic sampling ensures that particles of all sizes are sampled without bias. Note that because the primary interest in this program is directed to PM-10 emissions, sampling under moderately nonisokinetic conditions poses no difficulty. It is accepted that 10 µm (aerodynamic diameter) and smaller particles have weak inertial characteristics at normal wind speeds and, thus, are relatively unaffected by anisokinesis.

Exposure represents the net passage of mass through a unit area normal to the direction of plume transport (wind direction) and is calculated by:

$$E_{10} = 10^{-7} \times CUt \tag{3-3}$$

where: E_{10} = PM-10 exposure (mg/cm^2)
C = net concentration ($\mu g/m^3$)
U = approaching wind speed (m/s)
t = duration of sampling (s)

Exposure values vary over the spatial extent of the plume. If exposure is integrated over the plume-effective cross section, then the quantity obtained represents the total passage of airborne particulate matter (i.e., mass flux) due to the source.

For each test roadway, a one-dimensional integration scheme is used:

$$I = \int_{O}^{H} E_{10} \, dh \tag{3-4}$$

where: I = integrated PM-10 exposure (m-mg/cm^2)
E_{10} = PM-10 exposure (mg/cm^2)
h = vertical distance coordinate (m)
H = effective extent of plume above ground (m)

The effective height of the plume (H) in Eq. 3-4 is found by linear extrapolation of the uppermost net concentrations to a value of zero.

Because exposures are measured at discrete heights of the plume, a numerical integration is necessary to determine I. The exposure must equal zero at the vertical extremes of the profile (i.e., at the ground where the wind velocity equals zero and at the effective height of the plume where the net concentration equals zero). However, the maximum exposure usually occurs below a height of 1 m so that there is a sharp decay in exposure near the ground. To account for this sharp decay, the value of exposure at ground level is set equal to the value at a height of 1 m. The integration is then performed from 1 m to the plume height, H, using Simpson's approximation.

3.5.2 Particulate Emission Factors

The emission factor for PM-10 generated by vehicular traffic on roadways, expressed in grams of emissions per vehicle-kilometer traveled (VKT), is given by:

$$e = 10^4 \frac{I}{N} \tag{3-5}$$

where: e = PM-10 emission factor (g/VKT)
I = integrated PM-10 exposure (m-mg/cm^2)
N = number of vehicle passes (dimensionless)

The emission factor for PM-2.5 is calculated as the product of the PM-10 emission factor and the appropriate ratio of PM-2.5 to PM-10 from measured net concentrations at downwind sampling heights that represent the plume core.

Section 4
Test Results—Unpaved Roads

Particulate matter emissions from unpaved roads were tested in Grandview, MO (Kansas City area); Raleigh, NC; and Reno, NV geographical areas.

4.1 Grandview, MO (Kansas City Area)

This section summarizes the results of field testing of dust emissions from an unpaved road on the property of MRI's Deramus Field Station (DFS) in Grandview, Missouri. The testing was performed in late November and early December of 1995. A total of five test runs (BG-1 through BG-5) were completed.

4.1.1 Test Parameters

The one-lane test road at the DFS consisted of an east-west segment, approximately ¼ mile in length. The road had been surfaced with crushed limestone in 1994, for an earlier test program. A slight bend in the road provided for plume profiling over a wide range of wind directions, generally of a south or north orientation.

For these tests, "captive" vehicles were driven by MRI personnel. The vehicles consisted of:

Vehicle 1—1995 Ford Model F-250 pickup truck
Vehicle 2—1987 Chevrolet Celebrity 4-door sedan
Vehicle 3—1989 GMC Jimmy 2-door sport vehicle

Usually only one and never more than two vehicles were operated at any one time.

The test vehicles traveled at a speed of 30 mph along the midsection of the test strip where the sampling instruments were located. A turnaround at each end was used to change directions when two vehicles were operated; one followed the other so that it was not necessary to veer off the one-lane road for passing a vehicle moving in the opposite direction.

The types and deployment of the air samplers are shown in Table 4-1.

Table 4-1. Equipment Deployment for Kansas City Unpaved Road

Sampler	Flow	Intake Height
Upwind Station: 10 to 15 m from upwind edge of road		
Wedding PM-10 monitor	40 cfm	2.0 m
Cyclone/impactor	20 cfm	3.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	3.0 m
R.M. Young wind monitor		3.0 m
Downwind Station: 5 m from downwind edge of road		
Wedding PM-10 monitor	40 cfm	2.0 m
Cyclone/impactor	20 cfm	1.5 m, 3.0 m, 4.5 m
Dichotomous sampler (Teflon filters)	16.7 lpm	1.5 m
Dichotomous sampler (quartz filters)	16.7 lpm	1.5 m
Dichotomous sampler (Teflon filters)	16.7 lpm	3.0 m
TSI DustTrak Monitor	1.7 lpm	1.5 m, 3.0 m, 4.5 m
MiniVol Sampler (quartz or Teflon filters)	5 lpm	Various locations
Wind odometer		1.4 m

A set of 10 MiniVol samplers (also referred to as "Saturation Samplers") with PM-10 and PM-2.5 inlets were colocated to provide for comparison of the performance of metal to plastic inlet construction and the performance of Teflon to quartz fiber filter media (47-mm in diameter). Some of the filters also were analyzed by XRF and TOR. Table 4-2 shows the chemical analysis matrix for the various types of air samplers used at the Kansas City area test site.

As indicated in Table 4-1, an R.M. Young wind monitor recorded wind speed and direction at the upwind station. Wind odometers were operated at three heights at the downwind location.

The test conditions are shown in Table 4-3.

Table 4-2. Particulate Samples for Chemical Analysis

Sample Type	Sampler	Sample Location	Sample Pre-processing	Particle Size Fraction	Filter Media	Chemical Analysis
Airborne	Dichotomous sampler	5 m downwind	None	Coarse (<10 µm, >2.5 µm)	Teflon membrane	XRF - 38 elements
					Quartz fiber	TOR - EC/OC
				PM-2.5	Teflon	XRF
					Quartz	TOR
		15 m upwind	None	Coarse (<10 µm, >2.5 µm)	Teflon	XRF
					Quartz	TOR
				PM-2.5	Teflon	XRF
					Quartz	TOR
	MiniVol	5 m downwind	None	PM-10	Teflon	XRF
					Quartz	TOR
				PM-2.5	Teflon	XRF
					Quartz	TOR
Bulk source material	Brush and dustpan	Traveled road surface	MRI dustiness test chamber (unsieved)	PM-10	Teflon	XRF
					Quartz	TOR
				PM-2.5	Teflon	XRF
					Quartz	TOR
			MRI dustiness test chamber (sieved to < 0.95 cm)	PM-10	Teflon	XRF
					Quartz	TOR
				PM-2.5	Teflon	XRF
					Quartz	TOR
			DRI resuspension chamber (sieved to <38 µm)	PM-10	Teflon	XRF
					Quartz	TOR
				PM-2.5	Teflon	XRF
					Quartz	TOR

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Table 4-3. Test Conditions—Kansas City Unpaved Road

Run No.	Date	Start Time[a]	Sampling Duration (min)[b]	Vehicle Passes	Temp (°F)	Wind Speed (mph) at Indicated Height 1.5 m	3 m	4.5 m	Road Surface Properties Silt Content (%)	Moisture Content (%)
BG-1	11/25/95	14:30[c]	85[c]	110	60	3.7	NA	4.7	7.20	0.93
BG-2	11/30/95	11:05[c]	125[c]	330	60	10.3	11.6	12.9	6.22	0.65
BG-3	11/30/95	14:44	84	300	65	11.2	12.4	13.0	6.07	0.54
BG-4	12/2/95	09:15	102	306	57	5.25	6.0	6.75	7.56	1.38
BG-5	12/2/95	11:56	88	320	62	3.0	3.75	5.25	7.97	1.12

[a] Nominal start time for downwind sampler.
[b] Based on downwind sampler operating period.
[c] Approximate.

The DustTrak measurements at the Deramus Field Station are identified in Table 4-4.

Table 4-4. DustTrak Test Summary—Kansas City Unpaved Road

DustTrak Test No.	MRI Run ID	Start Time	Stop Time	Cyclone (Y/N)	Comments
1	Pre-test BG-2	9:45	9:48	N	Flow and zero checks
2	Pre-test BG-2	10:58	11:03	Y	Background @ 15 m upwind, 1 m height
3	BG-2	11:17	13:35	Y	5 m downwind, 1 m height
4	BG-3	14:24	16:11	Y	5 m downwind, 1 m height
5	Pre-test BG-4	8:43	8:46	N	Flow and zero checks
6	BG-4	9:10	10:24	Y	5 m downwind, 1 m height
7	BG-4	10:26	10:53	Y	5 m downwind, 3.25 m height
8	Pre-test BG-5	11:57	11:59	N	Zero check
9	BG-5	12:00	12:57	Y	5 m downwind, 1.75 m height
10	BG-5	12:58	13:32	Y	5 m downwind, 3.25 m height
11	Post-test BG-5	13:34	13:35	Y	Background
12	Post-test BG-5	13:35	13:37	N	Background
13	Post-test BG-5	13:38	13:43	N	Zero check

The average ambient temperature and wind speed during each test are shown in Table 4-3. Temperatures were well above normal for the period. High winds were encountered during Runs BG-2 and BG-3. During Run BG-3, brief wind gusts up to 25 mph toppled the 3-m dichotomous samplers, so that the partial samples were not reliable. One unit was taken out of service because it required repair, but the second unit was restored for Runs BG-4 and BG-5.

Mean wind direction was in the S-SW range during all the tests. Only for brief periods (less than 2% of the time) was the angle between the wind direction and the road less than 45-degree criterion for minimum acceptable wind angle.

On the final test day (Runs BG-4 and BG-5), wind speeds were lower and relative humidity was higher, with occasional light mist encountered. These conditions were reflected in higher road surface moisture content and significantly lower net downwind concentrations of PM-10. However, PM-2.5 concentrations were not significantly different. The concentration data are presented in the following section.

4.1.2 Road Surface Characteristics

Eight composite samples of the unpaved road surface material were obtained. Road samples consisted of a light gray gravel material from Valley Falls limestone deposits as mined underground in the Kansas City area. Surface samples were collected and analyzed for silt and moisture contents according to methods described in Appendix C of AP-42, (USEPA, 1995). Surface samples were split for comparative resuspension by MRI and DRI techniques. MRI splits were sieved through a 9.5 mm (3/8 in.) standard test sieve to remove gravel greater than about 1 cm diameter. Splits sent to DRI for resuspension were sieved through a series of screens, ending with a 200-mesh sieve, to obtain the silt component.

The silt content of the eight samples averaged 6.9 percent, with a range of 5.7 percent to 8.4 percent. The moisture content ranged from 0.5 percent to 1.2 percent, with the exception of one sample collected early on the final test day. On that misty morning the moisture content measured 1.6 percent. Visible dust from light duty captive traffic on the unpaved road was considerably decreased on this particular morning.

The MRI dustiness test chamber was used to suspend the road surface material for collection as PM-10 and PM-2.5 samples. The test chamber is a bench-scale device used to generate and sample airborne particulate resulting from the dropping of bulk material (27 L) over a 25 cm distance to the floor of the chamber. Air is drawn at 8.3 L/min through the sampling device (open-faced 47 mm diameter filter) at the top of the chamber for a period of 10 min beginning with the 30 sec pouring period.

For portions of this series of tests, the chamber was modified from its standard configuration to incorporate a MiniVol (saturation) sampler with a PM-10 or a PM-2.5 inlet mounted in an inverted position. The MiniVol sampler drew air from the chamber at 5.0 L/min, as contrasted with the standard flowrate of 8.3 L/min. The size-selected inlets consisted of PM-10 or PM-2.5 greased impactors preceding the 47-m filter. The test procedure also was modified to begin sampling only after large particles had settled, which consumed a 1-min period following the end of each pouring event.

The net weights of particulate matter captured on quartz fiber and Teflon membrane filters were used to calculate the dustiness index (or emission factor)—in units of mg of suspended particulate matter per kg of material poured. The PM-2.5/PM-10 ratio in the suspended particulate was of special interest in this study and was determined by comparing the respective dustiness indices.

Table 4-5 shows the results of two series of dustiness tests of the unpaved road surface samples. The first series of tests (Tests RM-1 through RM-17) utilized unsieved material, causing nonuniformity of sample volumes being dropped in the chamber and emission bursts to occur when larger rocks of 1 in. or more fell onto material that had already been deposited at the bottom of the chamber.

The second series of tests (Tests RM-18 through RM-38) were conducted after the larger pieces of gravel were removed by sieving through a 0.95 cm screen. As shown in Table 4-4, the second series of tests produced more uniform dustiness results, especially on quartz fiber filters. A particle loss problem was suspected to occur on some Teflon membrane filters because of the slick surface.

Table 4-5. Dustiness Tests of Unpaved Road Surface Material

Run No.	Sample Inlet	Sample Media	No. of Pours	Sampling Delay, Time (sec)	Total Mass Dropped (g)	Dustiness Index (mg/kg)	Footnote
RM-1	PM-10	Quartz	3	33	1,328.1	5.20	1,2
RM-2	PM-10	Quartz	1	12	446.0	3.79	2
RM-3	PM-10	Quartz	1	12	428.5	4.04	2
RM-4	PM-10	Quartz	1	12	431.6	10.66	2
RM-5	PM-10	Quartz	0	12	0.0	Blank run	2
RM-6	PM-10	Quartz	1	12	427.0	5.13	2
RM-7	PM-2.5	Quartz	3	12	1,336.1	5.80	2
RM-8	PM-2.5	Quartz	3	75	1,289.2	2.23	2
RM-9	PM-10	Quartz	0	60	0.0	Blank run	2
RM-10	PM-10	Quartz	1	60	431.0	–	3
RM-11	PM-10	Quartz	1	60	448.1	5.67	4
RM-12	PM-10	Quartz	1	60	424.5	15.95	4
RM-13	PM-10	Teflon	0	60	0.0	Blank run	4
RM-14	PM-10	Quartz	1	60	426.6	4.24	4
RM-15	PM-10	Teflon	1	60	428.5	–	4
RM-16	PM-10	Teflon	1	60	444.6	6.32	4
RM-17	PM-10	Teflon	1	60	446.0	0.72	4
RM-18	PM-2.5	Quartz	2	60	877.6	6.14	5
RM-19	PM-2.5	Quartz	2	60	860.1	5.73	5
RM-20	PM-2.5	Quartz	2	60	856.6	3.56	5
RM-21	PM-2.5	Teflon	2	60	859.1	2.15	5
RM-22	PM-2.5	Teflon	2	60	869.6	2.78	5
RM-23	PM-2.5	Teflon	2	60	843.1	0.70	5,6
RM-24	PM-10	Teflon	1	60	442.6	24.79	5
RM-25	PM-10	Teflon	1	60	435.0	4.25	5,7
RM-26	PM-10	Teflon	1	60	435.1	2.99	5,7
RM-27	PM-10	Quartz	1	60	429.5	17.69	5
RM-28	PM-10	Quartz	1	60	429.6	22.44	5
RM-29	PM-10	Quartz	1	60	431.5	12.40	5
RM-30	No impactor	Teflon	1	60	429.6	25.33	5
RM-31	No impactor	Teflon	1	60	420.5	23.42	5
RM-32	No impactor	Teflon	1	60	432.1	19.44	5
RM-33	No impactor	Quartz	1	60	426.6	22.25	5
RM-34	No impactor	Quartz	1	60	436.1	23.76	5
RM-35	No impactor	Quartz	1	60	443.5	11.12	5,6
RM-36	No impactor	Quartz	1	60	321.7	0.40	5,8
RM-37	No impactor	Quartz	1	60	354.2	35.23	5,8
RM-38	No impactor	Quartz	1	60	353.3	37.14	5,8

1 No wait time for large particle settling.
2 Impactor top surface not greased.
3 No sampling flow.
4 Mass loss due to filter handling problem.
5 Sieved material before pouring.
6 Suspected mass loss.
7 Poly ring of filter retaining dust.
8 Portland cement.

The average dustiness indices for the quartz fiber filters were calculated as:

- 5.1 mg/kg for PM-2.5,
- 17.5 mg/kg for PM-10, and
- 19.0 mg/kg for suspended particulate.

The first two values yielded a PM-2.5/PM-10 ratio of 0.29, which is quite comparable to previous field measurements of fugitive dust particle size distributions.

4.1.3 Particulate Concentrations

Table 4-6 shows the average PM-10 concentrations measured upwind and downwind of the test road. The "<" values denote cases where one or more component sample masses were less than three standard deviations of the blank values for the specific test run, sampling device, and collection medium in question. The numbers in parentheses in the column headings represent the heights of the respective samplers.

Table 4-6. PM-10 Concentrations ($\mu g/m^3$)—Kansas City Unpaved Road[a]

	Background			Downwind							
Run	W (2 m)	C/I (3 m)	DT (3 m)	DQ (1.5 m)	DT (1.5 m)	C/I (1.5 m)	W (2 m)	DQ (3 m)	DT (3 m)	C/I (3 m)	C/I (4.5 m)
BG-1	22	22	NA	851	613	548	251	303	546	256	111
BG-2	21	24	51	1929	1799	779	355	368	823	453	< 59
BG-3	21	24	51	2161	2257	1267	673	NA	NA	423	< 59
BG-4	40	23	63	323	335	244	107	NA	171	104	40
BG-5	40	23	63	389	389	305	202	NA	178	172	86

W = Wedding PM-10 monitor.
C/I = Cyclone/impactor.
DT = Dichotomous sampler (Teflon filters).
DQ = Dichotomous sampler (quartz filters).
[a] Numbers in parentheses are sampling heights.

The PM-10 concentrations from the various air sampling devices are plotted in Appendix A (one for each test run), with open and closed symbols representing upwind and downwind measurements, respectively. As expected, the downwind PM-10 concentrations decrease with height and indicate that the "core" of the plume lies below the 3-m height. The dichotomous sampler results generally show significantly higher PM-10 concentrations than the cyclone/impactors, and the PM-10 concentrations determined by the reference PM-10 sampler (Wedding inlet) are somewhat lower than the 2-m point (interpolated) on the vertical PM-10 profile generated from the cyclone/impactors.

As indicated in Table 4-6, the largest differences between PM-10 concentrations measured by the dichotomous samplers and the other instruments occurred during Runs BG-2 and BG-3, which produced the highest PM-10 concentrations. These discrepancies are evident in Figure 4-1 (reproduced from Appendix A), which shows the upwind and downwind PM-10 concentration values from Run BG-3. This phenomenon is believed to be due to penetration of significant amounts of particles much larger than 10 μm when large plume concentrations (peak values exceeding 20,000 μg/m^3) impact the samplers as each dust plume drifts by the downwind sampling array.[2] In effect, the cutpoint of the dichotomous sampler inlet is shifted upward, above 10 μm.

Table 4-7 shows the average PM-2.5 concentrations upwind and downwind of the test road. The "<" values denote cases where one or more component sample masses were less than three standard deviations of the blank values for the specific test run, sampling device, and collection medium in question. The numbers in parentheses in the column headings represent the heights of the respective samplers.

Table 4-7 indicates that at the downwind locations, the dichotomous samplers generally measured PM-2.5 concentrations that are lower than the values measured by the cyclone/impactors. This is the reverse of the findings stated above for PM-10. Thus, it appears that the added mass of coarse particles that penetrate the PM-10 inlet of the dichotomous sampler is collected on the coarse filter.

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 4-8. The upwind percentages produced by the dichotomous sampler and the cyclone/impactor are consistent. The downwind percentages are generally in the range of 25% for cyclone/impactors, except at the 4.5-m height, which represents the upper fringe of the plume. The PM-2.5 percentages in PM-10 derived from the dichotomous samplers are around 10% at the 1.5-m height and 15% at the 3-m height.

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[2] This peak concentration estimate was determined from DustTrak monitoring data at the test site, using an averaging time of a few seconds. It is interesting to note that the upper end of the PM-10 concentration range for equivalency testing of PM-10 monitors is 500 μg/m^3.

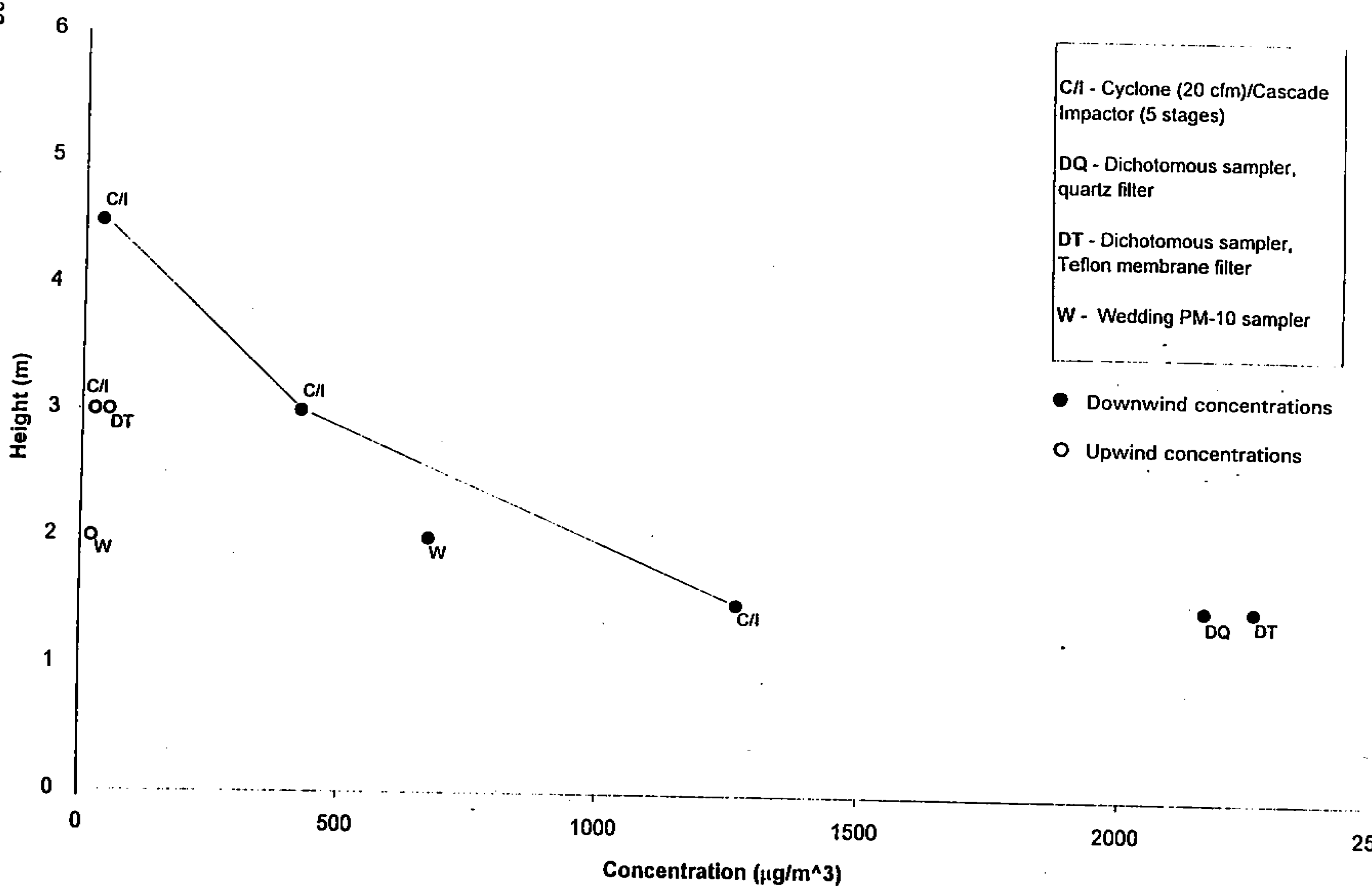

Figure 4-1. Upwind/Downwind PM-10 Concentration Profiles for Run BG-3

Table 4-7. PM-2.5 Concentrations (μg/m³)—Kansas City Unpaved Road[a]

	Background		Downwind						
Run	C/I (3 m)	DT (3 m)	DQ (1.5 m)	DT (1.5 m)	C/I (1.5 m)	DQ (3 m)	DT (3 m)	C/I (3 m)	C/I (4.5 m)
BG-1	10	NA	64	118	140	< 42	104	49	21
BG-2	9	11	44	38	224	< 65	64	124	< 15
BG-3	9	11	44	39	318	NA	NA	101	< 27
BG-4	18	45	33	37	93	NA	26	26	13
BG-5	18	45	33	37	71	NA	34	37	45

W = Wedding PM-10 monitor.
C/I = Cyclone/impactor (cut point = 2.1 μm).
DT = Dichotomous sampler (Teflon filters).
DQ = Dichotomous sampler (quartz filters).
[a]Numbers in parentheses are sampling heights.

Table 4-8. Percentage of PM-2.5 in PM-10—Kansas City Unpaved Road[a]

	Background		Downwind						
Run	C/I[b] (3 m)	DT (3 m)	DQ (1.5 m)	DT (1.5 m)	C/I[b] (1.5 m)	DQ (3 m)	DT (3 m)	C/I[b] (3 m)	C/I[b] (4.5 m)
BG-1	45	NA	8	19	26	< 14	19	19	19
BG-2	37	22	~ 6[c]	~ 6[c]	29	< 18	8	27	-
BG-3	37	22	~ 6[c]	~ 6[c]	25	NA	NA	24	-
BG-4	75	72	10	11	38	NA	16	25	32
BG-5	75	72	9	10	23	NA	15	20	52

W = Wedding PM-10 monitor.
C/I = Cyclone/impactor.
DT = Dichotomous sampler (Teflon filters).
DQ = Dichotomous sampler (quartz filters).
[a] Numbers in parentheses are sampling heights.
[b] PM-2.1 as a percentage of PM-10.2.
[c]Corrected for coarse particle carryover.

The MiniVol mass samples and calculated PM-10 and PM-2.5 concentrations are presented in Table 4-9. Ten colocated MiniVols were utilized for each of the three tests and allowed comparisons of metal to plastic samplers, quartz fiber to Teflon membrane filters, and PM-10 to PM-2.5 mass concentrations.

The MiniVol Sampler IDs that ends with "M" denotes a grounded metal head (i.e., inlet and impactor) especially constructed by MRI. The remaining MiniVols have standard plastic heads. As shown in Table 4-9, the metal units consistently captured more PM-10 than the plastic MiniVols. This is believed to be due to electrostatic plating of dust particles on the non-conducting plastic inlets.

Table 4-9. Colocated MiniVol Sampler Concentrations—Kansas City Unpaved Roads

Test ID	Filter Type	PM Fraction	Sampler ID	Test Dur (min)	Particulate Concentrations (ug/m³)					
					Metal PM-10		Plastic PM-10		Metal PM-2.5	
					Teflon	Quartz	Teflon	Quartz	Teflon	Quartz
BG-1	Quartz	10	1A	79				110		
BG-1	Quartz	10	2A	79				618		
BG-1	Teflon	10	4M	71	1137					
BG-1	Teflon	10	5M	79	489					
BG-1	Teflon	10	1x	79			286			
BG-1	Teflon	10	2	79			489			
BG-1	Teflon	10	3	79			539			
BG-1	Teflon	2.5	1M	79					666	
BG-1	Teflon	2.5	2M	79					336	
BG-1	Teflon	2.5	3M	79					1149	
		Average BG-1			**813**		**438**	**364**	**501**	
BG-2 & BG-3	Quartz	10	3	228				727		
BG-2 & BG-3	Quartz	10	4A	228				932		
BG-2 & BG-3	Quartz	10	5A	228				1055		
BG-2 & BG-3	Teflon	10	4							
BG-2 & BG-3	Teflon	10	5	228			1361			
BG-2 & BG-3	Teflon	10	4M	228	1464					
BG-2 & BG-3	Teflon	10	5M	228	2621					
BG-2 & BG-3	Teflon	2.5	1M	228					2123	
BG-2 & BG-3	Teflon	2.5	2M	228					3253	
BG-2 & BG-3	Teflon	2.5	3M	228					1492	
		Average BG-2 & BG-3			**2043**		**1361**	**904**	**2289**	
BG-4 & BG-5	Quartz	10	3M	187		827				
BG-4 & BG-5	Quartz	10	4M	187		1251				
BG-4 & BG-5	Quartz	10	5M							
BG-4 & BG-5	Quartz	10	1A	187				514		
BG-4 & BG-5	Quartz	10	2A	187				514		
BG-4 & BG-5	Teflon	10	1M	187	726					
BG-4 & BG-5	Teflon	10	2M	187	896					
BG-4 & BG-5	Teflon	10	1x	187			439			
BG-4 & BG-5	Teflon	10	2	187			375			
BG-4 & BG-5	Teflon	10	3	187			399			
		Average BG-4 & BG-5			**8111**	**1039**	**404**	**514**		

Most importantly, the Mini-Vols with PM-2.5 inlets can be observed to be subject to severe particle bounce problems, resulting in higher PM-2.5 values than PM-10, a physical impossibility. The MiniVols with 2.5 μm inlets were greased on the forward impactor faces, but this was not sufficient to prevent bounce effects. Later during laboratory tests to measure the dustiness of road surface samples, as described in Section 4.1.2, the PM-2.5 impactor units also were greased on the rearward face to provide a second surface for bouncing particles to be captured. This effort and a 1-min wait period to remove large particles appeared to eliminate the particle bounce problem in the dustiness tests.

The DustTrak monitoring provided useful data on the real-time variation of the emission rate, even though a 6-sec averaging time was used. Figure 4-2 illustrates the output of the DustTrak during the period from about 3:00 p.m. to 4:00 p.m. on November 30, 1995, which encompassed Run BG-3. The output illustrates the variation in the emission rate from one vehicle pass to the next. It should be noted that some of the variation was due to the relatively few cases when the plume passage (approximately 1-2 sec) overlapped two 6-sec averaging periods.

Maximum downwind concentrations appear to be very sensitive to the particular vehicle pass and vehicle type (e.g., driving on the edge of the road so that the tires encountered larger pieces of gravel produced larger clouds of dust behind vehicles). Additionally, a comparison of maximum concentrations produced by the GMC Jimmy and the Ford 150 truck showed the GMC Jimmy to be the larger emitter. This could be due to either the tire size or the greater vehicle exhaust component from the older vehicle, the GMC Jimmy.

4.1.4 Particulate Emission Factors

Table 4-10 presents the "observed" PM-10 emission factors that were calculated from the exposure profiling data. These values are compared with those predicted using the AP-42 emission factor equation for unpaved roads. Except for Runs BG-4 and BG-5, the ratios of predicted to observed emission factors are well within the predictive capability of the AP-42 emission factor equation, which applies to dry conditions (i.e., moisture content less than about 1%). The low ratios obtained for Runs BG-4 and BG-5 reflect natural mitigation caused by the misty conditions of the final test day, which significantly increased the moisture content of the road surface material.

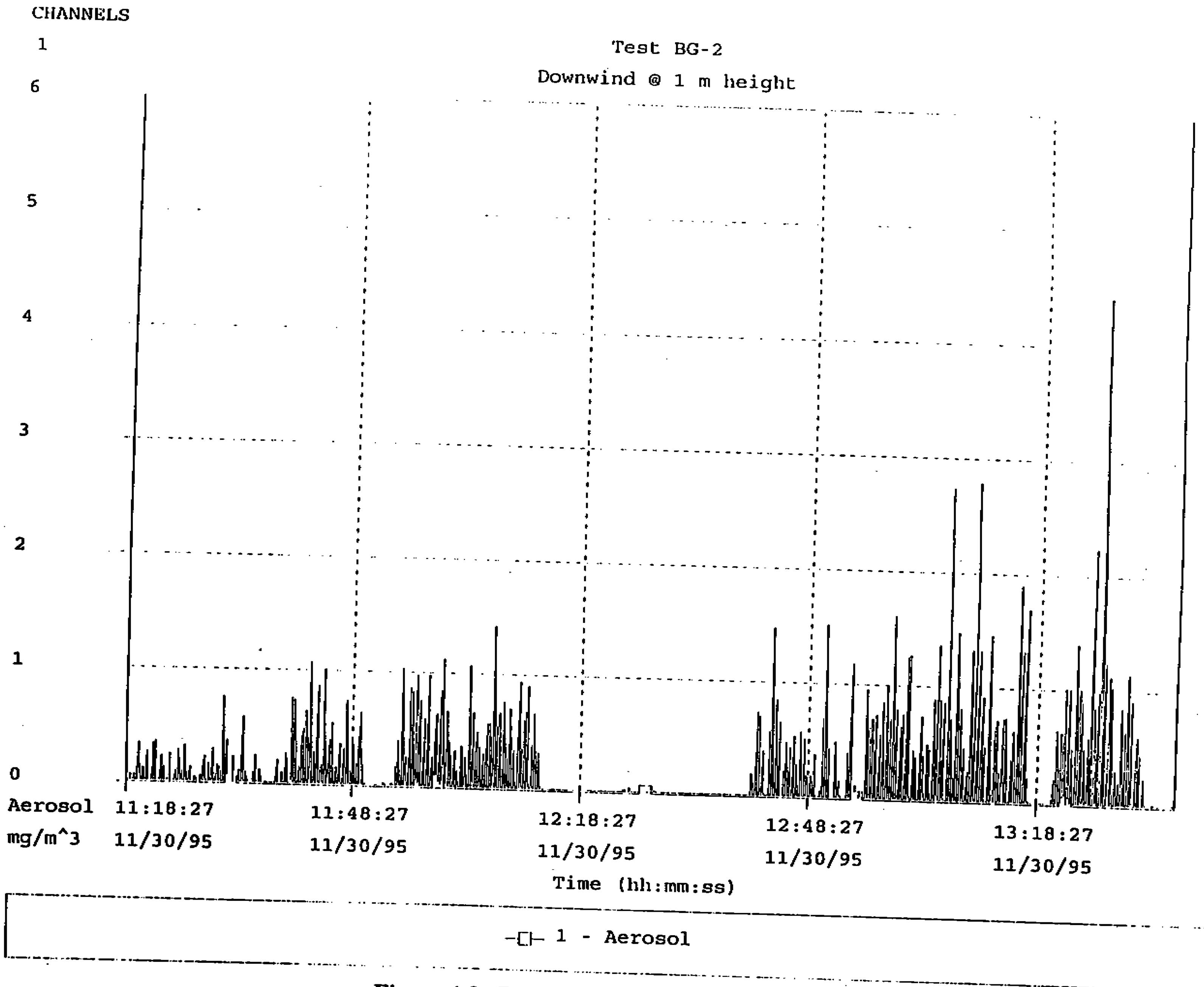

Figure 4-2. Example DustTrak Out for Run BG-3

Table 4-10. PM-10 Emission Factor Comparison—Kansas City Unpaved Road

Run	Silt Content (%)	PM-10 Emission Factor AP-42 [a] lb/VMT	PM-10 Emission Factor Observed lb/VMT	Ratio of Predicted (AP-42) to Observed
BG-1	7.20	0.949	0.503	1.9
BG-2	6.22	0.820	0.925	0.89
BG-3	6.07	0.800	1.12	0.71
BG-4	7.56	0.996	0.118	0.12
BG-5	7.97	1.05	0.0884	0.084

[a] Based on specified silt content, mean vehicle weight equal to 2 tons, mean vehicle wheels equal to 4 wheels, and mean vehicle speed of 30 mph.

4.2 Raleigh, North Carolina

This section summarizes the results of field testing of dust emissions from a 2-lane gravel road in Raleigh, North Carolina. The test site was an unpaved section of Reedy Creek Road, approximately 0.5 mi west of Blue Ridge Road. The testing was performed in late May and early June of 1996. A total of four test runs were completed.

4.2.1 Test Parameters

For these tests, captive vehicles were used to provide most of the vehicle passes. The two captive vehicles were:

Vehicle 1—1996 Dodge Intrepid
Vehicle 2—1989 Oldsmobile Cutlass Sierra

The test speed of these vehicles was 30 mph.

The types and deployment of the air samplers are given in Table 4-11. Although Ron Speer of EPA attempted to operate the Amherst Aerosizer Particle Sizer during the testing, the device failed because of a problem with the power supply, so that no comparative testing at this site could be performed.

The test conditions are shown in Table 4-12.

Table 4-11. Equipment Deployment for Raleigh Unpaved Road

Sampler	Flow	Intake Height
Upwind Station: 10 to 15 m from upwind edge of road		
Cyclone/impactor	20 cfm	2.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	2.0 m
Downwind Station: 5 m from downwind edge of road		
Cyclone/impactor	20 cfm	1.0 m, 3.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	1.0 m, 3.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	1.0 m, 3.0 m
Cyclone	40 cfm	1.0 m, 3.0 m, 5.0 m
Wedding PM-10 monitor	40 cfm	2.0 m

Table 4-12. Test Conditions—Raleigh Unpaved Road

						Wind Speed (mph) at Indicated Height			Road Surface Properties	
Run No.	Date	Start Time[a]	Sampling Duration (min)[b]	Vehicle Passes	Temp (°F)	1 m	3 m	5 m	Silt Content (%)	Moisture Content (%)
BJ-1	4/22/96	13:55	92	257	84	8.6	10.7	11.4	4.01	0.10
BJ-2	4/22/96	15:56	115	261	84	8.6	10.7	12.3	2.90	0.10
BJ-3	4/23/96	10:56	115	247	75	12.7	15.1	16.1	4.26	0.07
BJ-4	4/23/96	15:05	82	251	82	13.6	17.1	18.6	4.26	0.07

[a] Nominal start time for downwind sampler.
[b] Based on downwind sampler operating period.

4.2.2 Particulate Concentrations

Table 4-13 shows the average PM-10 concentrations measured upwind and downwind of the test road. Bolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least three times the standard deviation of the applicable blank values. Unbolded values indicate instances where each of the component sample masses is at least one standard deviation of the applicable blank correction. Values preceded by < should be interpreted as follows:

Table 4-13. PM-10 Concentrations (μg/m³)—Raleigh Unpaved Road[a]

	Background		Downwind									
Run	C/I (2 m)	DQ (2 m)	C/I (1 m)	DT (1 m)	DQ (1 m)	C/I (3 m)	DT (3 m)	DQ (3 m)	C (1 m)	C (3 m)	C (5 m)	W (2 m)
BJ-1	40	52	827	951	1082	247	267	303	2306	166	28	371
BJ-2	40	52	796	951	1082	198	267	303	1919	177	24	333
BJ-3	37	91	729	791	807	133	343	419	753	133	38	295
BJ-4	37	91	1152	1519	1555	>177 <184	343	419	1714	132	39	425

C/I = Cyclone/impactor
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
C = Cyclone
W = Wedding PM-10 sampler
[a]Numbers in parentheses are sampling heights.

1. For samplers with only one collection filter/substrate of interest (e.g., cyclones and Wedding PM-10 samplers), < indicates that the blank corrected sample weight is less than the standard deviation of the applicable blank values. The standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

2. For samples with multiple collection filters/substrates (e.g., cyclone/impactors and dichotomous samplers), < indicates that all of the corrected net filter/substrate weights are less than the respective standard deviations of the applicable blank values. For each filter/substrate, the standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

In some cases, both an upper limit (preceded by a <) and a lower limit (preceded by a >) are provided for samplers with more than one collection substrate. In these cases, at least one blank corrected net filter weight exceeds the standard deviation of the blank values for the specific test run, sampling device and collection medium in question. To determine the lower concentration limit, zero net filter weights are used for any filter/substrate for which the actual net filter weight is less than the standard deviation of the applicable blank values.

As found at the Kansas City test site, the dichotomous samplers showed consistently higher PM-10 concentrations than the other samplers, except for the cyclone sampler at the 1-m height, which gave the highest concentrations in three out of four runs. At the 3-m height, however, the cyclone values were close to those of the cyclone/impactor. The PM-10 concentration profiles showed that most of the plume was below the 5-m height of the uppermost profiler sampler. These observations are illustrated in Figure 4-3 (reproduced from Appendix A), which shows the upwind and downwind PM-10 concentration profiles from Run BJ-4.

Note that downwind dichotomous sampler filters were left in place for Runs BJ-1 and BJ-2 (at both the 1-m and 3-m heights) and for Runs BJ-3 and BJ-4 (at the 3-m height only), in an attempt to assure the particulate mass catches on all collection stages were quantifiable. For the same reason, the upwind sampler filters were changed at the end of each day (every two runs).

Table 4-14 shows the average PM-2.5 concentrations measured upwind and downwind of the test road. The comments made about bolded and unbolded values and about upper and lower limits in relation to Table 4-13 also apply to Table 4-14. Similarly, the comments about filter changes relative to PM-10 concentration measurements, also apply to PM-2.5 concentration measurements.

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 4-15. Once again, the downwind percentages are generally in the range of 25% for cyclone/impactors in the more concentrated portion of the plume and in the range of 10 to 15% for the dichotomous samplers.

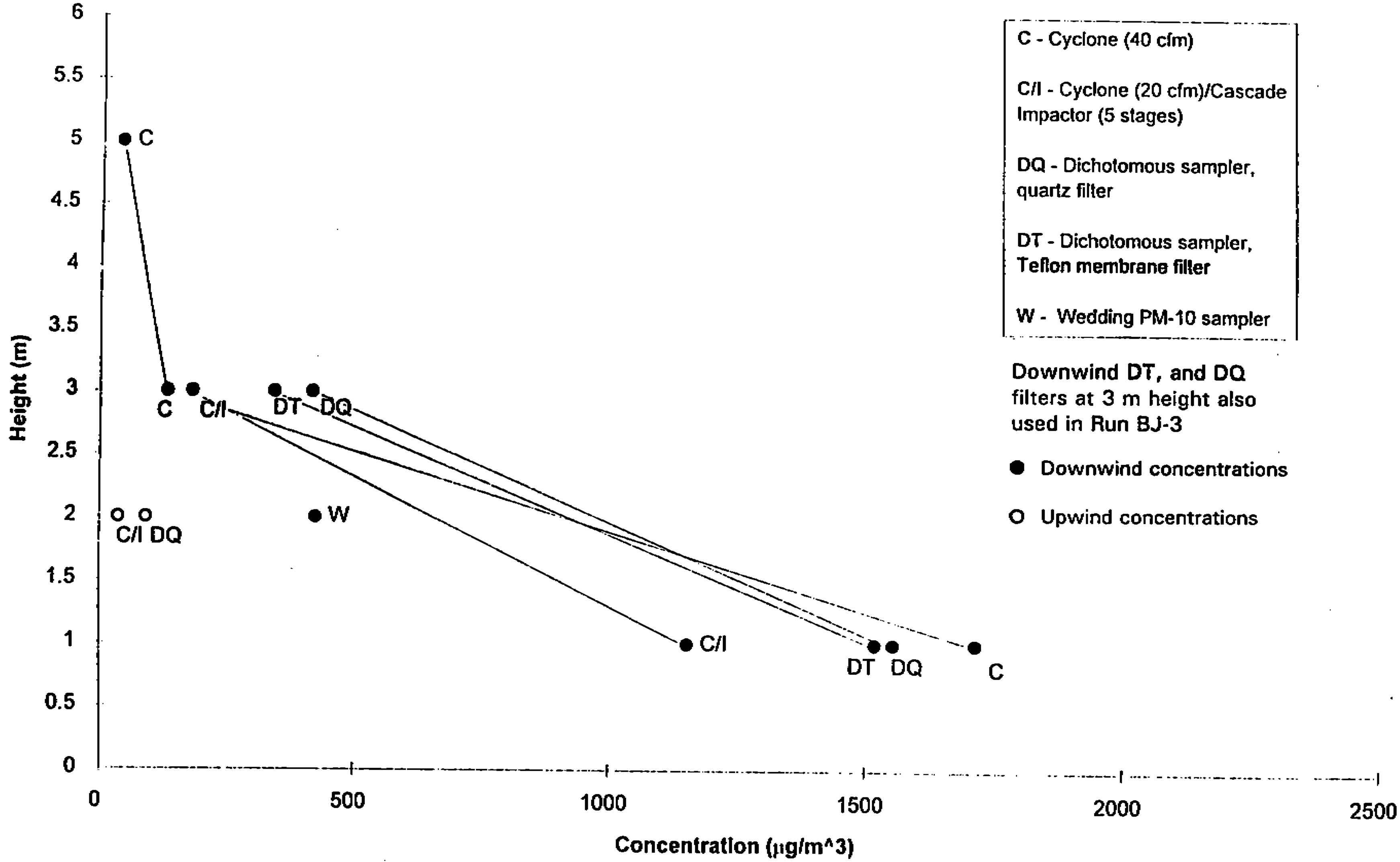

Figure 4-3. Upwind/Downwind PM-10 Concentration Profiles for Run BJ-4

Table 4-14. PM-2.5 Concentrations (μg/m3)—Raleigh Unpaved Road[a]

Run	Background C/I (2 m)	Background DQ (2 m)	Downwind C/I (1 m)	Downwind DT (1 m)	Downwind DQ (1 m)	Downwind C/I (3 m)	Downwind DT (3 m)	Downwind DQ (3 m)
BJ-1	26	26	203	114	100	81	49	52
BJ-2	26	26	214	114	100	80	49	52
BJ-3	13	19	185	70	122	40	61	47
BJ-4	13	19	321	130	106	>46 <52	61	47

C/I = Cyclone/impactor (cutpoint = 2.1 μm)
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
[a] Numbers in parentheses are sampling heights.

Table 4-15. Percentage of PM-2.5 in PM-10—Raleigh Unpaved Road[a]

Run	Background C/I[b] (2 m)	Background DQ (2 m)	Downwind C/I[b] (1 m)	Downwind DT (1 m)	Downwind DQ (1 m)	Downwind C/I[b] (3 m)	Downwind DT (3 m)	Downwind DQ (3 m)
BJ-1	65	50	25	12	9	33	18	17
BJ-2	65	50	27	12	9	40	18	17
BJ-3	35	21	25	9	15	30	18	11
BJ-4	35	21	28	9	7	27	18	11

[a] Numbers in parentheses are sampling heights.
[b] PM-2.1 as a percentage of PM-10.2.

4.2.3 Particulate Emission Factors

Table 4-16 presents the "observed" PM-10 emission factors that were calculated from the exposure profiling data. These values are compared with those predicted using the AP-42 emission factor equation for unpaved roads. As indicated the observed emission factors consistently exceed the AP-42 predictions. The ratios for predicted to observed emission factor were generally within, but in the lower range of, the predictive capability of the AP-42 equation.

Table 4-16. PM-10 Emission Factor Comparison—Raleigh Unpaved Road

Run	Silt Content (%)	PM-10 Emission Factor		Ratio of Predicted (AP-42) to Observed
		AP-42[a] (g/VKT)	Observed (g/VKT)	
BJ-1	4.0	150	350	0.43
BJ-2	2.9	110	360	0.30
BJ-3	4.3	160	240	0.67
BJ-4	3.7	140	370	0.38

a Based on the specified silt content, mean vehicle weight of 2 tons, mean vehicle weight of 2 tons, mean vehicle wheels equal to 4 wheels, and mean vehicle speed of 30 mph.

4.3 Reno, Nevada

This section summarizes the results of field testing of dust emissions from a unpaved road in the Reno area. The unpaved road was a relatively untraveled access road leading to Mira Loma Road near the Sage Hill Gun Club. The road consisted of a 200 ft segment (connecting two other roads) that had a favorable orientation relative to the expected wind direction. The testing was performed in late May 1996. A total of four test runs were completed.

4.3.1 Test Parameters

The traffic for the unpaved road testing consisted entirely of captive vehicles. The first two runs were conducted with a Ford Contour and the last two were conducted with a Chevrolet Suburban. All passes were at a nominal speed of 15 mph. The lower vehicle speed was required because of the road configuration (intersections at each end of the 200 ft test section) and its relative poor construction.*

* In spite of considerable assistance by Washoe County personnel in identifying candidate test roads, no highly suitable roads could be located.

The types and deployment of the air samplers are given in Table 4-17. Included in the downwind equipment were colocated pairs of dichotomous samplers with Teflon filters and with quartz fiber filters. The test conditions are shown in Table 4-18.

Table 4-17. Equipment Deployment—Reno Unpaved Road

Sampler	Flow	Intake Height
Upwind Station: 10 to 15 m from upwind edge of road		
Wedding PM-10 monitor	40 cfm	2.0 m
Downwind Station: 5 m from downwind edge of road		
Cyclone/impactor	20 cfm	1.0 m, 3.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	2.0 m[a]
Dichotomous sampler (quartz filters)	16.7 lpm	2.0 m[a]
Cyclone	40 cfm	1.0 m, 3.0 m, 5.0 m
Wedding PM-10 monitor	40 cfm	2.0 m

[a] Colocated

Table 4-18. Test Conditions—Reno Unpaved Road

Run No.	Date	Start Time[a]	Sampling Duration (min)[b]	Vehicle Passes	Temp (°F)	Wind Speed (mph) at Indicated Height: 1 m	3 m	5 m	Road Surface Properties: Silt Content (%)	Moisture Content (%)
BK-1	5/28/96	16:19	59	138	72	3.0	6.0	6.0	7.20	0.48
BK-2	5/28/96	17:35	29	150	70	2.8	6.5	7.5	5.24	0.44
BK-3	5/29/96	15:33	47	100	70	3.4	7.4	8.7	5.88	0.45
BK-4	5/29/96	16:40	27	80	71	3.4	7.4	8.7	6.55	0.38

[a] Nominal start time for downwind sampler.
[b] Based on downwind sampler operating period.

4.3.2 Particulate Concentrations

Tables 4-19 and 4-20 show the average PM-10 and PM-2.5 concentrations, respectively, measured upwind and downwind of the test road. Bolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least three standard deviations of the applicable blank correction. Unbolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least onetandard deviation of the applicable blank values.

Table 4-19. PM-10 Concentrations (µg/m³)—Reno Unpaved Road[a]

		Downwind									
Run	W (2 m)	C/I (1 m)	C/I (3 m)	DT #707 (2 m)	DT #053 (2 m)	DQ #057 (2 m)	DQ #242 (2 m)	C (1 m)	C (3 m)	C (5 m)	W (2 m)
BK-1	33	1788	233	582	720	846	950	1551	127	35	493
BK-2	33	1788	233	582	720	846	950	2994	216	32	859
BK-3	83	4426	856	2032	2230	2472	2478	4286	616	146	1453
BK-4	83	8832	856	2032	2230	2472	2478	10581	1373	194	2858

C/I = Cyclone/impactor
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
C = Cyclone
[a]Numbers in parentheses are sampling heights.

Table 4-20. PM-2.5 Concentrations (µg/m³)—Reno Unpaved Road[a]

	Downwind					
Run	C/I (1 m)	C/I (3 m)	DT #707 (2 m)	DT #053 (2 m)	DQ #057 (2 m)	DQ #242 (2 m)
BK-1	490	82	45	90	77	58
BK-2	490	82	45	90	77	58
BK-3	1169	232	177	156	199	177
BK-4	2072	232	177	156	199	177

C/I = Cyclone/impactor (cutpoint = 2.1 µm)
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
[a]Numbers in parentheses are sampling heights.

At the Reno unpaved test road, the colocated downwind dichotomous samplers tended to measure PM-10 concentrations that were consistent with the measurements of the other samplers, taking into account the curvature of the concentration profile. Although the colocated dichotomous samplers with the same filter medium produced relatively consistent values of PM-10 concentration, the samplers with quartz fiber filters measured higher concentrations than the samplers with Teflon filters. Except for Run BK-2 at the 1-m height, the cyclones and the cyclone/impactors showed good agreement. These observations are illustrated in Figure 4-4 (reproduced from Appendix A), which shows the upwind and downwind PM-10 concentrations from Run BK-4.

Note that except for the cyclones the downwind filters were left in place for Runs BK-1 and BK-2. The same was true for Runs BK-3 and BK-4 except that the filter on the 1-m cyclone impactor was changed between runs. These steps were taken in an attempt to assure that the particulate mass catches on all collection stages were quantifiable. For the same reason, the upwind sampler filters were changed at the end of each day (every two runs).

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 4-21. Once again, the cyclone/impactors yielded percentages in the range of 25%, while the dichotomous samplers yielded percentages of the range of 10 to 15%.

Table 4-21. Percentage of PM-2.5 in PM-10—Reno Unpaved Road[a]

	Downwind					
Run	C/I[b] (1 m)	C/I[b] (3 m)	DT #707 (2 m)	DT #053 (2 m)	DQ #057 (2 m)	DQ #242 (2 m)
BK-1	27	35	8	13	9	6
BK-2	27	35	8	13	9	6
BK-3	26	27	9	7	8	7
BK-4	23	27	9	7	8	7

[a]Numbers in parentheses are sampling heights.
[b]PM-2.1 as a percentage of PM-10.2.

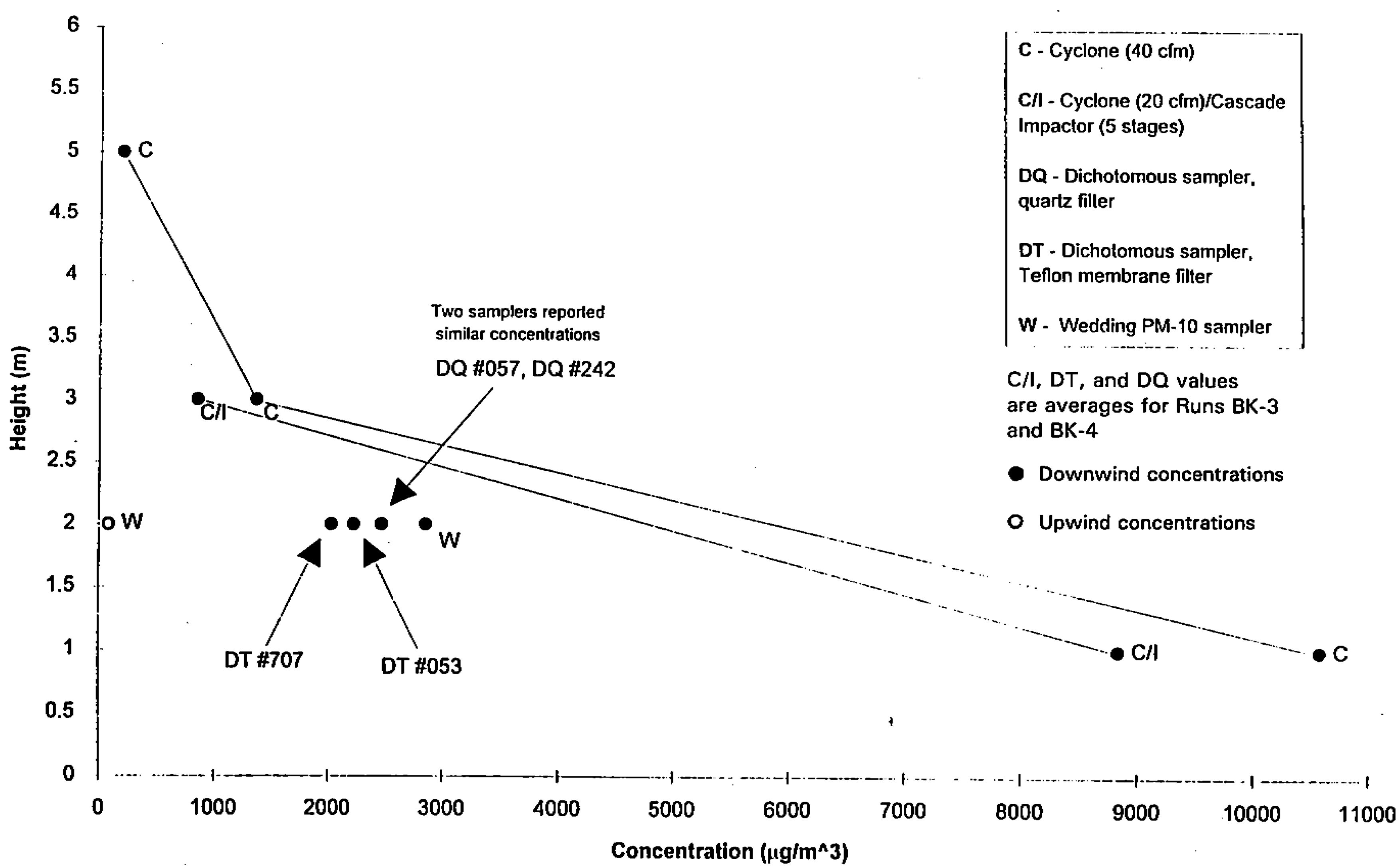

Figure 4-4. Upwind/Downwind PM-10 Concentration Profiles for Run BK-4

4.3.3 Particulate Emission Factors

Table 4-22 presents the "observed" PM-10 emission factors that were calculated from the exposure profiling data. These values are compared with those predicted using the AP-42 emission factor equation for unpaved roads. The time decrease in the ratio of predicted to observed emission factor reflects the noticeable deterioration in the poorly compacted surface of the test road as the testing progressed. The high intensity captive traffic created severe rutting in the road surface during the testing.

Table 4-22. PM-10 Emission Factor Comparison—Reno Unpaved Road

Run	Silt Content (%)	PM-10 Emission Factor: AP-42 [a] (g/VKT)	PM-10 Emission Factor: Observed (g/VKT)	Ratio of Predicted (AP-42) to Observed
BK-1	7.2	110	105	1.05
BK-2	5.2	81	87	0.93
BK-3	5.9	110	420	0.26
BK-4	6.6	120	740	0.16

a Based on specified silt content, mean vehicle weight of 1.5 tons for first two runs and 2 tons for remaining run, mean vehicle wheels of 4 wheels and mean vehicle speed of 15 mph.

Section 5
Test Results—Paved Roads

5.1 Denver, Colorado

Particulate matter emissions from paved roads were tested in Denver, CO; Raleigh, NC; and Reno, NV geographical areas.

This section summarizes the results of field testing of dust emissions from two paved roads in the Denver area. During March 1996, emission profiling tests were performed at two test sites:

- A north-south section of I-225 south of I-70 with two travel lanes in each direction, separated by a median: high volume, high speed traffic (55 mph speed limit).

- Separated one-way, two-lane facilities (York Street for southbound traffic and Josephine Sreet for northbound traffic) adjacent to the Denver Botanical Gardens: high volume, low speed traffic (40 mph speed limit).

These sites were selected primarily on the basis of road facility type (traffic volume, traffic speed). Table 5-1 lists the types and deployment of sampling equipment used at the Denver paved road sites. Table 5-2 lists the sampling periods for the exposure profiling tests.

5.1.1 Site Conditions

The average site conditions for the test runs are shown in Table 5-3. This includes the vehicle passes occurring during each sampling period. Note that wind speeds were marginally low during runs BH-1 and BH-6. During run BH-1 on I-225, the unusual wind speed maximum at the 1.5 m height is believed to reflect the effect of high speed traffic pushing air to the side of the roadway.

Table 5-1 Equipment Deployment—Denver Paved Roads

Upwind Station: 10 to 15 m from upwind edge of road		
Sampler	Flow	Intake Height
Cyclone	40 cfm	2.0 m, 7.0 m
Cyclone/impactor	20 cfm	2.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	2.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	2.0 m

Downwind Station: 5 m from downwind edge of road		
Sampler	Flow	Intake Height
Cyclone	40 cfm	1.0 m, 3.0 m, 5.0 m, 7.0 m
Wedding PM-10 monitor	20 cfm	2.0 m
Cyclone/impactor	20 cfm	2.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	2.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	2.0 m

Table 5-2. Sampling Periods—Denver Paved Roads

Run No.	Test Site	Date	Start Time	Sampling Duration (min)
BH-1	I-225	2/28/96	11:40	163
BH-2	I-225	3/1/96	09:46	360
BH-3	I-225	3/2/96	08:46	360
BH-4	I-225	3/2/96	—	Blank run
BH-5	York Street	3/7/96	—	Blank run
BH-6	York Street	3/16/96	09:09	240

Table 5-3. Site Conditions—Denver Paved Roads

Run No.	Test Site	Vehicle Passes	Temp (°F)	Wind Speed (mph)			Road Surface Material		
				1.5 m	3.0 m	4.5 m	s (%)	L (g/m²)	sL (g/m²)
BH-1	I-225	6,561	18	3.6	2.6	2.8	9.4	1.95	0.184
BH-2	I-225	17,568	37	14.5	16.2	17.5	41.0	0.0308	0.0127
BH-3	I-225	14,616	46	14.3	16.7	17.7	41.0	0.0308	0.0127
BH-6	York Street	3,112	48	2.3	2.8	3.3	1.2	125	1.47

L = Loading (g/m^2)
s = Silt content (%)
sL = Silt loading (g/m^2)

For tests BH-4 and BH-5, although favorable wind conditions were predicted, actual winds were unfavorable so that these became blank runs.

To the extent possible, each of the emission tests identified in Table 5-3 was performed during periods following snowfall, after the test road surface had dried. In most cases, sand application was ordered, because the relatively light snow conditions characteristic of the 1996 winter did not trigger routine sand application.

Also shown in Table 5-3 are the road surface material parameters. On I-225, the silt loading for run BH-1 was determined from surface sampling near the end of the run, when the travel lanes could be safely blocked (in succession). Because the road had been sanded near the beginning of the run, the average silt loading for the test period was undoubtedly higher than the reported value. The much lower silt loading obtained for runs BH-2 and BH-3 (based on surface sampling between runs) reflected a very effective removal of the sand by traffic flow, making it necessary to composite the samples from both runs. The resulting silt loading value represents a very clean surface (i.e., falling below the 10 percentile of silt loading values reported in AP-42 for high-ADT roadways). On York Street the much higher silt loading obtained during run BH-6 reflected the impact of sand application early in the test. Note that bulk samples of antiskid materials applied during runs BH-1 and BH-6, as collected from the application trucks, yielded silt contents of 1.47% and 1.17%, respectively.

This testing experience demonstrated that Denver wind conditions after a winter storm event tend to change frequently in relation to the 4-6 hour period required for collection of adequate airborne particulate sample mass, especially in the areas lying well within the perimeter interstate highway system. At the site adjacent to the Denver Botanical Gardens, for example, wind conditions were consistently disorganized after winter storm events. This made the task of plume profiling on a quantitative basis after such events very difficult.

On the other hand, at the I-225 site, wind conditions were more stable. However, because road sand was quickly thrown from the active roadway, once the surface had dried, little emission impact of the residual sand was suspected to be shown by the test results.

5.1.2 Particulate Concentrations

Table 5-4 shows the average PM-10 concentrations measured upwind and downwind of the test road. Bolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least three times the standard deviation of the applicable blank values. Unbolded values indicate instances where each of the component sample masses is at least one standard deviation of the applicable blank correction. Values preceded by < should be interpreted as follows:

1. For samplers with only one collection filter/substrate of interest (e.g., cyclones and Wedding PM-10 samplers), < indicates that the blank corrected sample weight is less than the standard deviation of the applicable blank values. The standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

2. For samples with multiple collection filters/substrates (e.g., cyclone/impactors and dichotomous samplers), < indicates that all of the corrected net filter/substrate weights are less than the respective standard deviations of the applicable blank values. For each filter/substrate, the standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

In some cases, both an upper limit (preceded by a <) and a lower limit (preceded by a >) are provided for samplers with more than one collection substrate. In these cases, at least one blank corrected net filter weight exceeds the standard deviation of the blank values for the specific test run, sampling device and collection medium in question. To determine the lower concentration limit, zero net filter weights are used for any filter/ substrate for which the actual net filter weight is less than the standard deviation of the applicable blank values.

Table 5-4. PM-10 Concentrations (µg/m³)—Denver Paved Roads[a]

Run	Background C/I (2 m)	Background DT (2 m)	Background DQ (2 m)	Background C (2 m)	Background C (7 m)	Downwind C/I (2 m)	Downwind DT (2 m)	Downwind DQ (2 m)	Downwind W (2 m)	Downwind C (1 m)	Downwind C (3 m)	Downwind C (5 m)	Downwind C (7 m)
BH-1	>31 <41	21	>6.1 <9.5	NA	NA	43	41	33	33	74	63	233	183
BH-2	>8.8 <11	17	>0 <3.7	NA	NA	16	22	>18 <20	15	29	16	13	27
BH-3	>5.1 <9.0	6.7	15	NA	NA	>10 <12	12	17	11	13	13	10	8.5
BH-6	52	42	>45 <48	40	27	70	>45 <46	100	53	295	338	64	46

C/I = Cyclone/impactor
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
C = Cyclone
W = Wedding PM-10 sampler

[a]Numbers in parentheses are sampling heights.

Generally, Table 5-4 shows that in the two runs with low wind speeds (Runs BH-1 and BH-6), the cyclones measured significantly higher PM-10 concentrations than the other downwind samplers. These observations are illustrated in Figure 5-1 (reproduced from Appendix A), which shows the upwind and downwind PM-10 concentrations from Run BH-1. Otherwise, there was good agreement between the results from different types of samplers.

The agreement between the different types of PM-10 samplers operated at the 2-m height was most consistent for runs BH-2 and BH-3, which had wind speeds that fully met the suitability for plume exposure profiling criteria. (This is illustrated in Figure 5-2, which shows the data from Run BH-3). During those runs the downwind PM-10 concentrations were low, showing only slight increases above background levels, because of effective ventilation of the plume.

The effect of an elevated plume centerline was observed for run BH-1 (see Figure 5-1), which had a maximum in the PM-10 concentration at a height of 5 m above the surface. This effect is believed to reflect buoyant plume rise from engine heat, under conditions of light winds and cold ambient temperatures. The effect is particularly important because it indicates that "ground-level" ambient monitoring (i.e., using a sampling height of about

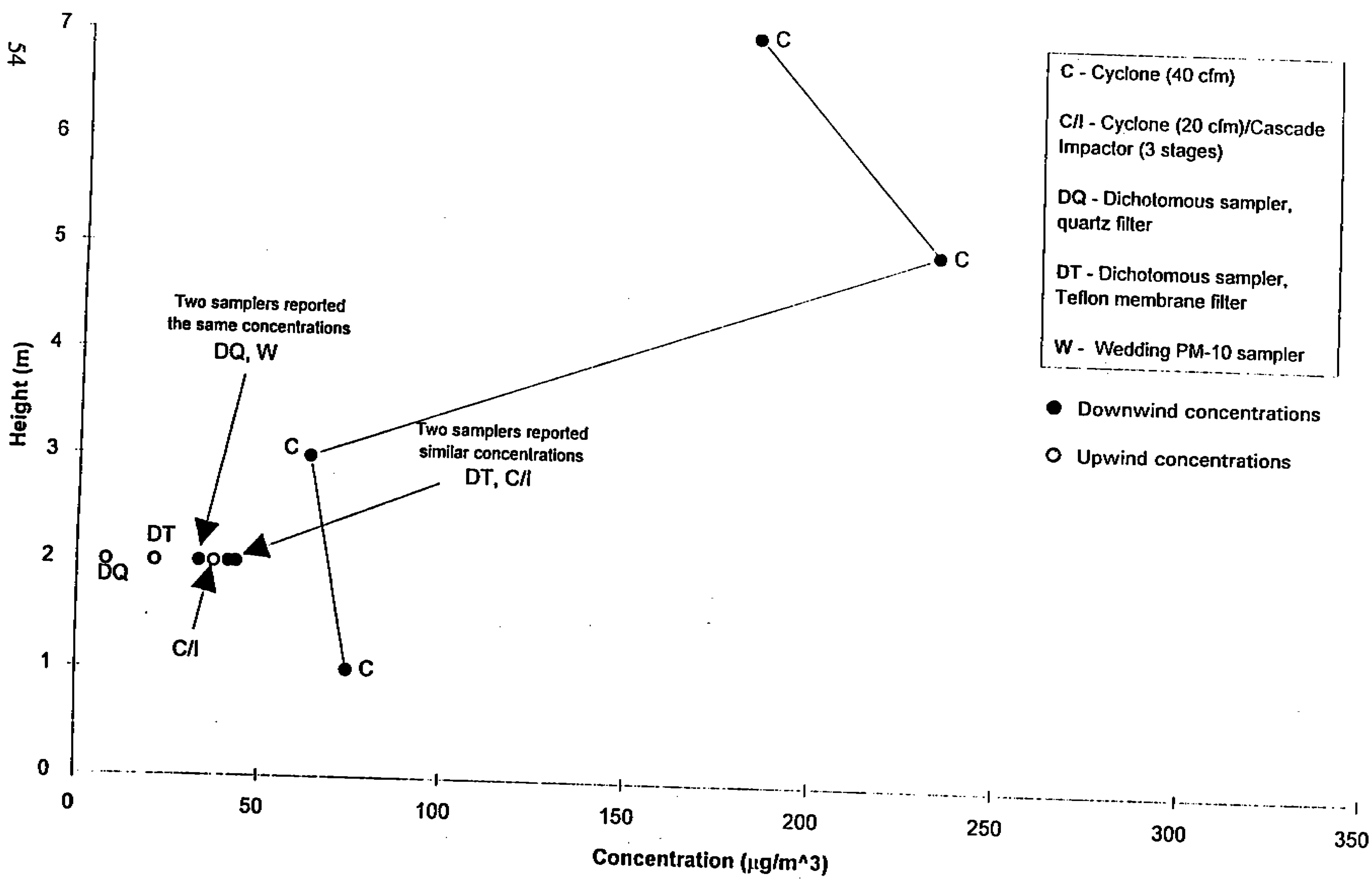

Figure 5-1. Upwind/Downwind PM-10 Concentration Profiles for Run BH-1

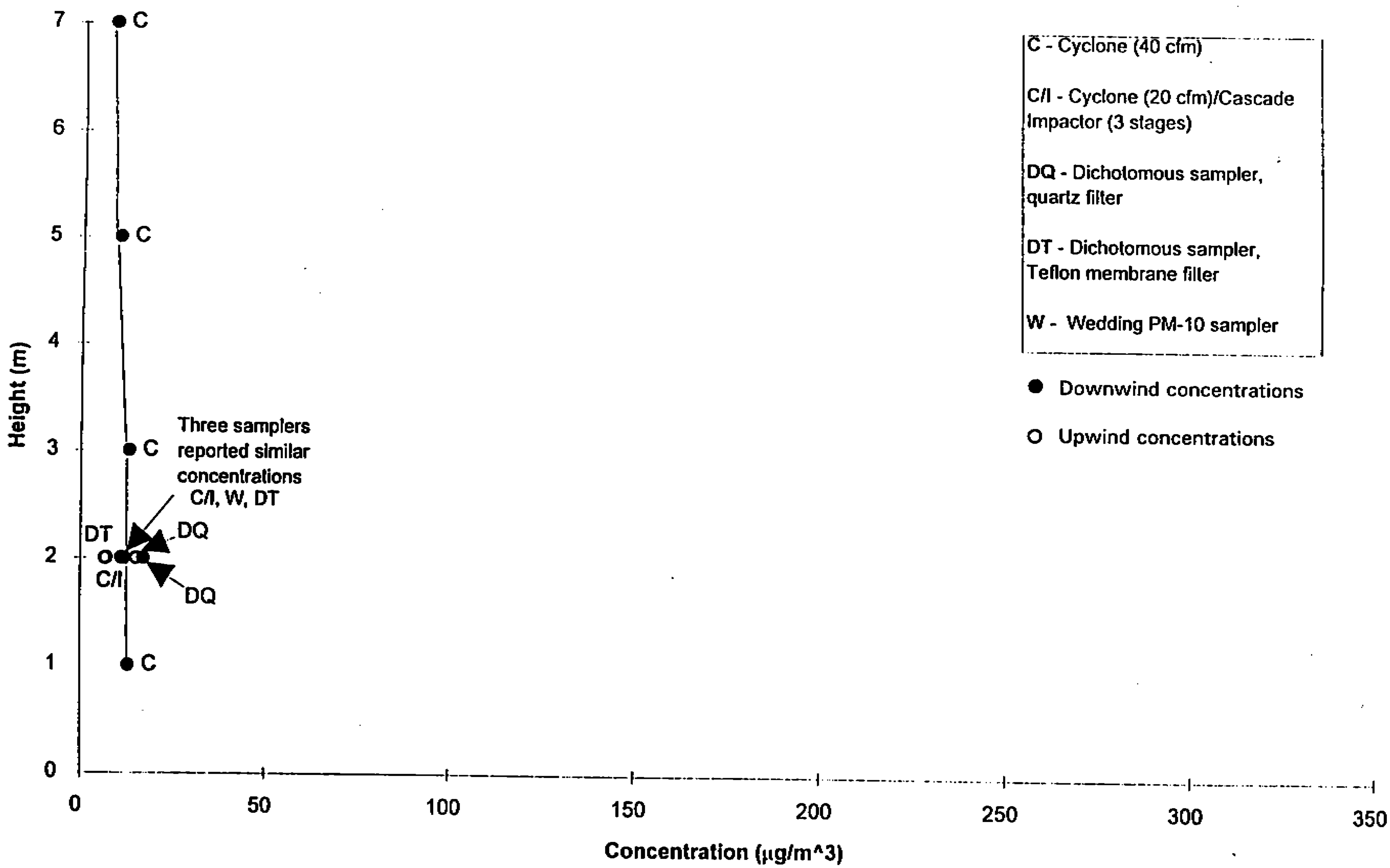

Figure 5-2. Upwind/Downwind PM-10 Concentration Profiles for Run BH-3

2 m) is not appropriate for representing the full impact of the roadway emission plume. Accordingly, use of the "upwind-downwind" method for back-calculation of the emission rate through the application of a standard atmospheric dispersion model would significantly underestimate the emission rate, if the monitored concentration is taken to represent plume core conditions.

The low PM-10 concentration values determined from the dichotomous sampler with the quartz filters may be indicative of the problems with fiber loss during filter handling. This problem is causing EPA to specify only Teflon filters in the new reference method that is being developed for PM-2.5 (Merrifield, 1996). The method PM-2.5 reference will utilize a flow rate and an inlet design identical to the dichotomous sampler.

Table 5-5 shows the average PM-2.5 concentrations measured upwind and downwind of the test road. The comments made about bolded and unbolded values and about upper and lower limits in relation to Table 5-4 also apply to Table 5-5.

It is clear from Table 5-5 that the cyclone/impactor tends to yield PM-2.5 concentration values that are higher than those given by the dichotomous samplers. The problem with low concentrations from the dichotomous samplers with quartz filters persists. For the tests with the most suitable wind conditions (runs BH-2 and BH-3), the downwind PM-2.5 concentrations show only slight increases above background levels.

Table 5-5. PM 2.5 Concentrations (μg/m³)—Denver Paved Roads[a]

Run	Background			Downwind		
	C/I (2 m)	DT (2 m)	DQ (2 m)	C/I (2 m)	DT (2 m)	DQ (2 m)
BH-1	33	10	>0 <3.7	27	8.3	4.1
BH-2	6.1	3.7	>0 <2.0	9.3	7.4	>0 <2.0
BH-3	5.1	5.6	7.4	6.4	1.9	3.7
BH-6	20	5.6	>0 <3.1	24	>0 <1.4	22

C/I = Cyclone/impactor (cutpoint = 2.1 μm)
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)

[a] Numbers in parentheses are sampling heights.

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 5-6. Once again, the downwind percentages are higher for the cascade impactor than for the dichotomous samplers. The relatively low values for Run BH-6 reflect the presence of large plume impact at the 2-m sampling height, enhanced by the sand application early in the test.

Table 5-6. Percentage of PM-2.5 in PM-10—Denver Paved Road[a]

	Background			Downwind		
Run	C/I[b] (2 m)	DT (2 m)	DQ (2 m)	C/I[b] (2 m)	DT (2 m)	DQ (2 m)
BH-1	92	48	47	63	20	12
BH-2	62	22	54	58	34	11
BH-3	72	84	49	58	16	22
BH-6	38	13	7	34	3	22

[a] Numbers in parentheses are sampling heights.
[b] PM-2.1 as a percentage of PM-10.2.

The PM-10 emission factors calculated from the test data are shown in Table 5-7. They span nearly two orders of magnitude. The measured factors are compared with those calculated from the AP-42 predictive emission factor equation for paved roads. An average vehicle weight of 2.2 tons was used as input to the AP-42 equation, along with silt loading values from Table 5-3.

A multiplier of 0.707 was incorporated into the calculated emission factor to reflect an average angle of about 45 degrees between the wind direction and the road direction. This correction was needed because omnidirectional cup anemometers were used to measure wind speed. In effect, the multiplier provided the component of wind speed normal to the road direction.

Table 5-7. PM-10 Emission Factor Comparison—Denver Paved Roads

Run	Avg. Veh Wt (tons)	sL (g/m²)	PM-10 Emission Factor: Predicted (AP-42) (g/VMT)	Predicted (AP-42) (g/VKT)	Observed (g/VKT)	Ratio of Predicted (AP-42) to Observed
BH-1	2.2	0.184[a]	0.977	0.613	1.08	0.57
BH-2	2.2	0.0127	0.172	0.108	0.102	1.06
BH-6	2.2	1.47	3.77	2.36	4.68	0.50

sL = Silt loading
a Based on road surface sample collected at end of test.

As indicated in Table 5-7, the measured PM-10 emission factors generally exceed the values predicted by the AP-42 equation. However, the ratios are well within the normal range of predictive capability for the equation. This result supports the use of silt loading as a predictor of PM-10 emissions. In other words, the large variation in emission factor is attributable to the large variation in silt loading which in turn reflects the time since sand application.

5.2 Raleigh, North Carolina

This section summarizes the results of field testing of dust emissions from a paved road in Raleigh, North Carolina. The test road was an east-west section of Western Boulevard at the 3600 block, adjacent to the campus of North Carolina State University. The roadway was divided by a median.

5.2.1 Test Parameters

Table 5-8 lists the types and deployment of sampling equipment used at the Raleigh paved road test site. The test conditions are shown in Table 5-9. Note that a single composite surface sample was collected on a Sunday morning approximately two weeks after emission testing was completed. At that time the semester at nearby North Carolina State University had ended, so that the traffic lanes could be safely blocked for surface sampling.

Table 5-8. Equipment Deployment—Raleigh Paved Road

Upwind Station: 10 to 15 m from upwind edge of road		
Sampler	**Flow**	**Intake Height**
Cyclone/impactor	20 cfm	2.0 m, 6.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	3.0 m

Downwind Station: 5 m from downwind edge of road		
Sampler	**Flow**	**Intake Height**
Cyclone/impactor	20 cfm	2.0 m, 6.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	2.0 m, 6.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	2.0 m, 6.0 m
Wedding PM-10 monitor	40 cfm	2.0 m

Table 5-9. Test Conditions—Raleigh Paved Road

						Wind Speed (mph) at Indicated Height			Road Surface Properties		
Run No.	Date	Start Time[a]	Sampling Duration (min)[b]	Vehicle Passes	Temp (°F)	1 m	3 m	5 m	s (%)	L (g/m²)	sL (g/m²)
BJ-6	4/25/96	10:12	450	14,670	71	5.9	7.7	8.7	52	0.115	0.060
BJ-7	4/26/96	9:10	143	3,748	68	7.7	8.8	9.9	52	0.115	0.060
BJ-9	4/29/96	9:34	178	4,616	71	4.2	4.9	5.6	52	0.115	0.060
BJ-10	5/1/96	12:51	288	10,218	68	3.0	3.8	4.0	52	0.115	0.060
BJ-11	5/3/96	8:54	387	13,216	75	3.7	4.6	5.5	52	0.115	0.060

[a] Nominal start time for downwind sampler.
[b] Based on downwind sampler operating period.
[c] Based on single composite sample (see text).
L = Loading (g/m2)
s = Silt content (%)
sL = Silt loading (g/m2)

5.2.2 Particulate Concentrations

Table 5-10 shows the average PM-10 concentrations measured upwind and downwind of the test road. Bolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least three times the standard deviation of the applicable blank values. Unbolded values indicate instances where each of the component sample masses is at least one standard deviation of the applicable blank correction. Values preceded by < should be interpreted as follows:

Table 5-10. Paved PM-10 Concentrations (μg/m³)—Raleigh Paved Road[a]

	Background			Downwind						
Run	C/I (2 m)	C/I (6 m)	DQ (3 m)	C/I (2 m)	DT (2 m)	DQ (2 m)	C/I (6 m)	DT (6 m)	DQ (6 m)	W (2 m)
BJ-6	>8.3 <30	>9.4 <32	30	>19 <46	37	32	>16 <43	29	81	17
BJ-7	>22 <95	>22 <95	NA	>38 <116	70	86	>68 <146	59	106	20
BJ-9	>50 <82	>131 <195	58	>17 <85	50	47	>32 <83	27	87	22
BJ-10	>4.9 <42	>8.0 <45	61	>14 <55	21	67	>7.7 <49	21	>31 <35	16
BJ-11	>16 <44	>9.9 <38	NA	>19 <50	31	57	>13 <44	34	63	23

C/I = Cyclone/impactor
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
C = Cyclone
W = Wedding PM-10 sampler
[a] Numbers in parentheses are sampling heights.

1. For samplers with only one collection filter/substrate of interest (e.g., cyclones and Wedding PM-10 samplers), < indicates that the blank corrected sample weight is less than the standard deviation of the applicable blank values. The standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

2. For samples with multiple collection filters/substrates (e.g., cyclone/impactors and dichotomous samplers), < indicates that all of the corrected net filter/substrate weights are less than the respective standard deviations of the applicable blank values. For each filter/substrate, the standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

In some cases, both an upper limit (preceded by a <) and a lower limit (preceded by a >) are provided for samplers with more than one collection substrate. In these cases, at least one blank corrected net filter weight exceeds the standard deviation of the blank values for the specific test run, sampling device and collection medium in question. To determine the lower concentration limit, zero net filter weights are used for any filter/ substrate for which the actual net filter weight is less than the standard deviation of the applicable blank values.

As shown in Table 5-10, agreement in PM-10 concentration between various types of samplers was mixed. The dichotomous samplers with the quartz filters (DQ) generally measured PM-10 concentrations that were significantly higher than the other samplers, especially at the 6-m height, where in all but one case (Run BJ-10) the DQ value substantially exceeded the value at a height of 2 m. Also the PM-10 concentration measured by the Wedding sampler (at the 2-m height) was consistently lower than any of the other downwind samples; this effect was more pronounced here than at any of the other test sites. These observations are illustrated in Figure 5-3 (reproduced from Appendix A), which shows that upwind and downwind PM-10 concentration profiles from Run BJ-6.

Table 5-11 shows the average PM-2.5 concentrations measured upwind and downwind of the test road. The comments made about bolded and unbolded values and about upper and lower limits in relation to Table 5-10 also apply to Table 5-11.

The values of PM-2.5 concentration measured by the cyclone impactors are consistently higher than those measured by the dichotomous samplers, with the values for dichotomous samplers with quartz filters exceeding those for dichotomous samplers with Teflon filters.

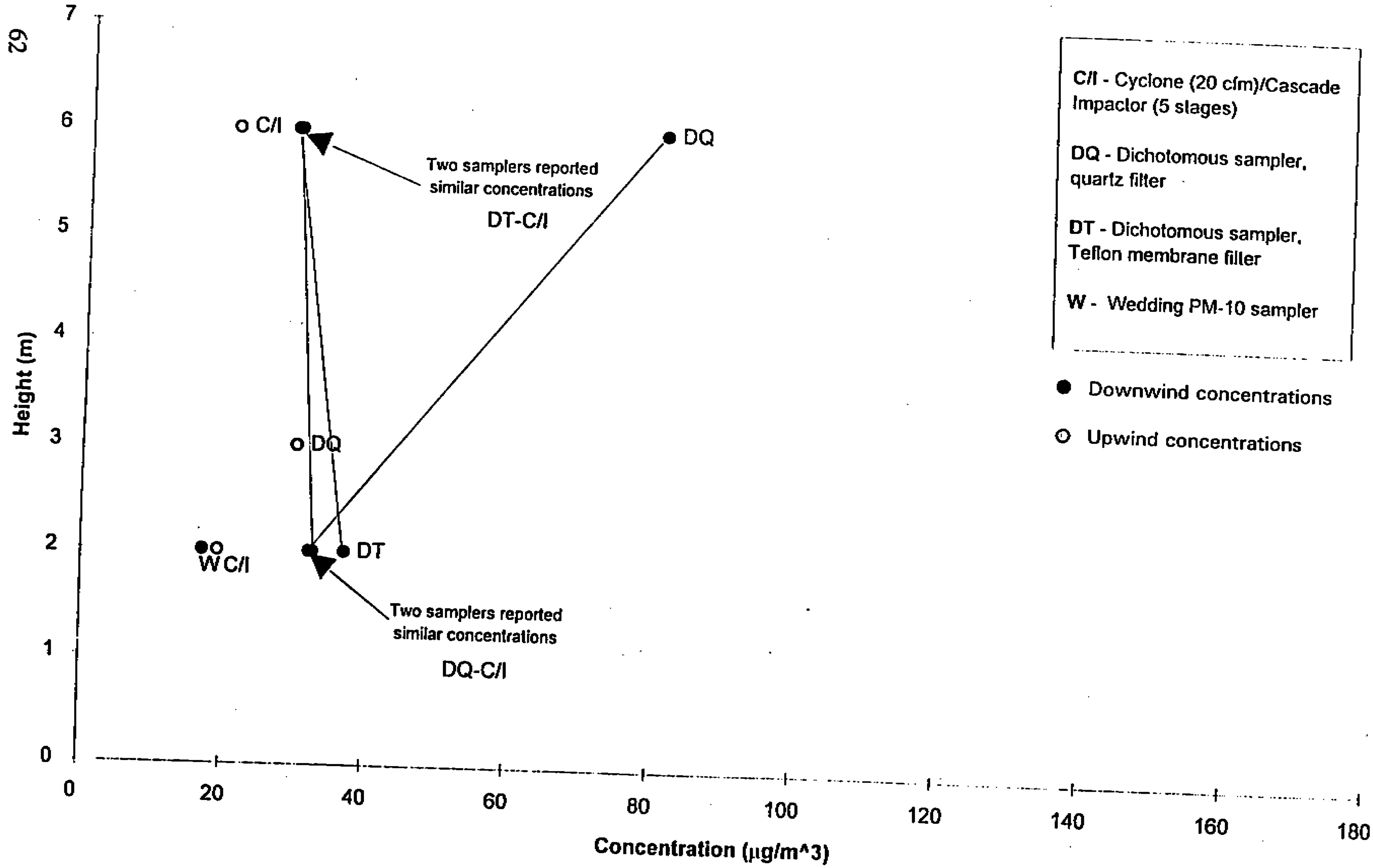

Figure 5-3. Upwind/Downwind PM-10 Concentration Profiles for Run BJ-6

Table 5-11. Paved PM-2.5 Concentrations (μg/m³)—Raleigh Paved Road[a]

	Background			Downwind					
Run	C/I (2 m)	C/I (6 m)	DQ (3 m)	C/I (2 m)	DT (2 m)	DQ (2 m)	C/I (6 m)	DT (6 m)	DQ (6 m)
BJ-6	>8.3 <19	>9.4 <21	6.9	>19 <32	10	13	>16 <29	10	13
BJ-7	>22 <58	>22 <58	NA	>38 <77	22	35	>68 <107	26	39
BJ-9	>15 <47	>131 <163	29	>17 <51	15	15	>15 <48	3.8	26
BJ-10	>4.9 <24	>8.0 <27	19	>14 <35	9.3	46	>7.7 <29	6.9	>0 <3.7
BJ-11	>16 <30	>9.9 <24	NA	>19 <34	21	28	>13 <58	16	31

C/I = Cyclone/impactor (cutpoint = μm)
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
[a] Numbers in parentheses are sampling heights.

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 5-12. The cascade impactors show consistently higher percentages of PM-2.5 in PM-10 than do the dichotomous samplers. The upwind and downwind percentages for the same type of sampler are very similar. This reflects the small plume impact in comparison with the background level, which in turn is indicative of the clean surface condition (low silt loading) of the test road.

Table 5-12. Percentage of PM-2.5 in PM-10—Raleigh Paved Road[a]

	Background			Downwind					
Run	C/I[b] (2 m)	C/I[b] (6 m)	DQ (3 m)	C/I (2 m)	DT (2 m)	DQ (2 m)	C/I[b] (6 m)	DT (6 m)	DQ (6 m)
BJ-6	71	73	23	78	27	41	76	34	16
BJ-7	68	68	NA	75	44	41	82	44	37
BJ-9	47	90	50	67	60	32	55	14	30
BJ-10	62	66	31	71	44	69	51	33	11
BJ-11	77	71	NA	77	68	49	125	47	49

[a] Numbers in parentheses are sampling heights.
[b] PM-2.1 as a percentage of PM-10.2.

Table 5-13 presents the "observed" PM-10 emission factors that were calculated from the exposure profiling data. These values are compared with those predicted using the AP-42 emission factor equation for paved roads. Small plume impacts observed for Runs BJ-9, 10, and 11 did not permit reliable calculation of the PM-10 emission factors for these tests. Only the ratio for Run BJ-6 was within the normal predictive capability of the equation.

Table 5-13. PM-10 Emission Factor Comparison—Raleigh Paved Road

Run	Avg Veh Wt (tons)	Silt Loading (%)	PM-10 Emission Factor		Ratio of Predicted (AP-42) to Observed
			AP-42 (g/VKT)	Observed (g/VKT)	
BJ-6	2.2	0.060	0.26	0.301	0.86
BJ-7	2.2	0.060	0.26	1.94	0.13

A multiplier of 0.707 was incorporated into the calculated emission factor to reflect an average angle of about 45 degrees between the wind direction and the road direction. This correction was needed because omnidirectional cup anemometers were used to measure wind speed. In effect, the multiplier provided the component of wind speed normal to the road direction.

It should be noted, however, that traffic flow could not be diverted so that the silt loading on the road surface could be measured on the test days. The silt loading measurement was obtained on a Sunday after classes had been adjourned at North Carolina State University.

5.3 Reno, Nevada

Field testing was performed in Reno, Nevada, during late May and early June 1996. The paved road site was one that Washoe County had characterized for its annual silt loading cycle. It was located on Virginia Street north of Parr Boulevard.

5.3.1 Test Parameters

The sampling array is described in Table 5-14. The array featured colocated downwind dichotomous samplers, so that the reproducibility of the test results from that type of sampler could be evaluated. The test conditions are shown in Table 5-15. Note that the road surface sampling was performed by Washoe County personnel on June 13, 1996. The reported surface properties were averages of results obtained from two samples collected on that day.

Table 5-14. Equipment Deployment—Reno Paved Road

Upwind Station: 10 to 15 m from upwind edge of road		
Sampler	**Flow**	**Intake Height**
Cyclone/Impactor	20 cfm	2.0 m, 6.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	3.0 m
Wedding PM-10 monitor	40 cfm	2.0 m
Downwind Station: 5 m from downwind edge of road		
Sampler	**Flow**	**Intake Height**
Cyclone/impactor	20 cfm	1.5 m, 3.0 m
Dichotomous sampler (Teflon filters)	16.7 lpm	3.0 m
Dichotomous sampler (quartz filters)	16.7 lpm	3.0 m
Cyclone/impactor	20 cfm	1.0 m, 3.0 m, 5.0 m, 7.0 m
Wedding PM-10 monitor	40 cfm	2.0 m

Table 5-15. Test Conditions—Reno Paved Road

						Wind Speed (mph)			Road Surface Properties		
Run No.	Date	Start Time[a]	Sampling Duration (min)[b]	Vehicle Passes	Temp (°F)	1 m	3 m	5 m	s (%)	L (g/m^2)	sL (g/m^2)
BK-7	6/3/96	12:17	420	7,394	89	5.6	6.9	7.6	3.4	2.4	0.082
BK-8	6/4/96	14:47	270	5,747	87	4.5	5.8	6.4	3.4	2.4	0.082
BK-9	6/6/96	14:45	240	4,622	90	1.6	2.4	2.8	3.4	2.4	0.082

[a] Nominal start time for downwind sampler.
[b] Based on downwind sampler operating period.
L = Loading (g/m2)
s = Silt content (%)
sL = Silt loading (g/m2)

5.3.2 Particulate Concentrations

Table 5-16 shows the average PM-10 concentrations measured upwind and downwind of the test road. Bolded values indicate instances where the blank corrected net filter/substrate weight for each component of the sample is at least three times the standard deviation of the applicable blank values. Unbolded values indicate instances where each of the component sample masses is at least one standard deviation of the applicable blank correction. Values preceded by < should be interpreted as follows:

1. For samplers with only one collection filter/substrate of interest (e.g., cyclones and Wedding PM-10 samplers), < indicates that the blank corrected sample weight is less than the standard deviation of the applicable blank values. The standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

2. For samples with multiple collection filters/substrates (e.g., cyclone/impactors and dichotomous samplers), < indicates that all of the corrected net filter/substrate weights are less than the respective standard deviations of the applicable blank values. For each filter/substrate, the standard deviation of the blank values is used in place of the net filter weight to calculate the concentration. This represents the estimated upper limit of the PM-10 concentration.

In some cases, both an upper limit (preceded by a <) and a lower limit (preceded by a >) are provided for samplers with more than one collection substrate. In these cases, at least one blank corrected net filter weight exceeds the standard deviation of the blank values for the specific test run, sampling device and collection medium in question. To determine the lower concentration limit, zero net filter weights are used for any filter/ substrate for which the actual net filter weight is less than the standard deviation of the applicable blank values.

Table 5-16. PM-10 Concentrations (μg/m³)—Reno Paved Road[a]

Run	Background				Downwind										
	C/I (2 m)	C/I (6 m)	DT (3 m)	W (2 m)	C/I (1.5 m)	C/I (3 m)	DT (3 m)	DT (3 m)	DQ (3 m)	DQ (3 m)	C (1 m)	C (3 m)	C (5 m)	C (7 m)	W (2 m)
BK-7	24	34	22	20	>33 <34	31	38	34	31	51	33	25	23	28	29
BK-8	33	35	22	17	>33 <37	>22 <28	38	44	27	42	33	21	23	26	26
BK-9	36	>24 <26	21	23	>24 <31	>21 <27	22	22	30	25	30	24	17	20	24

C/I = Cyclone/impactor
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
C = Cyclone
[a] Numbers in parentheses are sampling heights.

The dichotomous samplers consistently measured significantly higher downwind PM-10 concentrations than either the cyclones or cyclone/impactors, which tended to agree rather well. The agreement between the colocated dichotomous samplers with Teflon filters was much better than between dichotomous samplers with quartz filters. These observations are illustrated in Figure 5-4 (reproduced from Appendix A), which shows the upwind and downwind PM-10 concentrations from Run BK-7.

Table 5-17 shows the average PM-2.5 concentrations measured upwind and downwind of the test road. The comments made about bolded and other values and about upper and lower limits in relation to Table 5-16 also apply to Table 5-17.

The percentages of PM-2.5 in PM-10 derived from this testing are shown in Table 5-18. As with the other test sites, the percentages measured by cyclone/impactors were consistently higher than percentages measured by the dichotomous samplers.

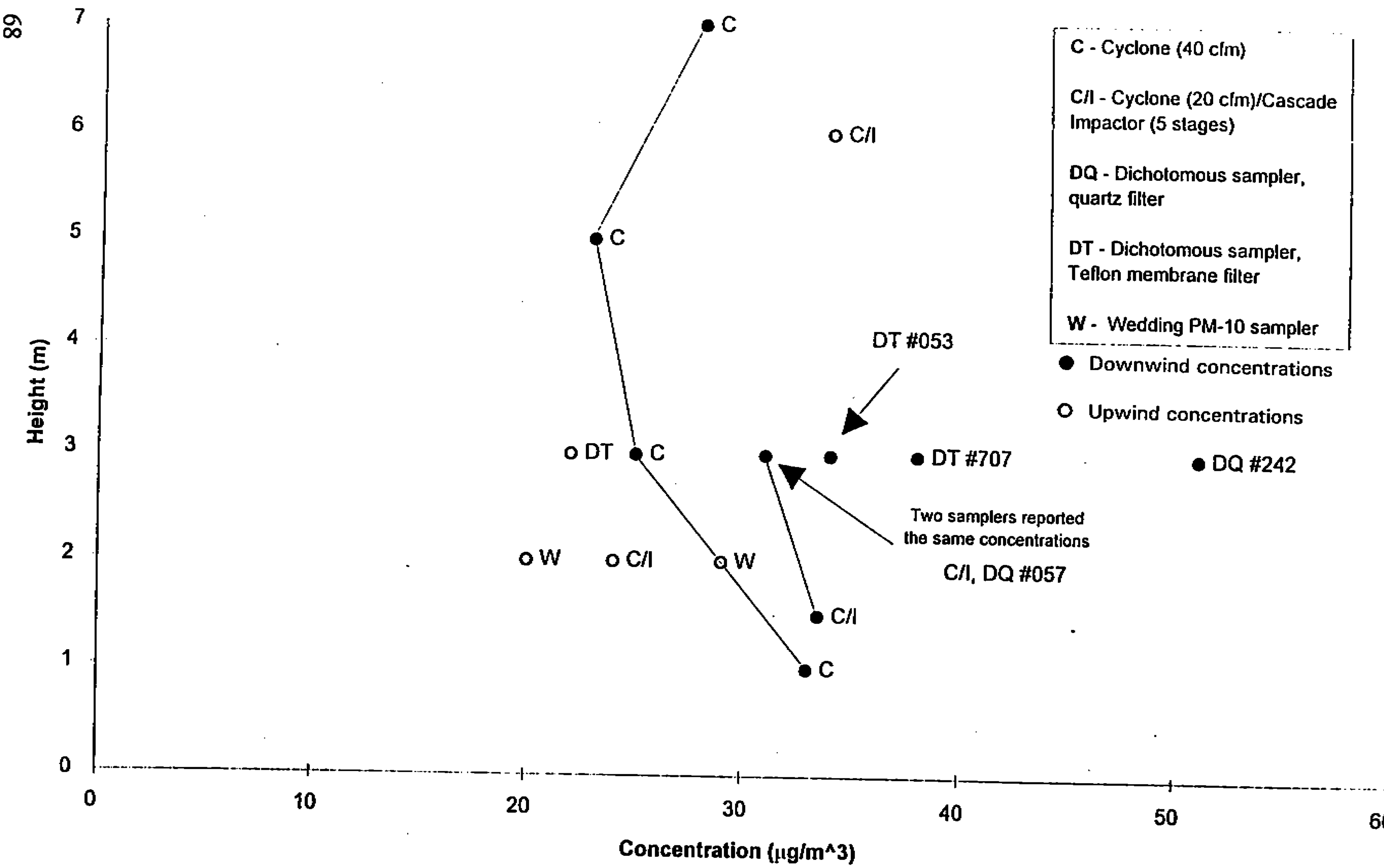

Figure 5-4. Upwind/Downwind PM-10 Concentration Profiles for Run BK-7

Table 5-17. PM-2.5 Concentrations (μg/m³)—Reno Paved Road[a]

	Background			Downwind					
Run	C/I (2 m)	C/I (6 m)	DT (3 m)	C/I (1.5 m)	C/I (3 m)	DT #707 (3 m)	DT #053 (3 m)	DQ #057 (3 m)	DQ #242 (3 m)
BK-7	16	18	7.2	>23 <24	20	11	11	9.5	4.8
BK-8	22	24	6.6	>22 <24	>18 <22	9.9	15	12	7.4
BK-9	23	>17 <19	7.7	>20 <24	>13 <17	2.8	8.3	14	14

C/I = Cyclone/impactor (cutpoint = 2.1 μm)
DT = Dichotomous sampler (Teflon filters)
DQ = Dichotomous sampler (quartz filters)
[a] Numbers in parentheses are sampling heights.

Table 5-18. Percentage of PM-2.5 in PM-10—Reno Paved Road[a]

	Background			Downwind					
Run	C/I[b] (2 m)	C/I[b] (6 m)	DT (3 m)	C/I[b] (1.5 m)	C/I[b] (3 m)	DT #707 (3 m)	DT #053 (3 m)	DQ #057 (3 m)	DQ #242 (3 m)
BK-7	67	53	33	70	65	29	33	31	9
BK-8	67	69	30	66	80	26	34	44	18
BK-9	64	72	37	80	63	13	38	47	56

[a] Numbers in parentheses are sampling heights.
[b] PM-2.1 as a percentage of PM-10.2.

Table 5-19 presents the "observed" PM-10 emission factors that were calculated from the exposure profiling data. These values are compared with those predicted using the AP-42 emission factor equation for unpaved roads. In both cases, the ratios of predicted to observed emission factors were within the normal predictive capability of the equation. The very light wind conditions encountered during Run BK-9 caused insignificant differences between upwind and downwind PM-10 concentrations so that no emission factor could be calculated from the test data.

A multiplier of 0.707 was incorporated into the calculated emission factor to reflect an average angle of about 45 degrees between the wind direction and the road direction. This correction was needed because omnidirectional cup anemometers were used to measure wind speed. In effect, the multiplier provided the component of wind speed normal to the road direction.

Table 5-19. PM-10 Emission Factor Comparison—Reno Paved Road

Run	Avg. Veh. Wt. (tons)	Silt Loading (%)	PM-10 Emission Factor: AP-42 (g/VKT)	PM-10 Emission Factor: Observed (g/VKT)	Ratio of Predicted (AP-42) to Observed
BK-7	2.2	0.082	0.31	0.57	0.54
BK-8	2.2	0.082	0.31	0.44	0.70

Section 6
Evaluation of Test Results

In this section, the most reliable PM-2.5/PM-10 ratios for emissions from paved and unpaved roads are presented. Then the observed emission factors (as calculated from exposure profiling test data) are compared with the predictions of the AP-42 emission factor equations. Next the chemical profiles of unpaved road dust are discussed. Finally, the differences in PM-2.5 and PM-10 concentrations as a function of sampler type are assessed.

6.1 PM-10/PM-2.5 Concentration Data

This subsection describes the procedures used to select the most reliable data for calculating PM-2.5/PM-10 ratios attributable to the roadway emission plumes.

6.1.1 Data Reliability

The amount of sample mass on a collection stage of a particle sizing device is dependent on the number of stages, which in effect subdivide the total mass collected by the device. As indicated in Table 3-1, the only PM-10 samplers with single collection stages are the high-volume sampler with the cyclone inlet and the high-volume sampler with the Wedding inlet. The dichotomous samplers have two collection stages (i.e., coarse and fine fraction filters) for measurement of PM-10 concentration, and the cyclone/impactors have either five stages (four impactor substrates plus back-up filter) or three stages (two impactor substrates plus back-up filter). In the last case, the final two impaction stages (cutpoints of 1.4 μmA and 0.7 μmA) are removed so that the back-up filter represents PM-2.1 (see Table 3-1).

As indicated in the Sections 4 and 5, the measured PM-10 and PM-2.5 concentrations have been placed into three categories of reliability. This entailed comparing the sample mass on each collection stage (filter or impaction substrate) with the standard deviation of the blank values for that collection medium.

The data reliability in the attached tables is as follows:

- **Bolded numbers**: concentration values derived from component sample masses that were all more than three times the standard deviation of the blank values for the collection materials in question. [In the Kansas City data tables, unbolded numbers met this criterion.]

- **"<" numbers**: concentration values derived from component sample mass at least one of which was less than one times the standard deviation of the blank values for the collection materials. [In the Kansas City data tables, less than three times the standard deviation was used.]

The remaining table entries represent situations where all component sample masses are greater than the standard deviation of the blank values for the collection media in question.

6.1.2 Data Selection Procedure

Once the data reliability determinations were completed, the following procedure was used to determine net concentrations attributable to the roadway emission plumes.

1. Select bolded upwind/downwind concentration pairs (PM-10 or PM-2.5) from the same sampler type and collection medium (and approximately the same sampling height). As a second choice (indicated by an *), allow change in dichotomous sampler collection medium (quartz vs. Teflon) between upwind and downwind sampler. For unpaved roads, exceptions were made in representing the upwind concentration because of its small contribution to the downwind concentration. It is considered highly desirable that at least the sampler types match, because of the observed differences between colocated samplers of different types.

2. For paved roads, eliminate upwind/downwind Criterion 1 concentration pairs with positive differences, of less than 3 $\mu g/m^3$ for PM-10 and less than 1 $\mu g/m^3$ for PM-2.5.

3. For unpaved roads eliminate upwind/downwind Criterion 1 concentration pairs with positive differences of less than 30 $\mu g/m^3$ for PM-10 and less than 10 $\mu g/m^3$ for PM-2.5.

4. For runs with surviving PM-10 and PM-2.5 concentration pairs, determine net PM-10 and PM-2.5 concentration (due to roadway emissions) and find the percentages of PM-2.5 and PM-10 from the roadway emissions.

It should be noted that further analysis of the data can be performed to set lower limits on the "<" concentration values. This can be done by adding together all component masses that meet retention criteria, as the basis for calculating the concentration floor.

6.1.3 PM-2.5/PM-10 Ratios—Paved Roads

The results of these calculations for paved roads are shown in Table 6-1. Primarily because of the relatively small plume impacts on downwind air quality, only a few test runs yielded PM-10 and PM-2.5 concentration pairs that met all of the above criteria. Most of these pairs came from dichotomous samplers, as opposed to cyclone/impactors.

Although cyclone/impactors collect much larger PM-10 and PM-2.5 sample masses, the samples are distributed over multiple collection surfaces. (In the cyclone/impactor the PM-10 sampler mass is distributed over the last four cascade impactor collection substrates plus the back-up filter, and the PM-2.5 sample mass is distributed over the last two impactor substrates plus the back-up filter). In addition, the individual media are of much larger size and have much higher tare weights.

Moreover, samples from more than one test could not be composited on the same impaction substrates because this would have required leaving the substrates in place overnight. Previous field experience with the substrates had shown that fiber loss might have occurred when the substrates were finally removed, because of the prolonged contact with the filter holder.

As expected, the test runs showing the greatest paved roadway impacts on air quality (reflecting a dominant contribution of resuspended road dust) also showed the lowest percentages of PM-2.5 in PM-10. In Denver, for example, Run BH-2 on I-225 had a low net PM-10 concentration (5 $\mu g/m^3$) and a high percentage of PM-2.5 in PM-10 (74%). On the other hand, Run BH-6 on the freshly sanded center city arterial showed a high net PM-10 concentration (18-58 $\mu g/m^3$) and a low percentage of PM-2.5 in PM-10 (22-28%).

Table 6-1. Selected Concentration Pairs (micrograms per cubic meter)—Paved Roads

		PM-10 (Based on min difference of 3)					PM-2.5 (Based on min difference of 1)					
		Background		Downwind		Difference	Background		Downwind		Difference	Percentage of PM-2.5 in PM-10
Raleigh	BJ-6	* DQ/3 m	30	DT/2 m	37	7	* DQ/3 m	6.9	DT/2 m	10	3.1	44
			30	DQ/6 m	81	51	*	6.9	DQ/6 m	13	6.1	12
Reno	BK-7	DT/3 m	22	DT/3 m	36	14	DT/3 m	7.2	DT/3 m	11	3.8	27
				DQ/3 m	31	9			DQ/3m	9.5	2.3	26
	BK-8	DT/3 m	22	DT/3 m	41	19	* DT/3 m	6.6	DT/3 m	12.45	5.85	31
		*	22	DQ/3 m	34.5	12.5	*	6.6	DQ/3 m	9.7	3.1	25
	BK-9	* DT/3 m	21	DQ/3 m	27.5	6.5	DT/3 m	7.7	DQ/3 m	14	6.3	97
Denver	BH-1	DQ/2m	4.8	DQ/2 m	33	28	DQ/2 m	1.9	DQ/2 m	4.1	2.2	8[a]
	BH-2	DT/2 m	17	DT/2 m	22	5	DT/2 m	3.7	DT/2 m	7.4	3.7	74
	BH-6	C/I/2 m	52	C/I/2 m	70	18	C/I/2 m	20	C/I/2 m	24	4	22
		* DT/2 m	42	DQ/2 m	100	58	* DT/2 m	5.6	DQ/2 m	22	16.4	28

* These concentration pairs entailed a difference in the dichotomous sampler filter medium.

[a] This entry is less reliable, because it was derived from "unbolded" concentrations.

As part of the selection of a representative PM-2.5/PM-10 ratio for paved roads, the values from Table 6-1 were plotted against the net downwind PM-10 concentration (as a measure of the intensity of the road dust plume impact). As shown in Figure 6-1, there is no apparent dependence of the PM-2.5/PM-10 ratio on the intensity of plume impact, except for two high ratios that were measured under conditions of very low plume impact and therefore lower reliability. If the other data points (excluding the less reliable value of 8%) are averaged, the result is 23.1%. This value is indistinguishable from 25% as a representative PM-2.5/PM-10 ratio for paved roads.

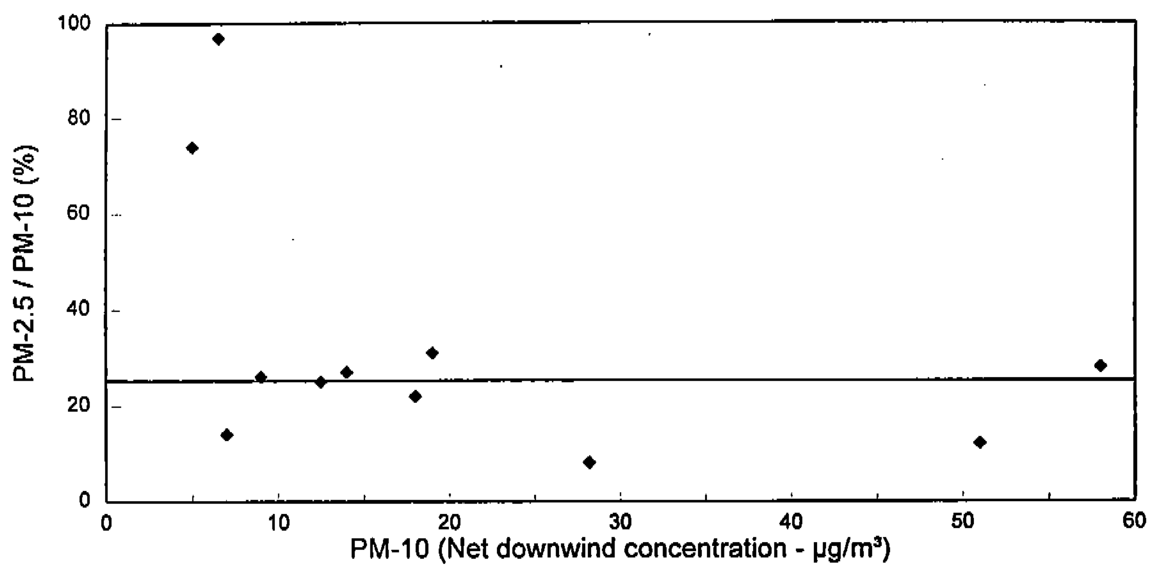

Figure 6-1. Dependence of PM-2.5/PM-10 Ratio on PM-10 Plume Impact

The results obtained by Ron Speer of EPA using the TSI Aerodynamic Particle Sizer at the Raleigh paved road site are shown in Table 6-2. These results, which were derived from downwind monitoring, assumed a density particle of 2.5 g/cm^3. As a matter of convenience, ratios of PM-2.5 to PM-9 were calculated, because 2.55 µm and 8.75 µm constituted the upper ends of two of the particle size intervals used by EPA in tabulating the output data from the device. The PM-2.5/PM-10 ratios, which require interpolation of the output data, would be a few percentage points smaller.

Table 6-2. EPA Particle Sizing Results (Raleigh Paved Road)

Run	Date	Time		Concentration (µg/m³)		PM-2.5/PM-9
		Start	Stop	PM-2.5	PM-9	
BJ-6	4/25/96	1125	1229	3.1	13.1	23%
		1250	1354	2.9	13.3	22%
		1410	1514	2.9	13.3	22%
		1528	1632	2.7	13.4	20%
BJ-7	4/26/96	0925	1029	9.9	30.4	32%
Aborted	5/2/96	1205	1304	3.8	13.7	28%
		1310	1403	3.5	13.8	25%
		1416	1501	3.8	15.9	24%
		1505	1524	3.9	16.2	24%
BJ-11	5/3/96	0930	0957	5.4	18.6	29%
		1000	1054	5.3	19.1	28%
		1107	1201	4.8	18.2	26%
		1212	1300	5.4	19.4	28%
		1310	1400	4.6	17.2	27%

The data obtained by Bruce Harris and Robert McCrillis using a Climet CI-4102 Laser Particle Counter take the form of particle counts in two size ranges (>0.5 µm and >50 µm) over 10 min sampling periods. These data require the use of fundamental assumptions enabling further manipulation before comparisons can be made with the results obtained by the other devices.

Based on the results of these tests, the particle size adjustment factor of 0.25 (or 25%), as recommended in the interim document, is believed to be an appropriate value for paved roads that contribute most to the emission inventory for an urban area. These roads are arterials and feeder roads that tend to combine relatively high silt loadings with relatively high traffic volume.

6.1.4 PM-2.5/PM-10 Ratios—Unpaved Roads

The results of the calculations for unpaved roads are shown in Table 6-3. Because of much larger sample masses, many more test runs yielded PM-10 and PM-2.5 concentration pairs that met all of the above criteria. These came both from cyclone/impactors and dichotomous samplers.

Examination of Table 6-3 shows that the percentages of PM-2.5 in PM-10 fall into two groups. Dichotomous samplers produce consistently lower percentages than cyclone/impactors.

It appears that when dichotomous samplers at the lower sampling heights are exposed to instantaneous PM-10 concentrations in the range of 20,000 $\mu g/m^3$, as each plume from an uncontrolled paved road drifts by the sampler array, the dichotomous sampler inlets accept an inordinate portion of particles larger than 10 µm in diameter. These particles are collected by the coarse fraction filters, so that the PM-10 concentrations are biased high. (For example, at the Kansas City test site, the PM-10 concentration values determined from dichotomous sampler test results were consistently about a factor of two larger than the values measured by the Wedding PM-10 sampler.) The result is that the apparent percentages of PM-2.5 drop significantly.

On the other hand, the cyclone/impactor results for unpaved roads may reflect a positive bias in the percentage of PM-2.5 in PM-10. Any residual particle bounce during periods of high PM-10 concentration (as plumes drift by the samplers) would result in a positive bias in the PM-2.5 concentration, by contributing excess mass to the back-up filter.

Thus, the true particle size multiplier for PM-2.5/PM-10 probably lies between the values yielded by the dichotomous samplers and the cyclones/impactors. Again in this case, the particle size adjustment factor of 0.15 (or 15%), as recommended in the interim document, is believed to be appropriate for unpaved roads.

Table 6-3. Selected Concentration Pairs (micrograms per cubic meter)—Unpaved Roads

			PM-10 (Based on min difference of 30)						PM-2.5 (Based on min difference of 10)					
			Background		Downwind		Difference		Background		Downwind		Difference	Percentage of PM-2.5 in PM-10
Raleigh	BJ-1		DQ/2 m	52	DQ/1 m	1082	1030		DQ/2 m	26	DQ/1 m	100	74	7
		*		52	DT/1 m	951	899	*		26	DT/1 m	114	88	10
		*		52	DT/3 m	267	215	*		26	DT/3 m	49	23	11
			C/I/2 m	40	C/I/1 m	827	787		C/I/2 m	26	C/I/1 m	203	177	22
	BJ-2		DQ/2 m	52	DQ/1 m	1082	1030		DQ/2 m	26	DQ/1 m	100	74	7
		*		52	DT/1 m	951	899	*		26	DT/1 m	114	88	10
		*		52	DT/3 m	267	215	*		26	DT/3 m	49	23	11
			C/I/2 m	40	C/I/1 m	796	756		C/I/2 m	26	C/I/1 m	214	188	25
				40	C/I/3 m	198	158			26	C/I/3 m	80	54	34
	BJ-3		DQ/2 m	91	DQ/1 m	807	716		DQ/2 m	19	DQ/1 m	122	103	14
		*		91	DT/1 m	791	700	*		19	DT/1 m	70	51	7
		*		91	DT/3 m	343	252	*		19	DT/3 m	61	42	17
			C/I/2 m	37	C/I/1 m	729	692		C/I/2 m	13	C/I/1 m	185	172	25
	BJ-4	*	DQ/2 m	91	DT/1 m	1519	1428	*	DQ/2 m	19	DT/1 m	130	111	8
		*		91	DT/3 m	343	252	*		19	DT/3 m	61	42	17
			C/I/2 m	37	C/I/1 m	1152	1115		C/I/2 m	13	C/I/1 m	321	308	28
Reno	BK-1/2	*	W/2 m	33	C/I/1 m	1788	1755	*	W/2 m	16.5	C/I/1 m	490	473.5	27
		*		33	C/I/3 m	233	200	*		16.5	C/I/3 m	82	65.5	33
		*		33	DT/2 m	651	618	*		16.5	DT/2 m	67.5	51	8
		*		33	DQ/2 m	898	865	*		16.5	DQ/2 m	67.5	51	6
	BK-3	*	W/2 m	83	C/I/1 m	4426	4343	*	W/2 m	41.5	C/I/1m	1169	1127.5	26
		*		83	C/I/3 m	856	773	*		41.5	C/I/3 m	232	190.5	25
		*		83	DT/2 m	2131	2048	*		41.5	DT/2 m	166.5	125	6
		*		83	DQ/2 m	2475	2392	*		41.5	DQ/2 m	188	146.5	6
	BK-4	*	W/2 m	83	C/I/1 m	8832	8749	*	W/2 m	41.5	C/I/1m	2072	2030.5	23
		*		83	C/I/3 m	856	773	*		41.5	C/I/3 m	232	190.5	25
		*		83	DT/2 m	2131	2048	*		41.5	DT/2 m	166.5	125	6
		*		83	DQ/2 m	2475	2392	*		41.5	DQ 2 m	188	146.5	6
Kansas City	BG-1		C/I/3 m	22	C/I/3 m	256	234		C/I/3 m	10	C/I/3 m	49	39	17
		*		22	C/I/1.5 m	548	526	*		10	C/I/1.5 m	140	130	25
		*		22	C/I/4.5 m	111	89	*		10	C/I/4.5 m	21	11	12
	BG-2		DT/3 m	51	DT/3 m	823	772		DT/3 m	11	DT/3 m	64	53	7
		*		51	DQ/1.5 m	1929	1878	*		11	DQ/1.5 m	44	33	2
		*		51	DT/1.5 m	1799	1748	*		11	DT/1.5 m	38	27	2
			C/I/3 m	24	C/I/3 m	453	429		C/I/3 m	9	C/I/3 m	124	115	27
		*		24	C/I/1.5 m	779	755	*		9	C/I/1.5 m	224	215	28
	BG-3	*	DT/3 m	51	DQ/1.5 m	2161	2110	*	DT/3 m	11	DQ/1.5 m	44	33	2
		*		51	DT/1.5 m	2257	2206	*		11	DT/1.5 m	39	28	1
			C/I/3 m	24	C/I/3 m	423	399		C/I/3 m	9	C/I/3 m	101	92	23
		*		24	C/I/1.5 m	1267	1243	*		9	C/I/1.5 m	318	309	25
	BG-4	*	C/I/3 m	23	C/I/1.5	244	221	*	C/I/3 m	18	C/I/3 m	93	75	34
	BG-5		C/I/3 m	23	C/I/3 m	172	149		C/I/3 m	18	C/I/3 m	37	19	13
		*		23	C/I/1/5 m	305	282	*		18	C/I/1.5 m	71	53	19
		*		23	C/I/4.5 m	86	63	*		18	C/I/4.5 m	45	27	4

* These concentration pairs entailed a difference in the dichotomous sampler filter medium.

6.2 Emission Factor Comparison

This study also provided new PM-10 emission factor data sets to test the reliability of the AP-42 equations in predicting the measured test results. The exposure profiling calculation scheme described in Section 3.5 was used to derive emission factors from the samplers operated at multiple heights, either cyclones or cyclone/impactors. The comparisons for unpaved roads and paved roads are shown in Tables 6-4 and 6.5, respectively.

In evaluating these comparisons, it is important to note the predictive capabilities of the AP-42 emission factor equations for estimating PM-10 emissions from paved and unpaved roads, as shown in Table 6-6. The 1-σ "confidence interval" represents the error limits that bound approximately two-thirds of the predictions. This is an approximate measure of the average uncertainty of prediction. Similarly, the 2-σ "confidence interval" represents the error limits that bound approximately 95% of the predictions. It should be noted that the average of several predictions approaches the average of corresponding observations, as the number of data points increases.

Examination of Table 6-4 indicates that in only three cases does the ratio of predicted to observed emission factors lie outside the range of predictive capability, i.e., the 95% "confidence interval" of the AP-42 emission factor equation for unpaved roads. The misty conditions of the final test day at the Kansas City area site (Runs BG-4 and BG-5) produced a much higher moisture content of the road surface material than could be associated with the dry test conditions used in developing the AP-42 equation. In addition, the final test at the Reno site (Run BK-4) showed the effects of surface deterioration of the poorly compacted test road; the resultant rutting produced about six times the emissions predicted by the AP-42 emission factor equation.

Table 6-4. Emission Factor Comparison—Unpaved Roads

	Run	Silt (%)	Weight (tons)	Speed (mph)	Wheels	PM-10 Emission Factor: AP-42 (g/VKT)	PM-10 Emission Factor: Observed (g/VKT)	Ratio of Predicted, (AP-42) to Observed
Kansas City	BG-1	7.2	2.0	30	4	265	140	1.9
	BG-2	6.2	2.0	30	4	230	259	0.89
	BG-3	6.1	2.0	30	4	224	313	0.71
	BG-4	7.6	2.0	30	4	279	33	0.12[a]
	BG-5	8.0	2.0	30	4	294	25	0.084[a]
Raleigh	BJ-1	4.0	2.0	30	4	150	350	0.43
	BJ-2	2.9	2.0	30	4	110	360	0.30
	BJ-3	4.3	2.0	30	4	160	240	0.67
	BJ-4	3.7	2.0	30	4	140	370	0.38
Reno	BK-1	7.2	1.5	15	4	110	105	1.05
	BK-2	5.2	1.5	15	4	81	87	0.93
	BK-3	5.9	2.0	15	4	110	420	0.26
	BK-4	6.6	2.0	15	4	120	740	0.16[b]

[a] Damp road surface condition.
[b] Rutted road surface.

Table 6-5. Emission Factor Comparison—Paved Roads

	Run	Silt Loading (g/m^2)	PM-10 Emission Factor: AP-42 (g/VKT)	PM-10 Emission Factor: Observed (g/VKT)	Ratio of Predicted (AP-42) to Observed
Denver	BH-1	0.184	0.613	1.08	0.57
	BH-2	0.0127	0.108	0.102	1.06
	BH-6	1.47	2.36	4.68	0.50
Raleigh	BJ-6	0.060	0.26	0.301	0.86
	BJ-7	0.060	0.26	1.94	0.13
Reno	BK-7	0.082	0.31	0.57	0.54
	BK-8	0.082	0.31	0.44	0.70

Table 6-6. Predictive Capabilities of AP-42 Emission Factor Equations

AP-42 Equation	Confidence Interval		Ratio of Predicted (AP-42) to Observed Emission Factor			
			Inner Bounds		Outer Bounds	
	1-σ	2-σ	Lower Limit	Upper Limit	Lower Limit	Upper Limit
Unpaved roads	factor of 2.3	factor of 4.6	0.43	2.3	0.22	4.6
Paved roads	factor of 4.2	factor of 8.4	0.24	4.2	0.12	8.4

Although poor wind conditions and small plume impacts on downwind air quality prevented calculation of emission factors from the results of several test runs at the paved road sites, the comparisons from the remaining test runs (listed in Table 6-5) showed that the AP-42 emission factor was successful in meeting its normal range of predictive capability. It should be noted that the observed paved road emission factors spanned a factor of 50 in range. Only for Run BJ-7 did the observed emission factor lie at the lower limit of the 95% confidence interval of the AP-42 equation, but this may have been due to the nonrepresentativeness of the silt loading value for that test day. The silt loading sample could not be taken until the road traffic could be safely diverted, several days after the emission testing was completed. Occasional wet road conditions during the 10-day test period could have caused an elevated loading (after drying) during Run BJ-7 because of trackout during the wet period.

In any case, there is little evidence justifying a need to revise the AP-42 emission factor equations for PM-10 emissions from unpaved or paved roads. The revisions to AP-42 should take the form of corrected particle size adjustment factors for PM-2.5, as recommended above.

6.3 Chemical Profiles of Road Dust

This section compares the chemical profiles of samples collected from the unpaved road test site in the Kansas City area. Two types of samples were collected at the site:

1. Airborne samples of PM-10 and PM-2.5. These samples were collected using paired dichotomous samplers, one with quartz fiber filters and one with Teflon filters.

2. Samples of loose road surface material. These samples were resuspended by two laboratory techniques (DRI's resuspension chamber and MRI's dustiness test chamber). Within the chambers, the PM-10 and PM-2.5 components of the resuspended samples of road surface material were collected on Teflon and quartz filters.

The resuspension techniques are described further in Section 4.1.2.

The samples were chemically analyzed by x-ray fluorescence, XRF (Teflon filters), and by thermal/optical reflectance, TOR (quartz filters), for 38 elements and for organic and elemental carbon, respectively. The analyses were performed by DRI at their laboratory facilities in Reno, Nevada. DRI's full report (two letters and attachments) is reproduced in Appendix C.

This phase of the work had two objectives:

1. Chemical fingerprinting of the source emission samples for potential use in receptor modeling.

2. Evaluation of the two resuspension techniques in relation to the process of actual road dust resuspension by vehicle traffic.

The results of the XRF analyses are shown in Tables 6-7 and 6-8 for PM-10 and PM-2.5, respectively. In each case three sets of data are presented:

Table 6-7. Comparison of Chemical Profiles for PM-10

Element	Average Mass Percent in PM-10			
	Airborne Emissions from Road[a]	DRI Resuspension of Road Surface Sample	MRI Resuspension of Road Surface Sample	Preferred Resuspension Technique (MRI or DRI)
Analytical Summary	74.23	56.00	52.74	DRI
Calcium	29.29	34.62	32.96	MRI
Silicon	7.33	9.25	7.71	MRI
Aluminum	1.61	1.88	1.38	MRI
Iron	0.79	1.04	0.91	MRI
Potassium	0.57	0.66	0.58	MRI
Chlorine	0.12	0.40	0.12	MRI
Magnesium	0.39	0.27	3.20	DRI
Sulfur	0.39	0.18	0.20	MRI
Titanium	0.07	0.10	0.09	MRI
Strontium	0.07	0.08	0.07	MRI
Lanthanum	0.00	0.07	0.01	MRI
Copper	0.00	0.06	0.00	MRI
Manganese	0.04	0.06	0.06	DRI
Phosphorus	0.07	0.02	0.04	MRI
Zinc	0.00	0.02	0.00	MRI
Barium	0.01	0.01	0.02	DRI
Silver	0.00	0.00	0.00	MRI

a Collected on the Teflon coarse fraction filter of a downwind dichotomous sampler with an intake height of 1.5 m.

Table 6.8. Comparison of Chemical Profiles for PM-2.5

Element	Average Mass Percent in PM-2.5			
	Airborne Emissions from Road[a]	DRI Resuspension of Road Surface Sample	MRI Resuspension of Road Surface Sample	Preferred Resuspension Technique (MRI or DRI)
Analytical Summary	23.77	45.15	35.43	MRI
Calcium	11.97	22.83	27.23	DRI
Silicon	4.37	8.24	5.40	MRI
Aluminum	0.90	1.20	0.77	MRI
Iron	0.72	1.10	0.93	MRI
Potassium	0.61	0.70	0.53	MRI
Chlorine	0.00	0.49	0.09	MRI
Magnesium	0.18	0.40	0.29	MRI
Sulfur	4.05	0.36	0.30	DRI
Titanium	0.04	0.11	0.10	MRI
Lanthanum	0.09	0.09	0.00	DRI
Copper	0.00	0.07	0.00	MRI
Strontium	0.03	0.06	0.08	DRI
Manganese	0.02	0.05	0.06	DRI
Barium	0.00	0.05	0.01	MRI
Zinc	0.03	0.02	0.00	DRI
Phosphorus	0.00	0.01	0.01	MRI
Lead	0.00	0.01	0.00	MRI
Cadmium	0.00	0.01	0.00	MRI
Silver	0.02	0.01	0.00	DRI

a Collected on the Teflon fine fraction filter of a downwind dichotomous sampler with an intake height of 1.5 m.

1. The analysis results for the samples of airborne particulate emissions collected by the downwind dichotomous samplers with a 1.5 m sampling height at the Kansas City area test location.

2. The analysis results for the samples of resuspended road dust collected in the DRI resuspension chamber.

3. The analysis results for the samples of resuspended road dust collected in the MRI dustiness test chamber.

The elemental concentrations are presented in units of mass percent of the total particulate sample after subtraction of respective filter blank values.

For each element, the appropriateness of the DRI versus the MRI resuspension technique is determined by comparing the average mass percent of the element in the resuspension samples with the average mass percent of the element in the airborne emissions samples collected at the test site. It is clear, that the MRI resuspension method produces chemical fingerprints that more closely match the fingerprints of the samples of airborne emissions.

The tables also show that, in the coarse fraction sample of the airborne emissions, the most concentrated elements (i.e., calcium, silicon, aluminum, and iron) relate to the chemistry of the limestone road surface material. The PM-2.5 component reflects similar chemistry except that sulfur ranks just below calcium and silicon in importance.

6.4 Differences Between Sampler Types

As noted in the presentation of test results in Sections 4 and 5 of this report, samples of one type consistently deviated from samplers of another type, especially in the measurement of PM-10 concentration. Certain differences were prevalent at unpaved road test sites, while others prevailed at paved road test sites. Regarding PM-2.5 measurements, the differences within a class of samplers were as great as the differences between samplers because of the very low sample masses in relation to blank corrections. Generally the cyclone/impactor seemed to produce the most consistent results for PM-10 and agreed most closely with the Wedding reference sampler.

Several unexpected field test findings emerged in this study. Under conditions of high PM-10 concentration (lowest downwind sampling heights at the unpaved road test sites), the dichotomous samplers consistently measured significantly higher concentrations than the cyclone/impactors; however, at the Raleigh unpaved road test site, the cyclone at the 1-m height measured even higher concentrations. Also there was a tendency for the dichotomous sampler with quartz filters to exceed the dichotomous sampler with Teflon filters at the same height, probably because of the tendency to lose non-sticky dust particles during the handling of the Teflon filters.

At the paved road sites, there was even more of an overall tendency for the samplers with quartz filters to measure higher PM-10 concentrations than samplers with Teflon filters. The cyclones tended to measure higher concentrations than the cyclone impactors (which operate at half the flowrate). This appears to be a matter of artifact contribution to the sample mass on quartz, possibly due to atmospheric organics (Chow, 1995).

Another important phenomenon was the elevated PM-10 plume centerline from paved roads under light wind conditions. This result is especially significant when interpreting impacts only from samplers operated at breathing height (1.5-2 m).

The results from downwind colocated dichotomous samplers at the Reno paved and unpaved road test sites are shown in Table 6-9. Range percent is defined as the difference between colocated samplers divided by the average of the two and then multiplied by 100.

Table 6-9. Mean Range Percents for Colocated Dichotomous Samplers (Reno, Nevada)

	Particle Size	Teflon Filters	Quartz Filters
Unpaved Road (Runs BK-1, 2, 3, 4)	PM-10	15.2	5.8
	PM-2.5	39.3	15.2
Paved Road (Runs BK-7, 8, 9)	PM-10	8.6	36.8
	PM-2.5	46.7	37.7

As shown in the table, quartz filters give the better results for PM-10 at the unpaved road sites, while Teflon filters show the better reproducibility at the paved road sites. The sticky particles in vehicle exhaust help to hold the dust to the Teflon filters downwind of paved roads. The reproducibility for PM-2.5 measurement is poor on either Teflon or quartz because of low sample mass.

Section 7
Conclusions and Recommendations

This study entailed the performance of 25 exposure profiling tests to measure PM emissions from representative paved and unpaved roads. Twelve tests were conducted at paved road sites in Denver, Raleigh, and Reno, and 13 tests at unpaved road sites in Kansas City, Raleigh, and Reno. These tests used state-of-the-art techniques and equipment for measurement of open source emissions of PM. The purpose of this study was to evaluate EPA's PM emission factor equations currently in use to estimate emissions from fugitive dust sources. Of particular emphasis were PM-10 (the particle size basis for the current NAAQS) and PM-2.5 (the basis for the proposed revisions to the NAAQS).

The PM-10 emission factors calculated from the test data agreed, in most cases, with the predictions of current AP-42 predictive emission factor equations for paved and unpaved roads, taking into account the ranges of predictive capability of the equations. Exceptions occurred (a) when poorly developed wind conditions resulted in low plume impacts on ambient air quality that were insufficient for reliable calculation of paved road emission factors, and (b) when unpaved road surfaces were either moist (low emissions) or poorly compacted (high emissions). Thus, there is no justification for revising the current equations on the basis of the field test results from this study.

As expected, the reliability of the measured upwind/downwind PM concentrations from the paved roads was substantially less than that of the measured concentrations from the unpaved roads. This resulted primarily from the small plume impacts of paved roads on downwind air quality. The road surface silt loadings of the paved roads were generally well below the default 0.4 g/m^2 recommended for high volume roadways, primarily because of the absence of adjacent track-out sources. The sample masses from the paved road test sites were generally of the order of the blank correction, so that only a relatively small subset of particle size samples qualified for determination of PM-2.5/PM-10 emission ratios.

The problems of low sample mass were accentuated for PM-2.5. This was evident, for example, from the results of colocated dichotomous samples, which showed poor reproducibility of PM-2.5 concentrations at both paved and unpaved road test sites. Generally the quartz fiber filters retained collected PM samples better than the Teflon filters, unless sticky particles such as soot from vehicle exhaust constituted a significant portion of the sample. However, the quartz filters may have shown an artifact effect from adsorbed atmospheric organics.

For measurement of PM-10 concentration profiles, the cyclone/impactors showed the greatest consistency. The dichotomous samplers tended to yield significantly higher PM-10 concentration values than obtained from the other samples, especially under high plume impact conditions (lowest sampling heights downwind of unpaved roads). The instantaneous PM-10 concentrations downwind of an unpaved road were found, in some cases, to be of the order of 20,000 $\mu g/m^3$, as each dust plume drifted by the samplers. Agreement between downwind samplers was better at the elevated heights with lower plume impacts. EPA's continuous particle monitoring of emissions from paved roads tended to support the particle sizing results from the conventional time-integrated sampling performed in this study.

An elevated plume centerline was observed downwind of paved test roads under light wind conditions. This effect is believed to reflect buoyant plume rise from engine heat, coupled with turbulent mixing created by higher speed traffic. The effect is particularly important because it indicates that "ground-level" ambient monitoring (i.e., using a sampling height of about 2 m) is not appropriate for representing the full impact of the paved roadway emission plume. Accordingly, use of the "upwind-downwind" method for back-calculation of the emission rate through the application of a standard atmospheric dispersion model would significantly underestimate the emission rate, if the monitored concentration at breathing height were to be taken to represent plume core conditions.

The PM-10 and PM-2.5 chemical fingerprints of road dust emissions were similar to those obtained by resuspending road surface samples. The MRI dustiness test chamber gave resuspension fingerprints that matched the emission fingerprints more closely than did the DRI resuspension fingerprints. The emission fingerprints obtained by XRF analysis reflected the chemical composition of the road surface material. The primary difference in the PM-10 and PM-2.5 fingerprints determined by XRF analysis was the greater prevalence of sulfur in the PM-2.5.

The test results from this study support the interim particle-size adjustment factors recommended earlier for paved and unpaved roads, on the basis of recent data from area-wide ambient studies and previous emission studies. The recommended ratios lie between the values given by the dichotomous samplers (lower bounds) and the values given by the cyclone/impactors (upper bounds).

The recommended ratios of PM-2.5 to PM-10 are 0.15 for unpaved roads and 0.25 for paved roads. Because these ratios are significantly smaller than those currently reported in AP-42, revised particle size multipliers should be incorporated into AP-42. The ratios recommended earlier for other fugitive dust sources, such as construction activities and agricultural tilling, should be retained. These ratios are shown in Table 7-1.

Table 7-1. Recommended Particle Size Ratios

Source Category	Ratio of PM-2.5 to PM-10
Wind erosion—agricultural land	0.15
Agricultural crops	0.20
Agricultural livestock	0.15
Paved roads	0.25
Unpaved roads	0.15
Construction activities	0.15

As a final point with regard to paved roads, the measured silt loadings in this study were found to lie in the lower percentiles of the distributions given in the paved road section of AP-42. The same situation was found in silt loading values that were obtained recently in four western serious PM-10 nonattainment areas (Muleski et al., 1996). Consequently, it is likely that the paved road components of particulate emission inventories are being overestimated, based on the assumption that the AP-42 silt loading distributions are generally representative of urban areas.

Section 8
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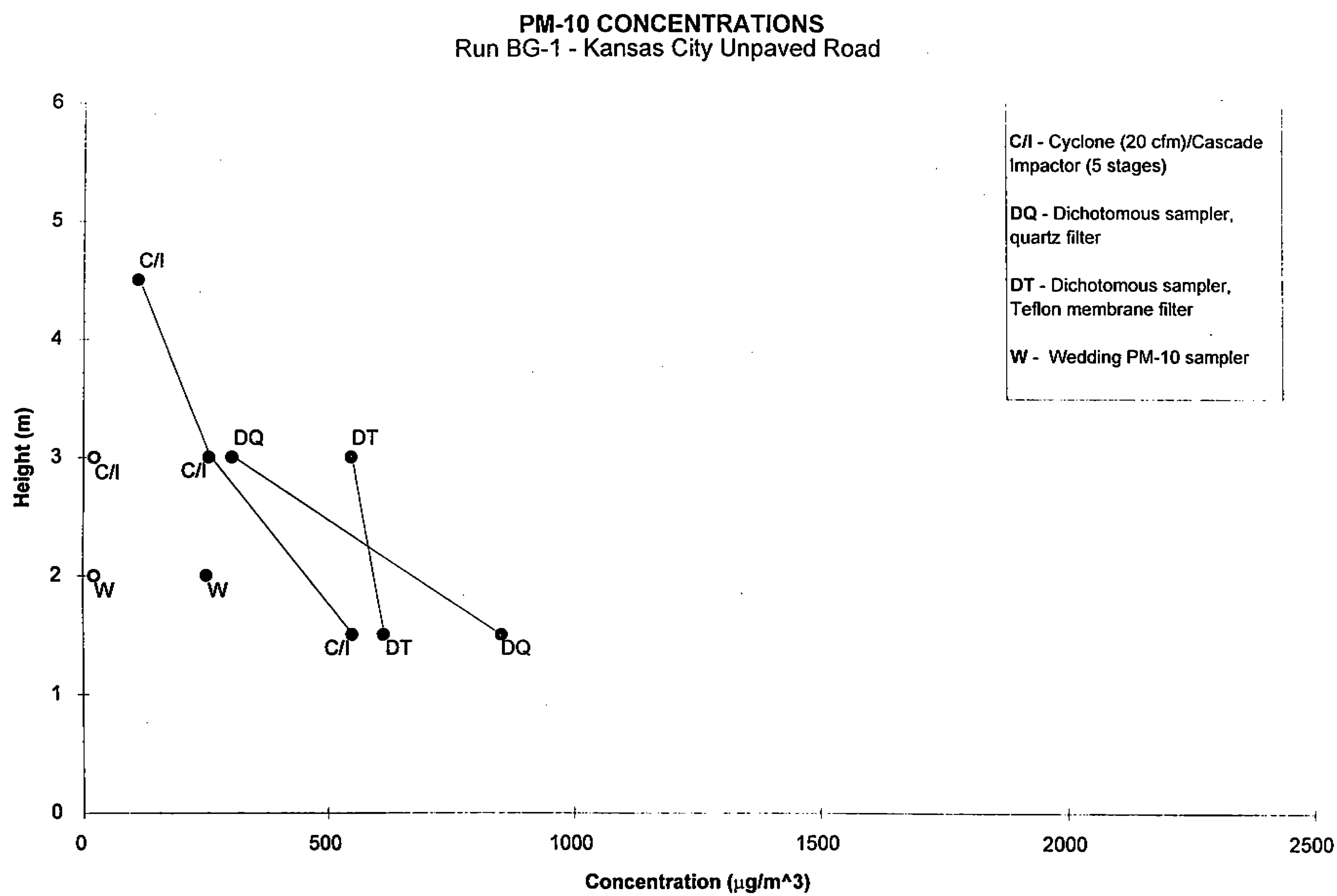
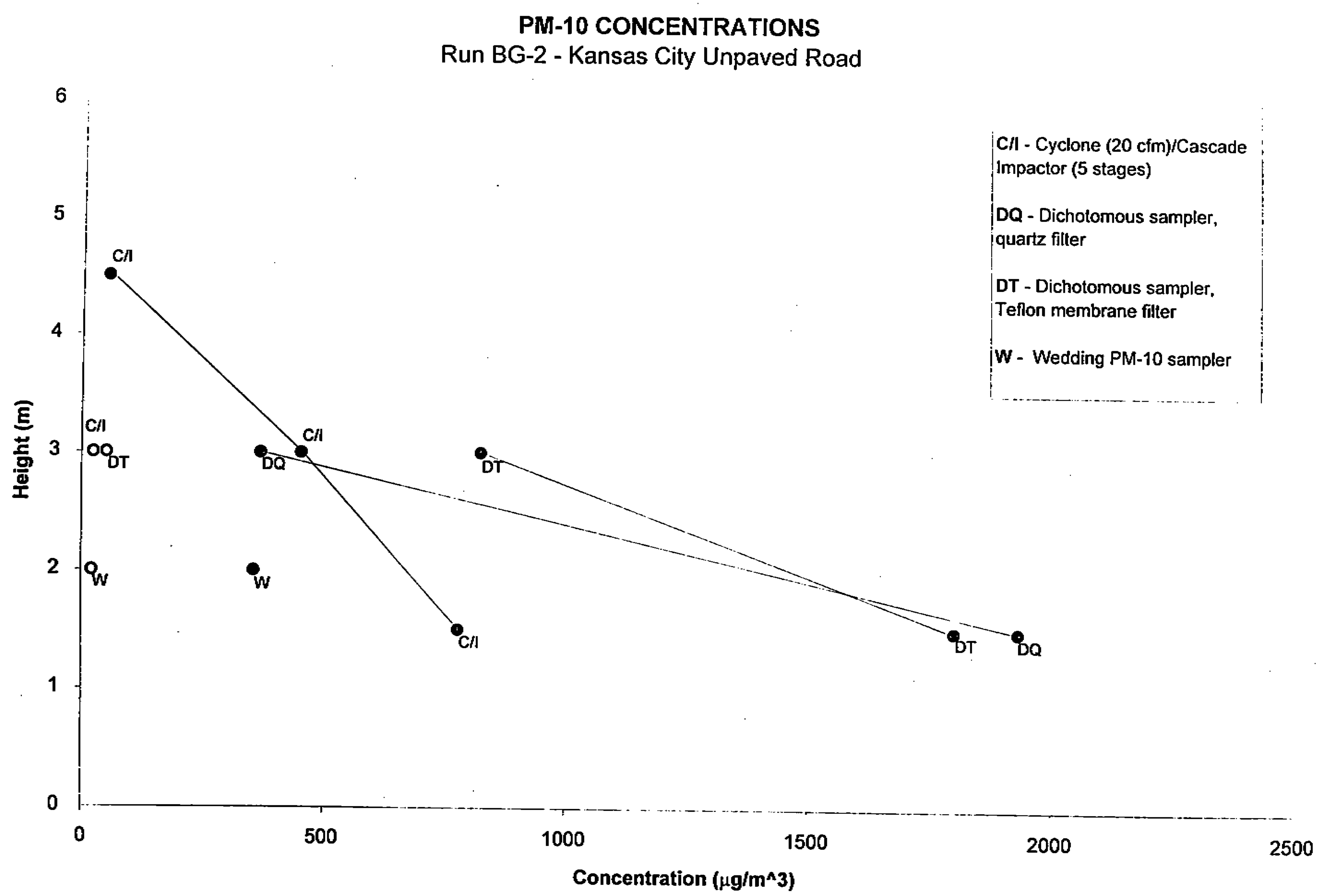
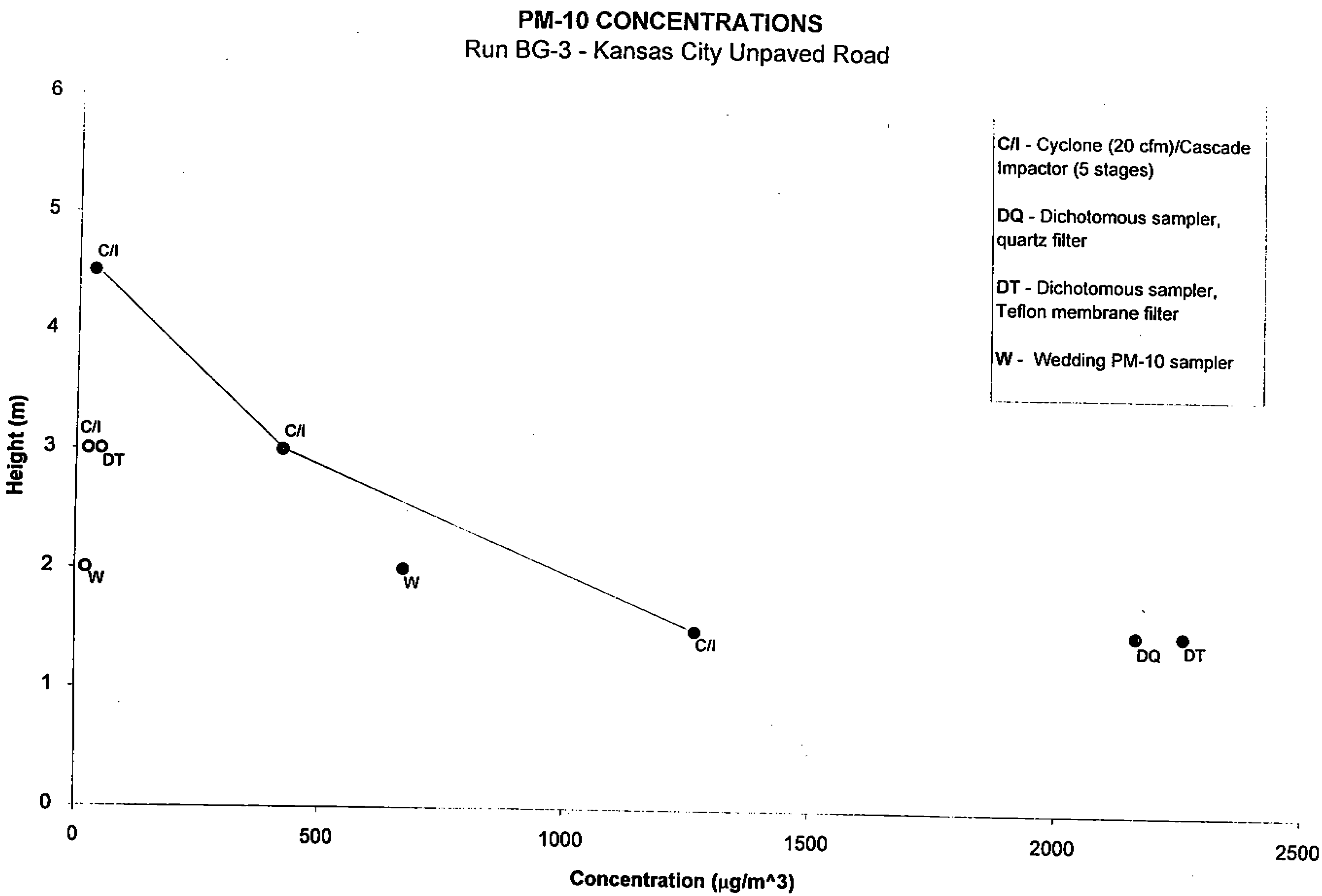
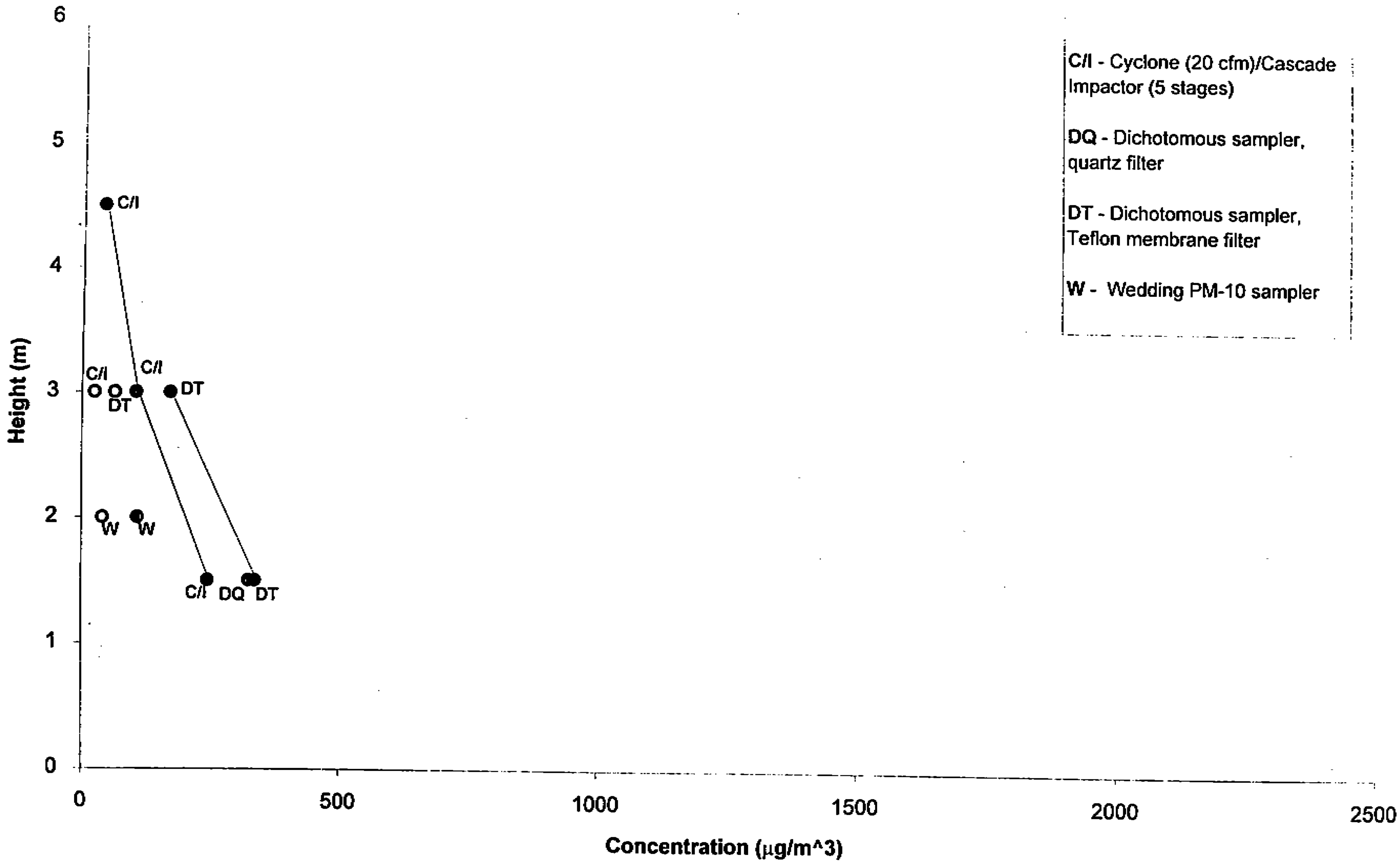

PM-10 CONCENTRATIONS
Run BG-1 - Kansas City Unpaved Road
Height (m)
Concentration (µg/m^3)
0
1
2
3
4
5
6
0
500
1000
1500
2000
2500
C/I
DQ
DT
W
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler



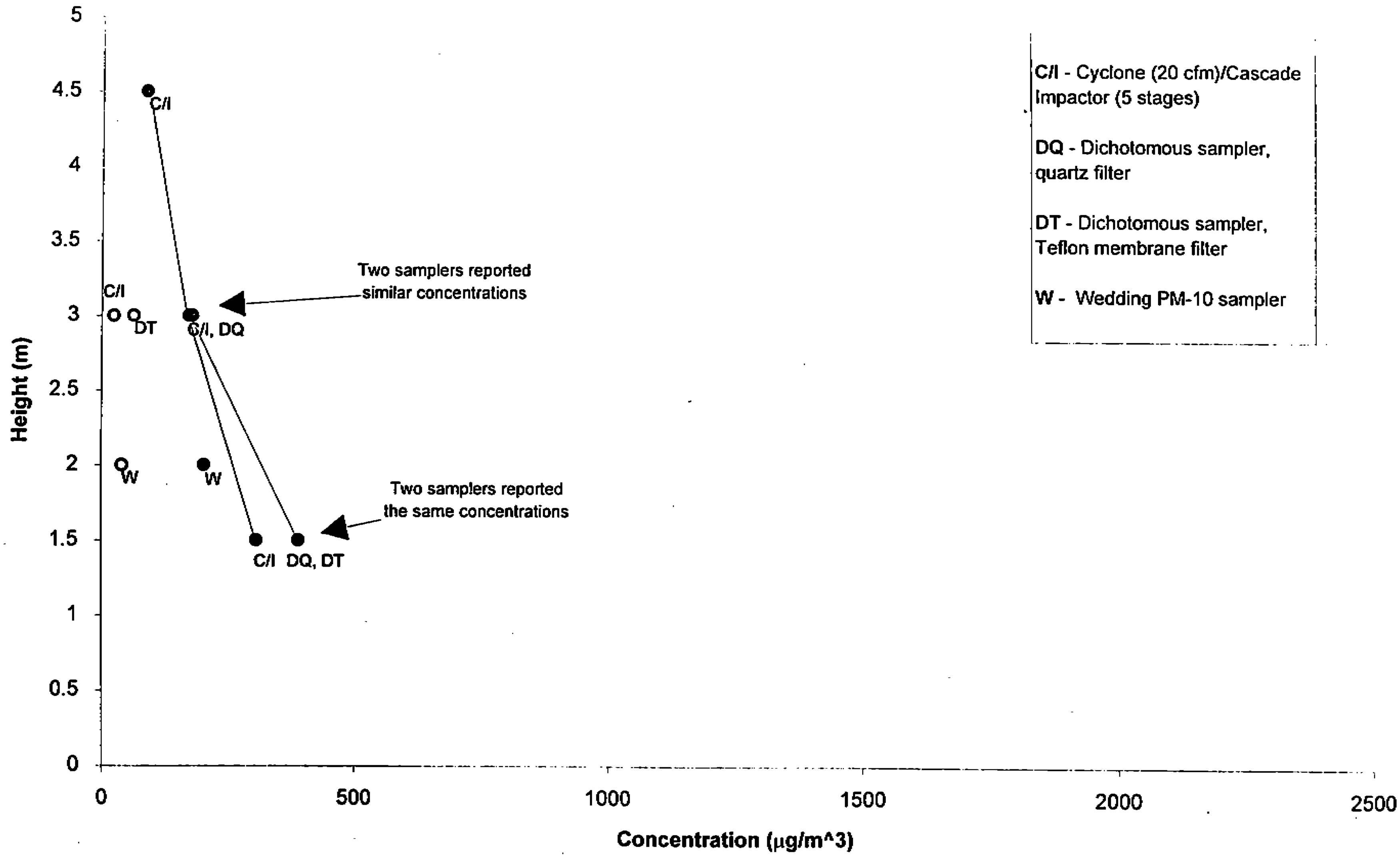
PM-10 CONCENTRATIONS
Run BG-2 - Kansas City Unpaved Road
Height (m)
Concentration (µg/m^3)
0
1
2
3
4
5
6
0
500
1000
1500
2000
2500
C/I
DQ
DT
W
O
OO
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler


PM-10 CONCENTRATIONS
Run BG-3 - Kansas City Unpaved Road
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Height (m)
Concentration (µg/m^3)
0
1
2
3
4
5
6
0
500
1000
1500
2000
2500
C/I
C/I
C/I
C/I
DT
W
W
DQ
DT

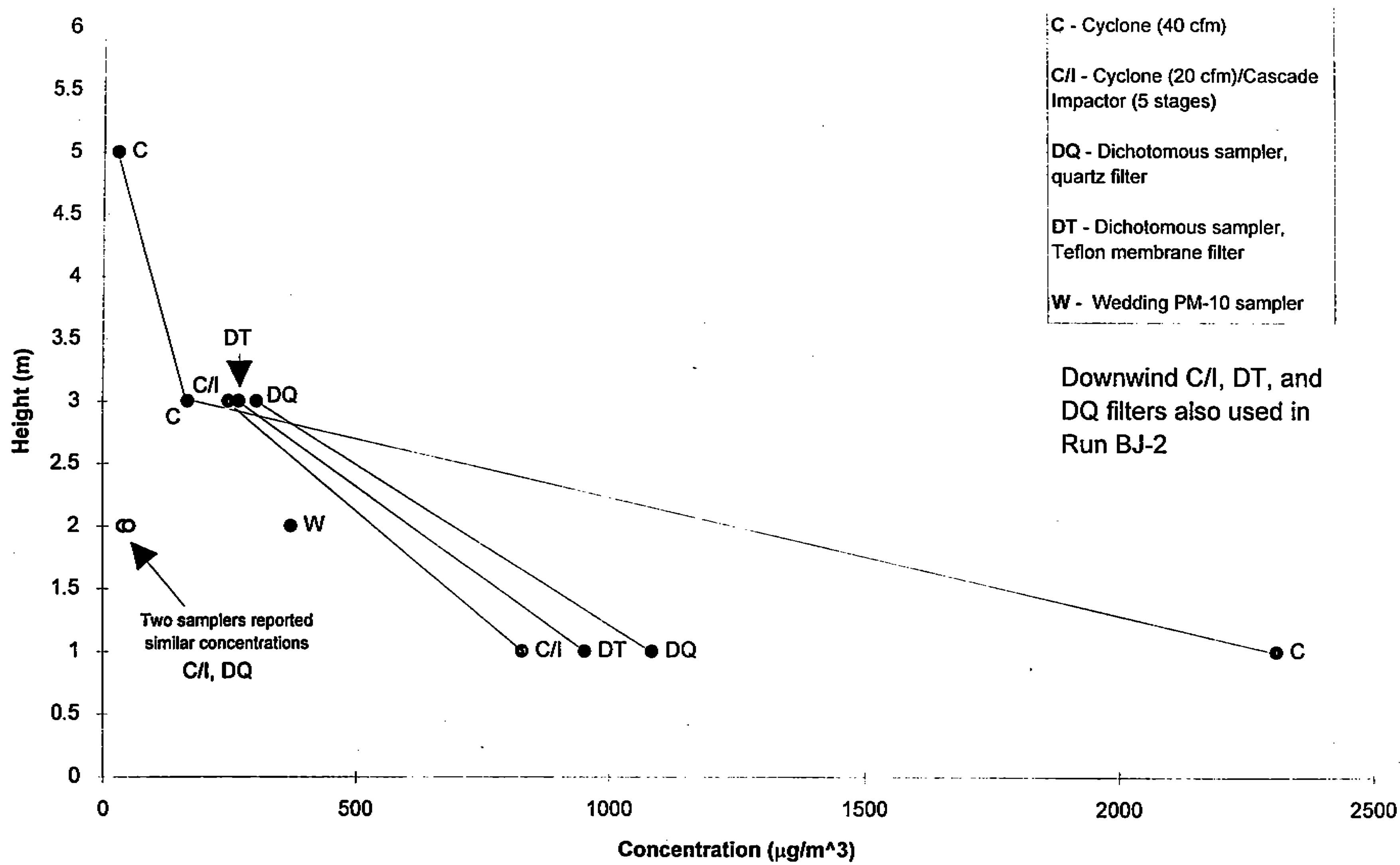
PM-10 CONCENTRATIONS
Run BG-4 - Kansas City Unpaved Road



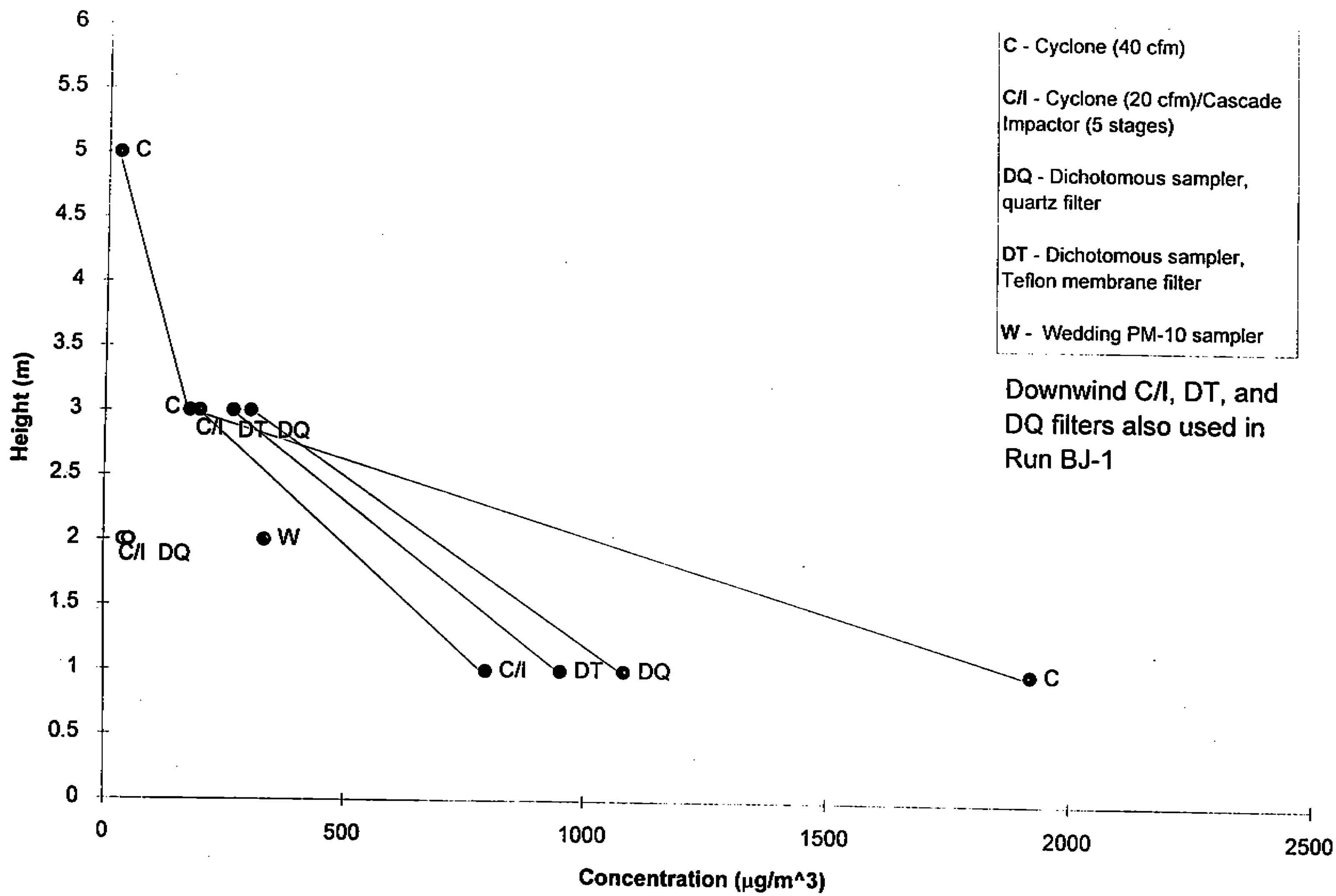
PM-10 CONCENTRATIONS
Run BG-5 - Kansas City Unpaved Road

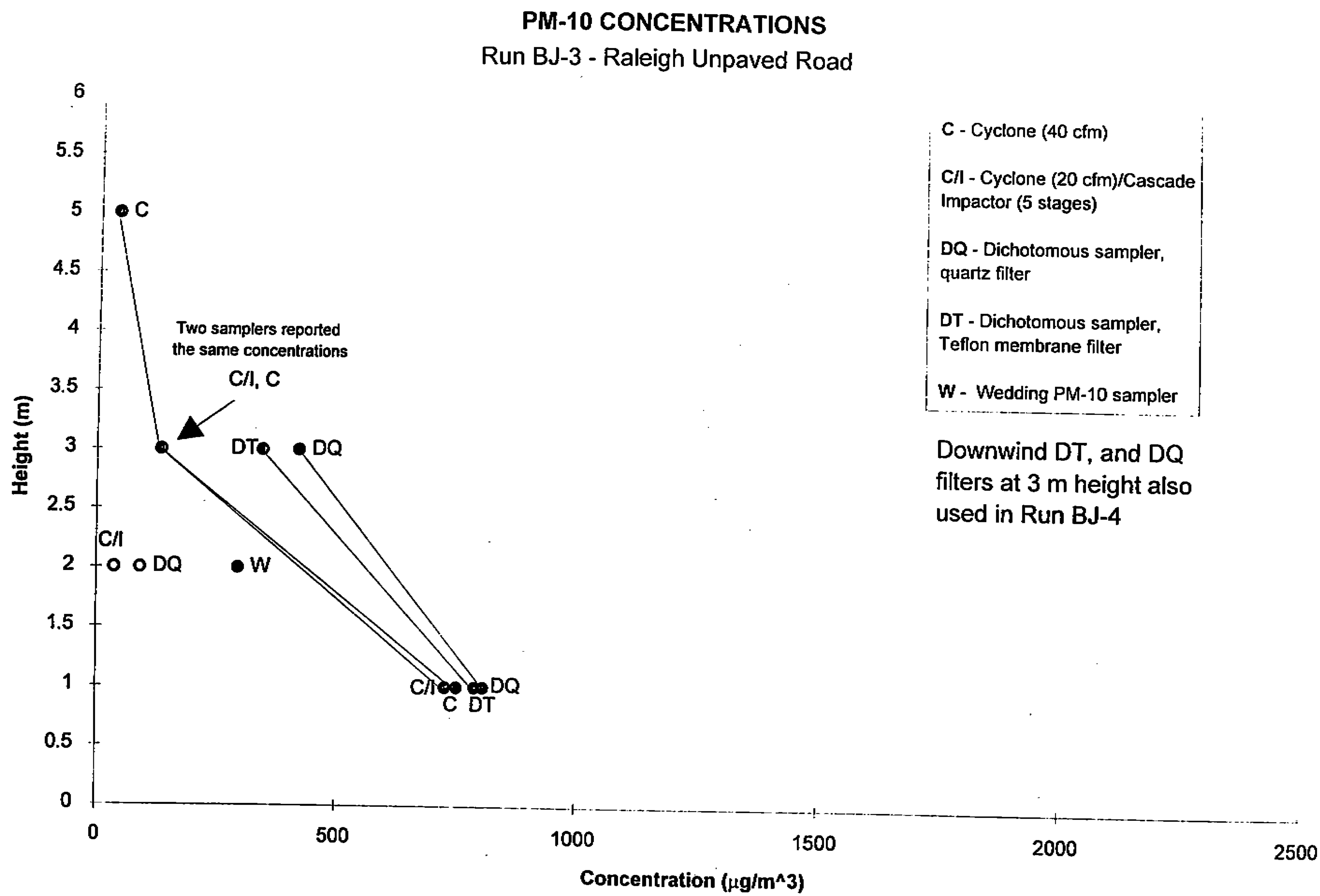


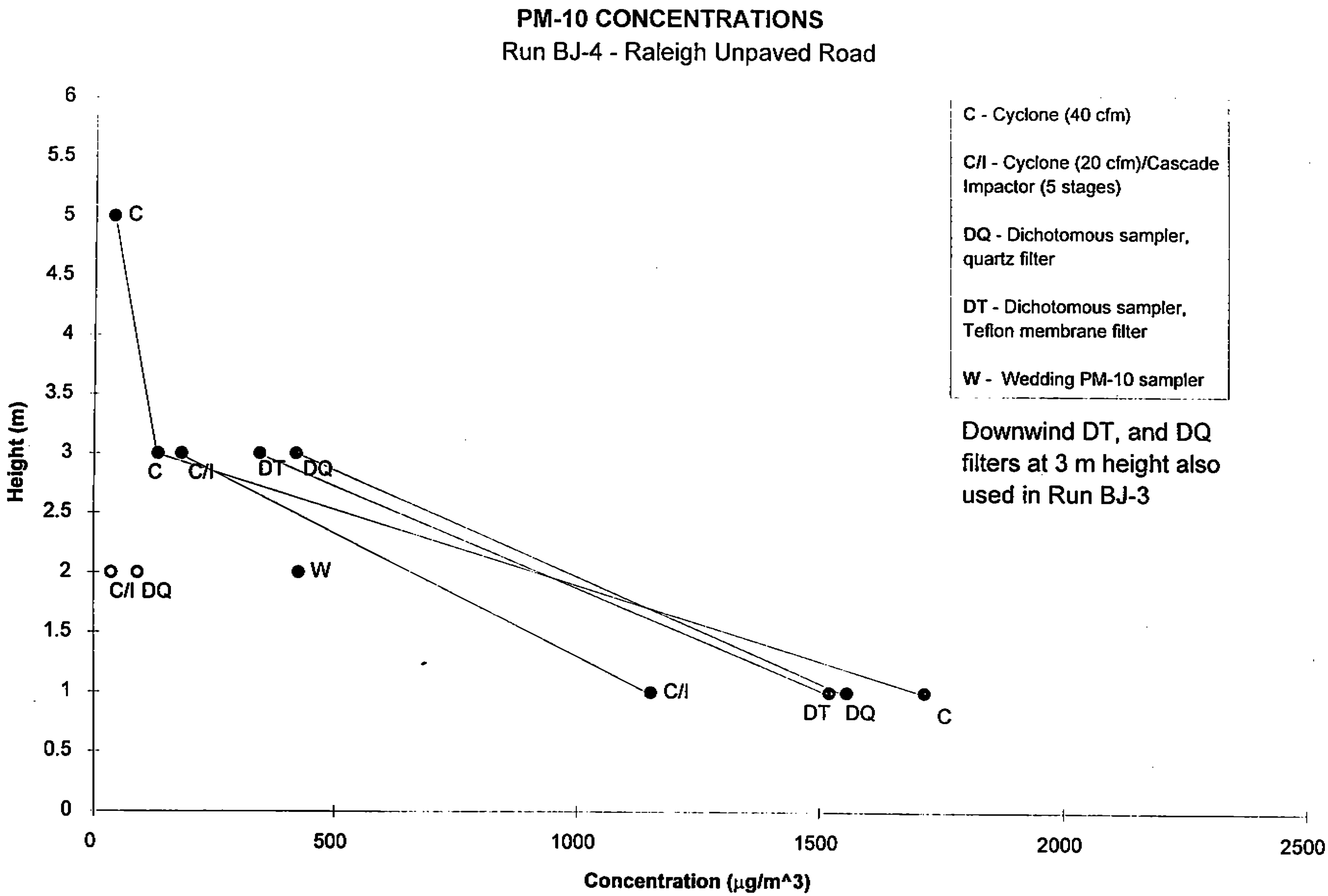
PM-10 CONCENTRATIONS
Run BJ-1 - Raleigh Unpaved Road

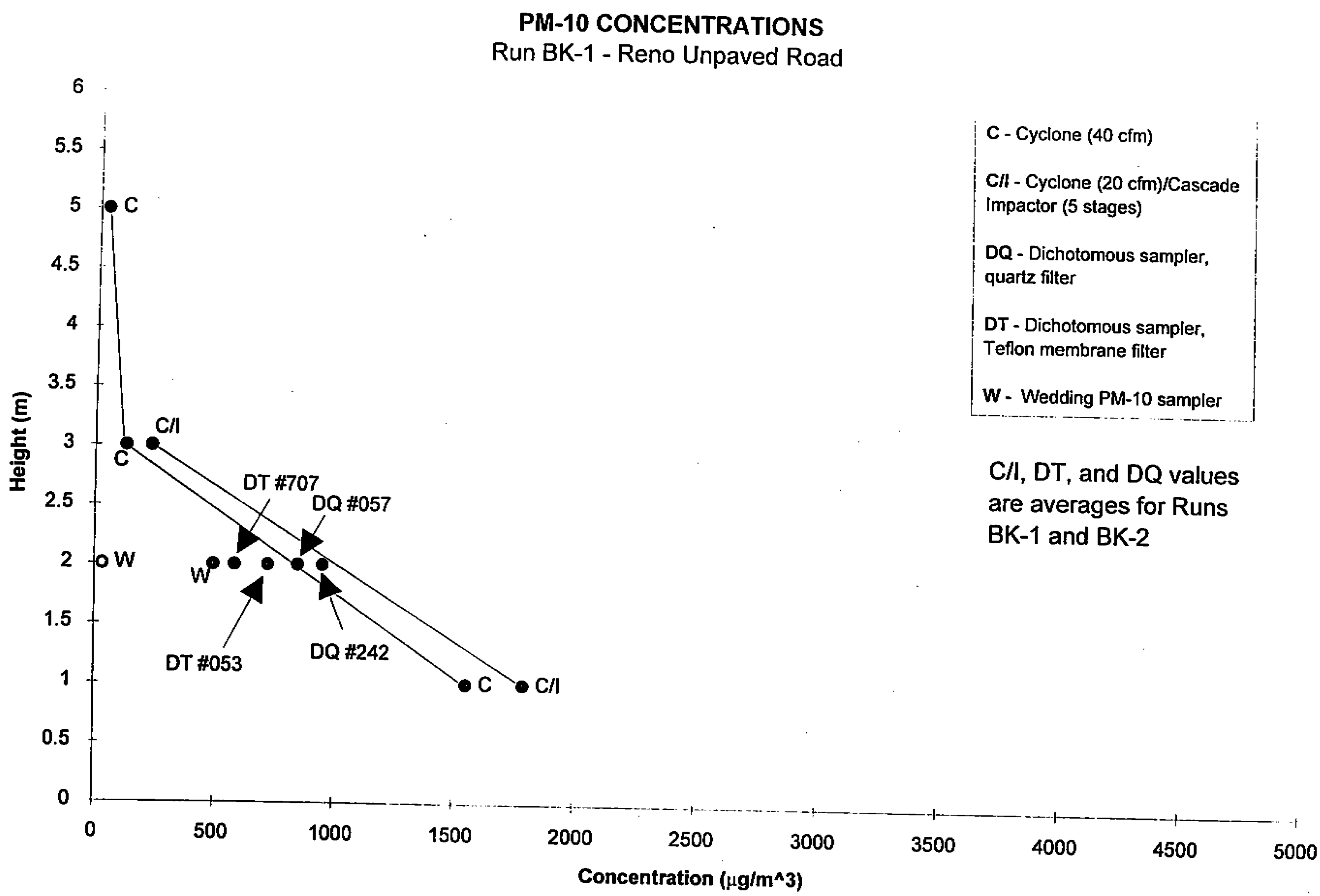


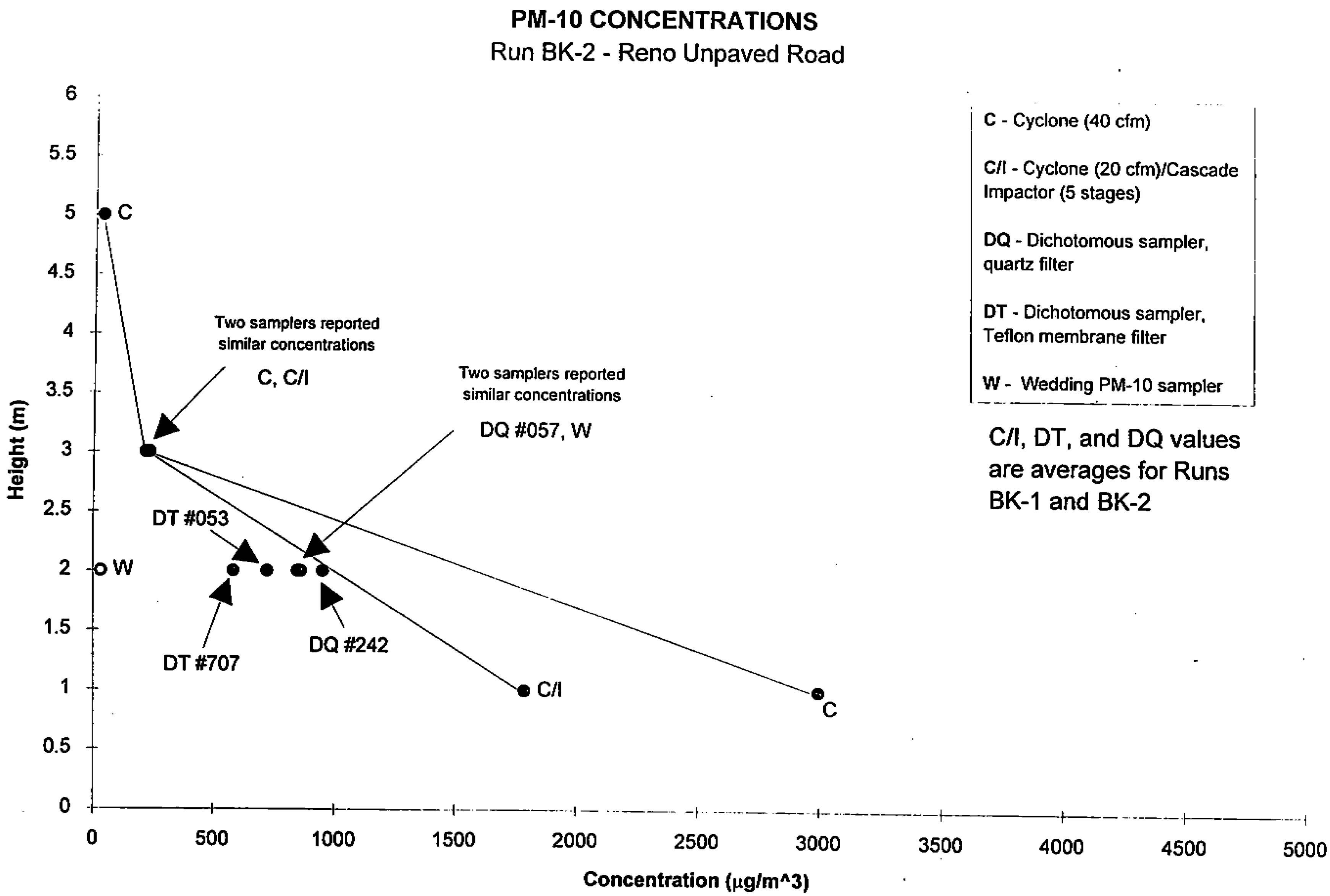
PM-10 CONCENTRATIONS
Run BJ-2 - Raleigh Unpaved Road




PM-10 CONCENTRATIONS
Run BJ-3 - Raleigh Unpaved Road
Height (m)
Concentration (µg/m^3)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
0
500
1000
1500
2000
2500
C
Two samplers reported the same concentrations
C/I, C
DT
DQ
C/I
DQ
W
C/I
C
DQ
DT
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Downwind DT, and DQ filters at 3 m height also used in Run BJ-4


PM-10 CONCENTRATIONS
Run BJ-4 - Raleigh Unpaved Road
Height (m)
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
500
1000
1500
2000
2500
Concentration (µg/m^3)
C
C
C/I
DT
DQ
C/I DQ
W
C/I
DT
DQ
C
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Downwind DT, and DQ filters at 3 m height also used in Run BJ-3

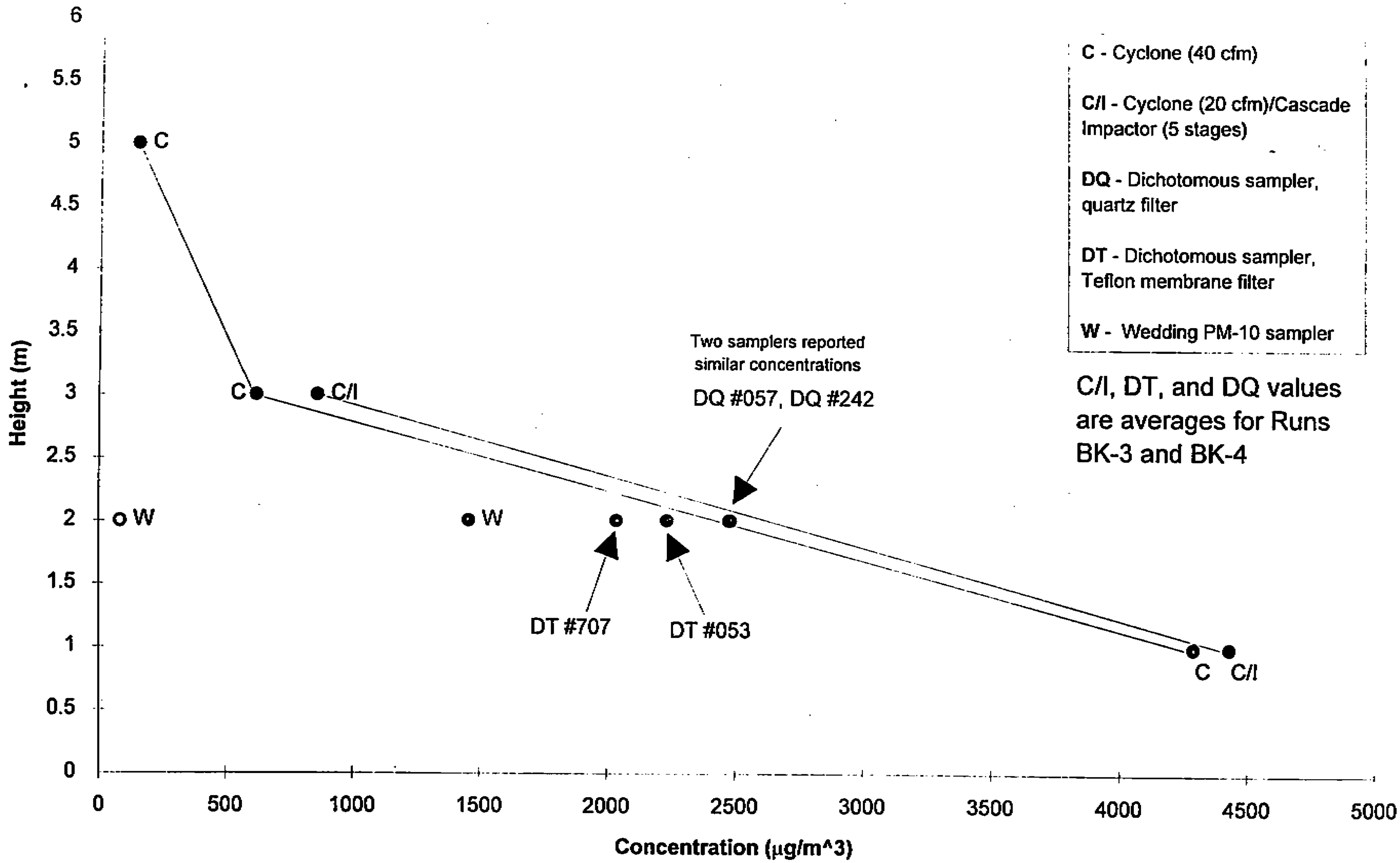

PM-10 CONCENTRATIONS
Run BK-1 - Reno Unpaved Road
Height (m)
Concentration (µg/m^3)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
C
C/I
W
DT #707
DQ #057
DT #053
DQ #242
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
C/I, DT, and DQ values are averages for Runs BK-1 and BK-2



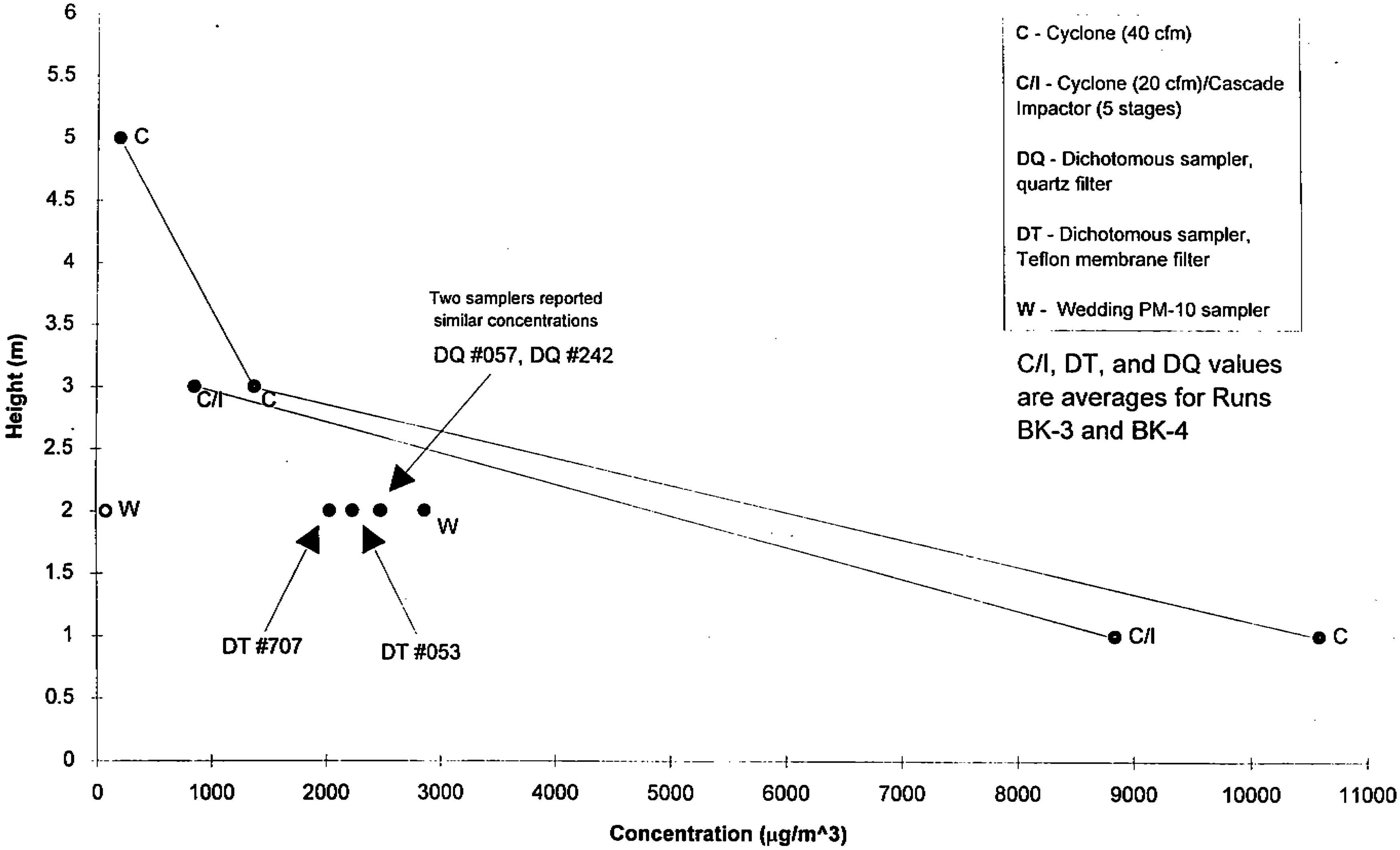
PM-10 CONCENTRATIONS
Run BK-2 - Reno Unpaved Road
Height (m)
Concentration (µg/m^3)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
C
W
C/I
Two samplers reported similar concentrations
C, C/I
Two samplers reported similar concentrations
DQ #057, W
DT #053
DT #707
DQ #242
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
C/I, DT, and DQ values are averages for Runs BK-1 and BK-2

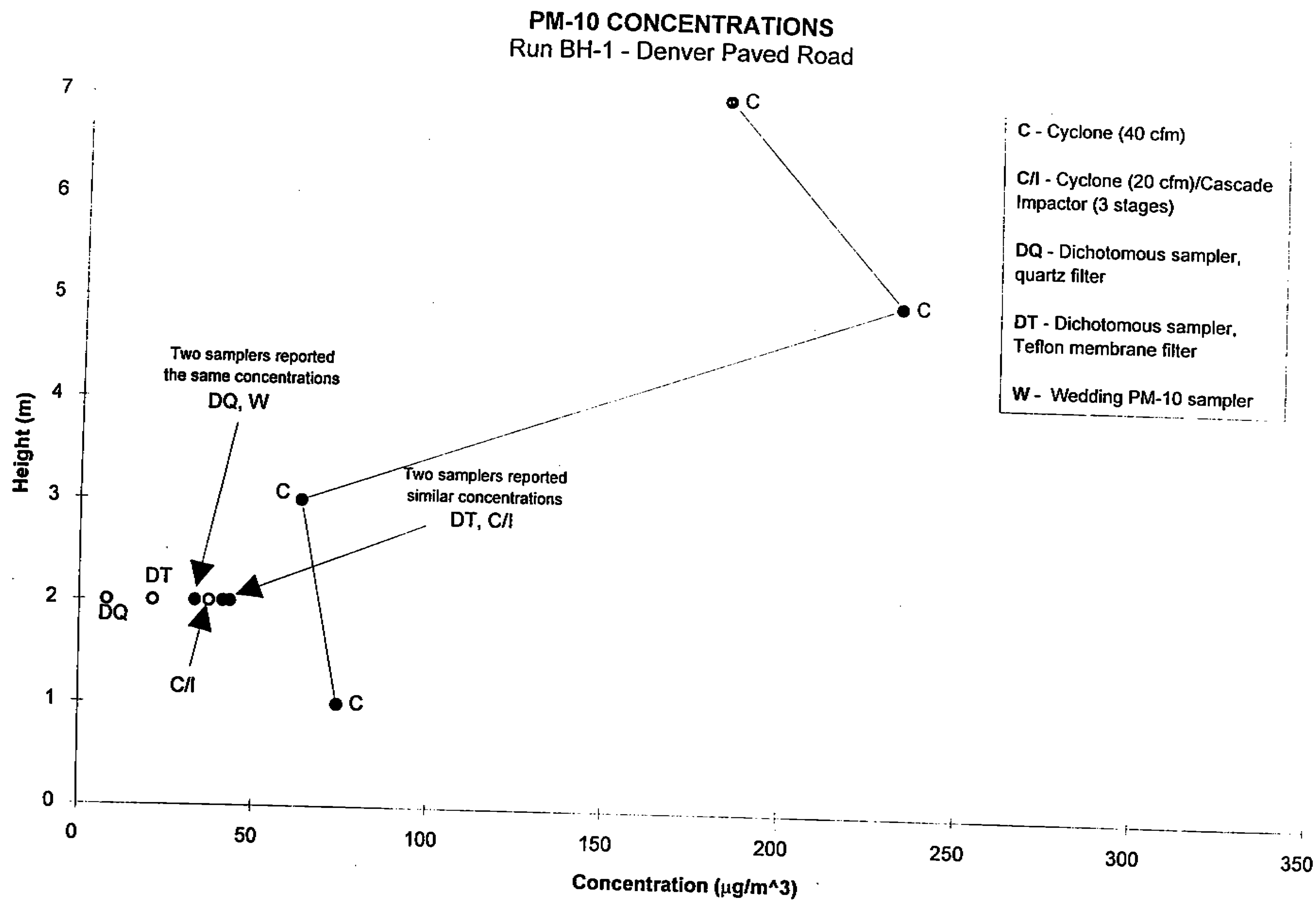
PM-10 CONCENTRATIONS

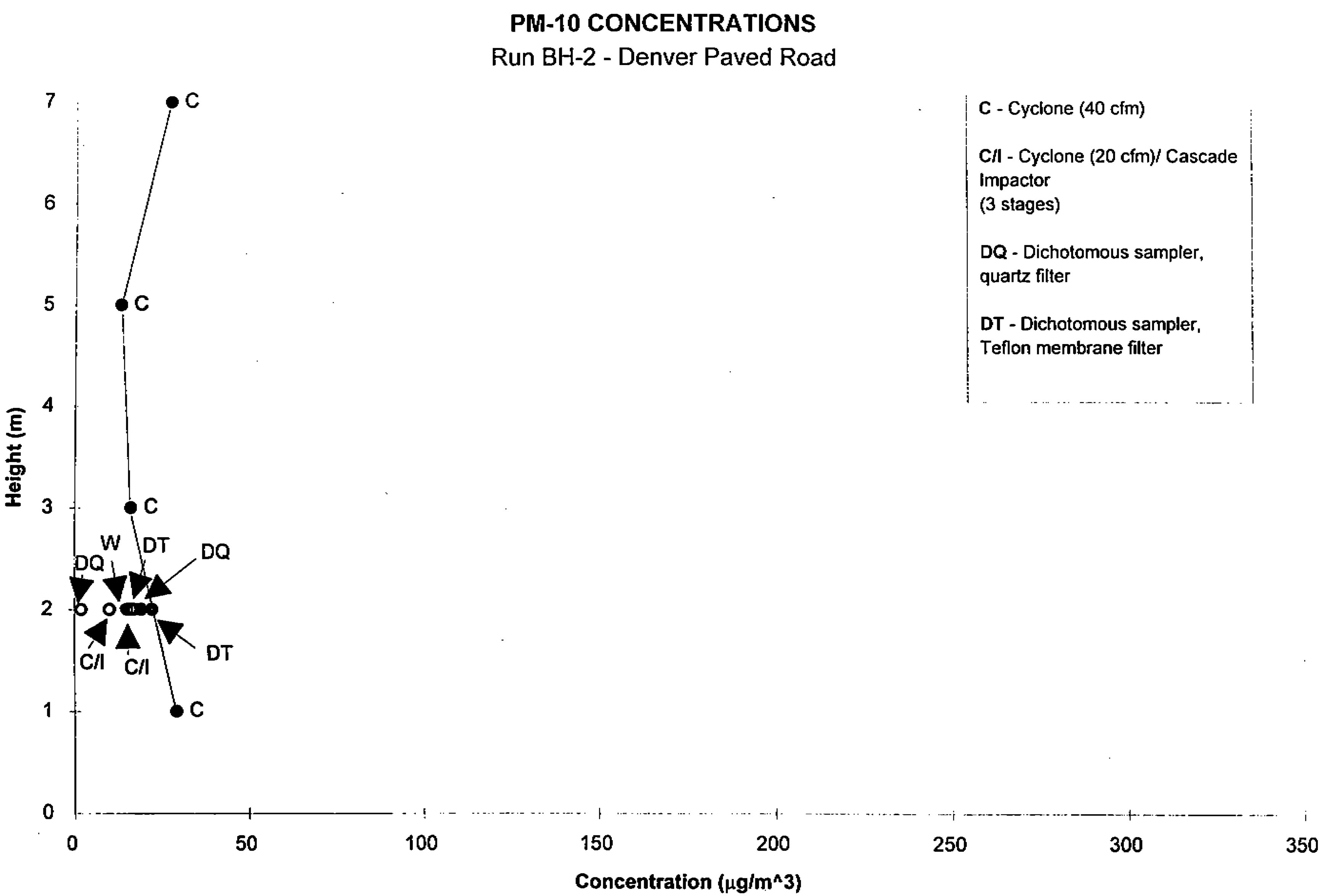
Run BK-3 - Reno Unpaved Road

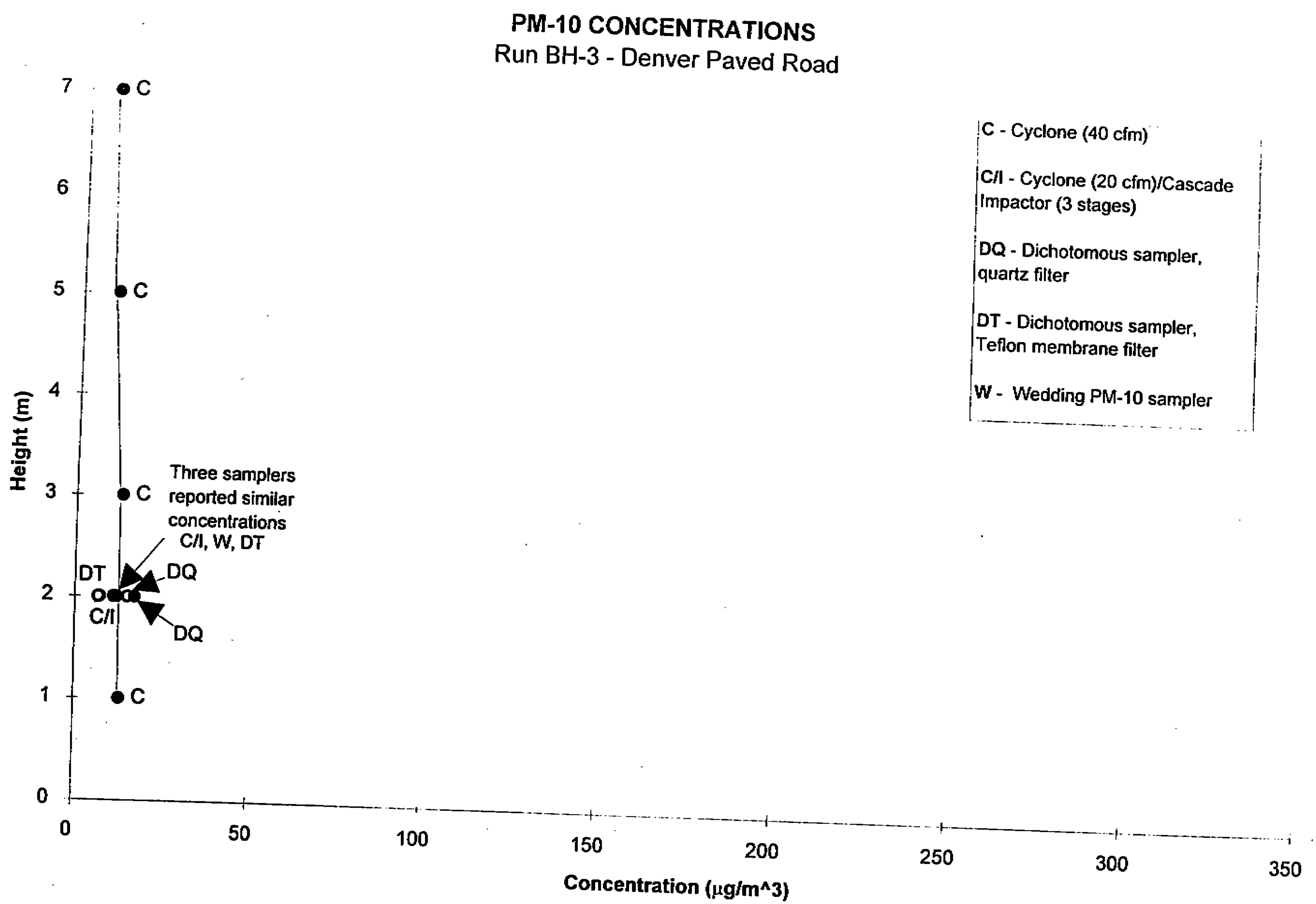


PM-10 CONCENTRATIONS
Run BK-4 - Reno Unpaved Road

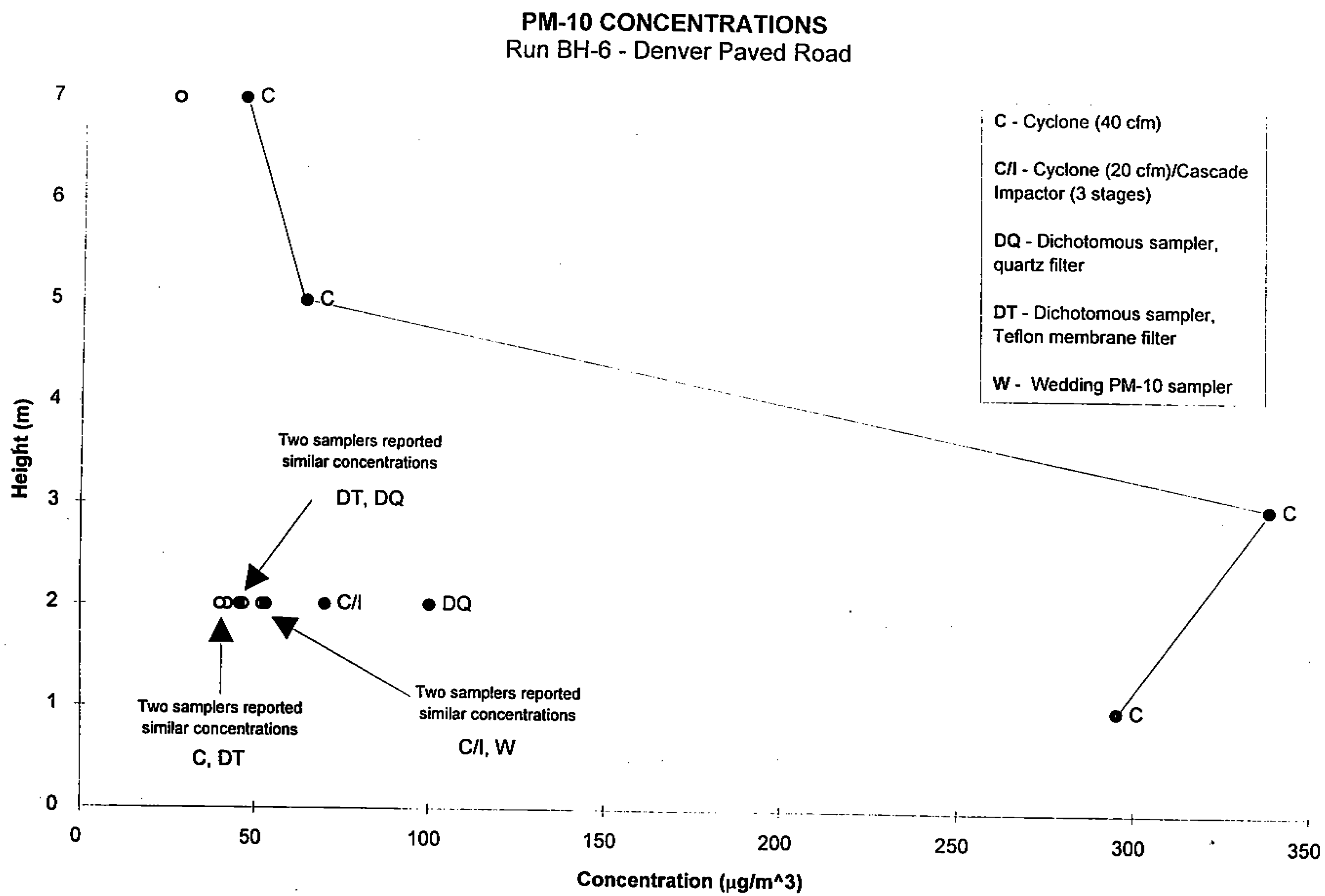



PM-10 CONCENTRATIONS
Run BH-1 - Denver Paved Road
Height (m)
Concentration (µg/m^3)
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300
350
C
C
C
C
DT
DQ
C/I
Two samplers reported
the same concentrations
DQ, W
Two samplers reported
similar concentrations
DT, C/I
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (3 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler


PM-10 CONCENTRATIONS
Run BH-2 - Denver Paved Road
Height (m)
Concentration (µg/m^3)
C
DQ
W
DT
C/I
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/ Cascade Impactor (3 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter

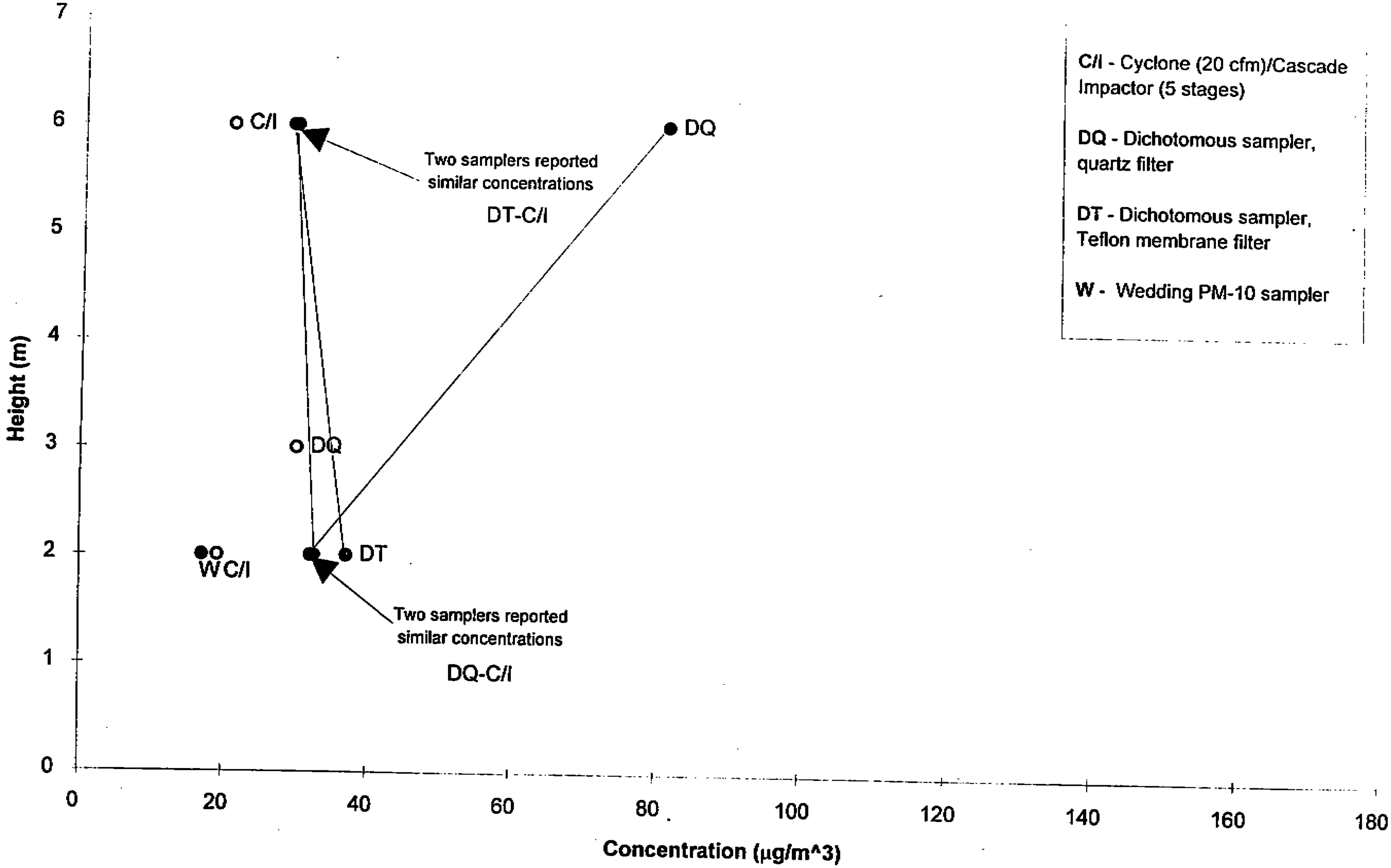


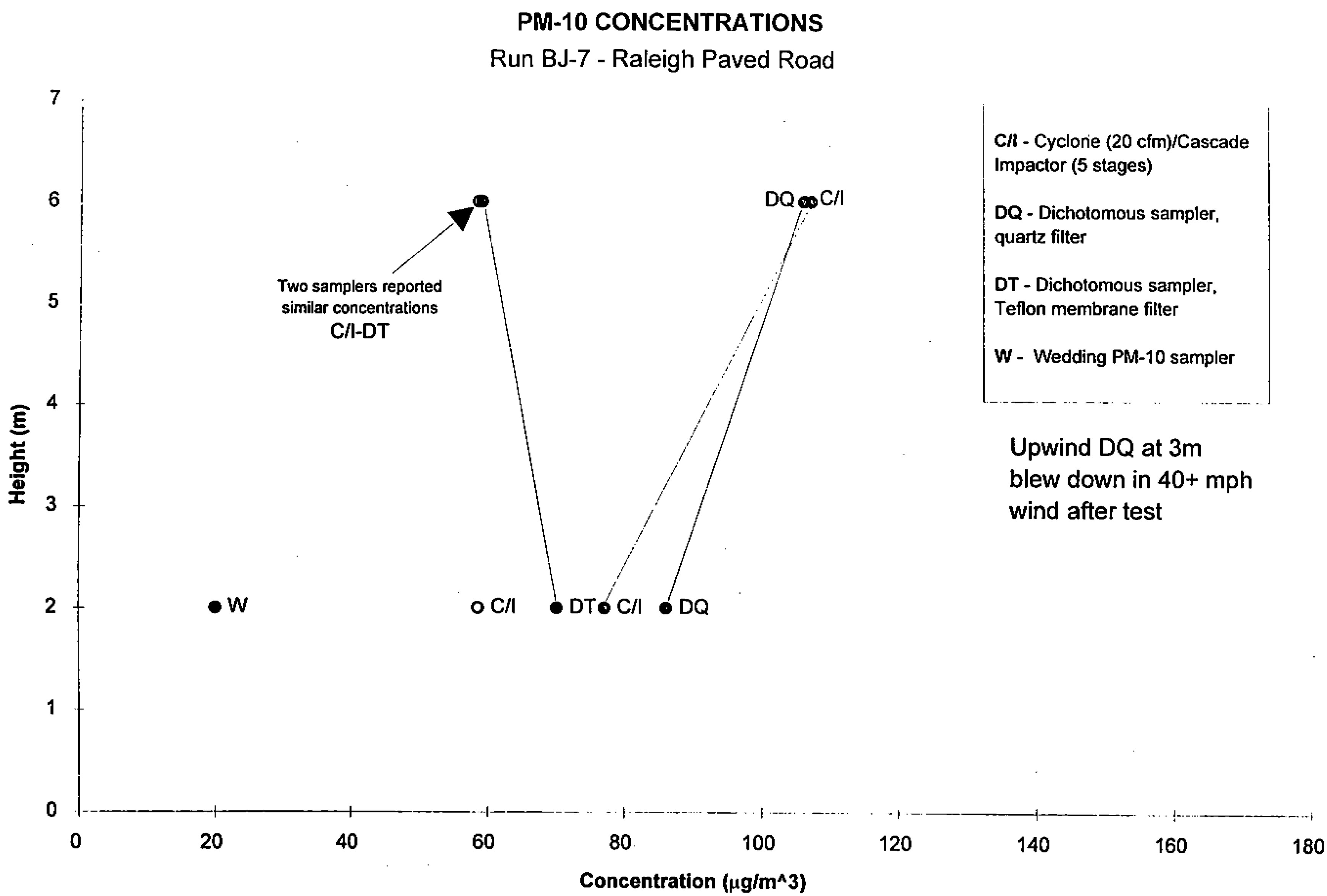
PM-10 CONCENTRATIONS
Run BH-3 - Denver Paved Road
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (3 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Three samplers reported similar concentrations C/I, W, DT
DT
C/I
DQ
DQ
C
C
C
C
Height (m)
0
1
2
3
4
5
6
7
Concentration (µg/m^3)
0
50
100
150
200
250
300
350



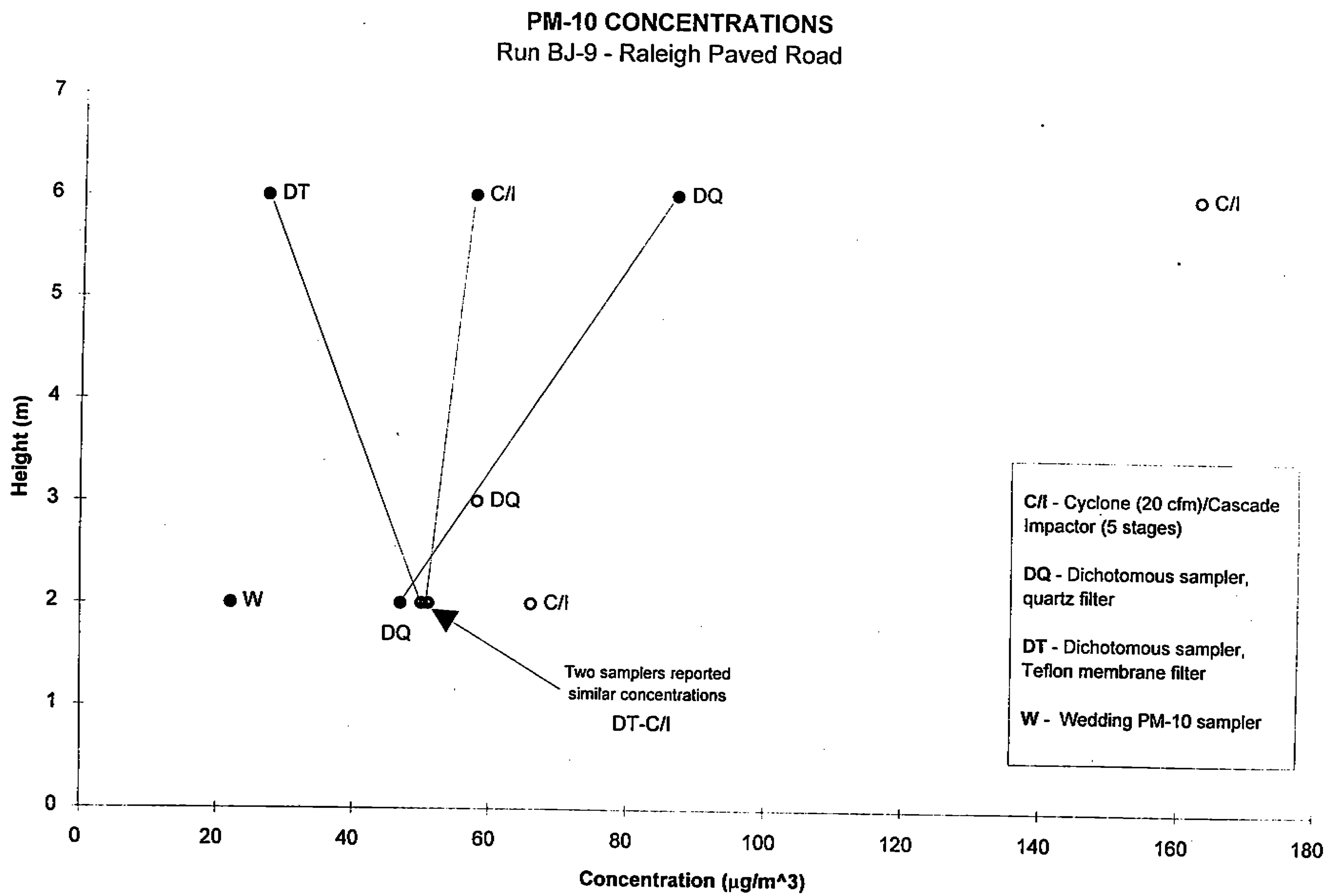
PM-10 CONCENTRATIONS
Run BH-6 - Denver Paved Road
Height (m)
Concentration (µg/m^3)
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (3 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Two samplers reported similar concentrations
DT, DQ
Two samplers reported similar concentrations
C, DT
Two samplers reported similar concentrations
C/I, W
C
C
C
C
C/I
DQ
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300
350

PM-10 CONCENTRATIONS
Run BJ-6 - Raleigh Paved Road

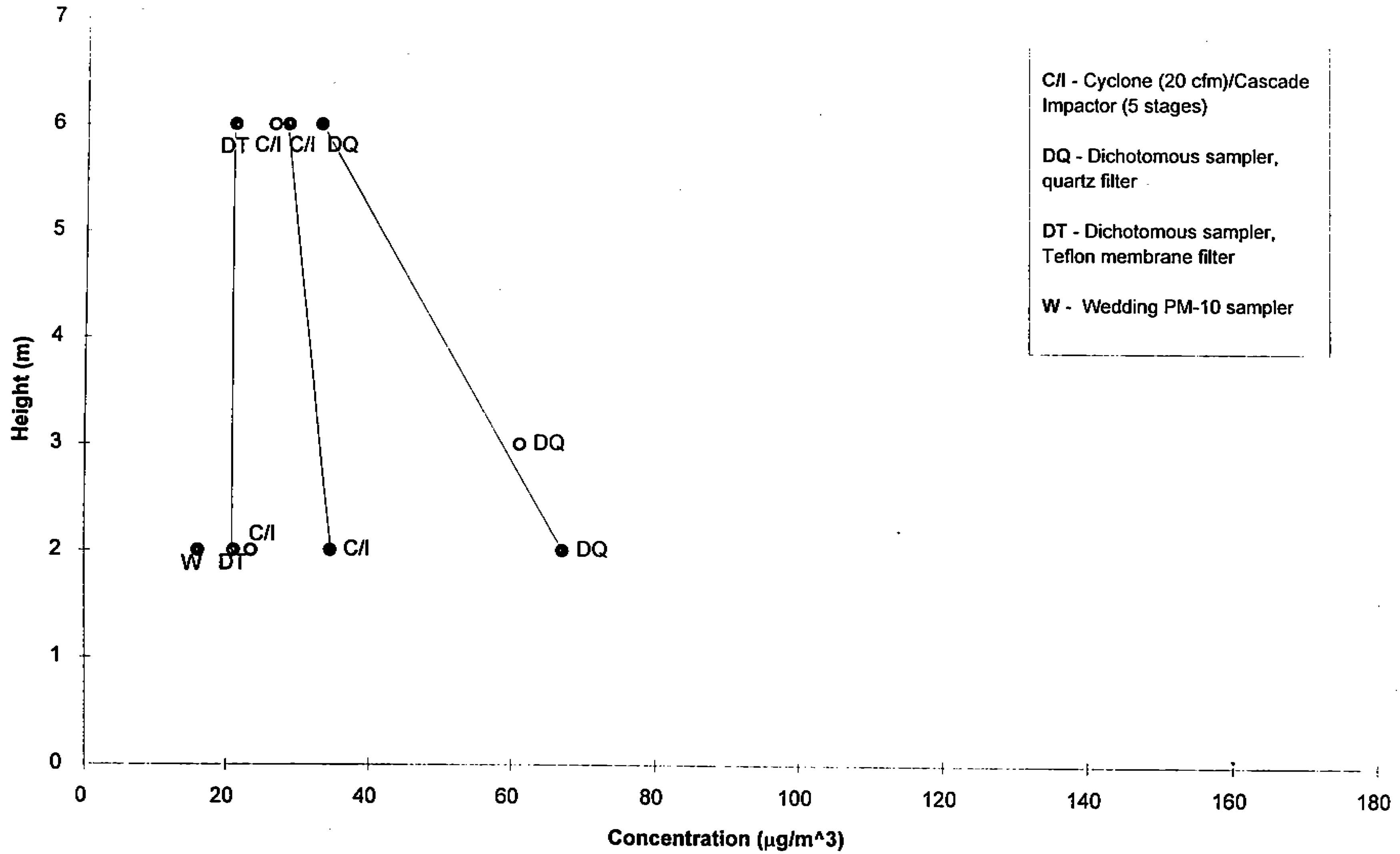


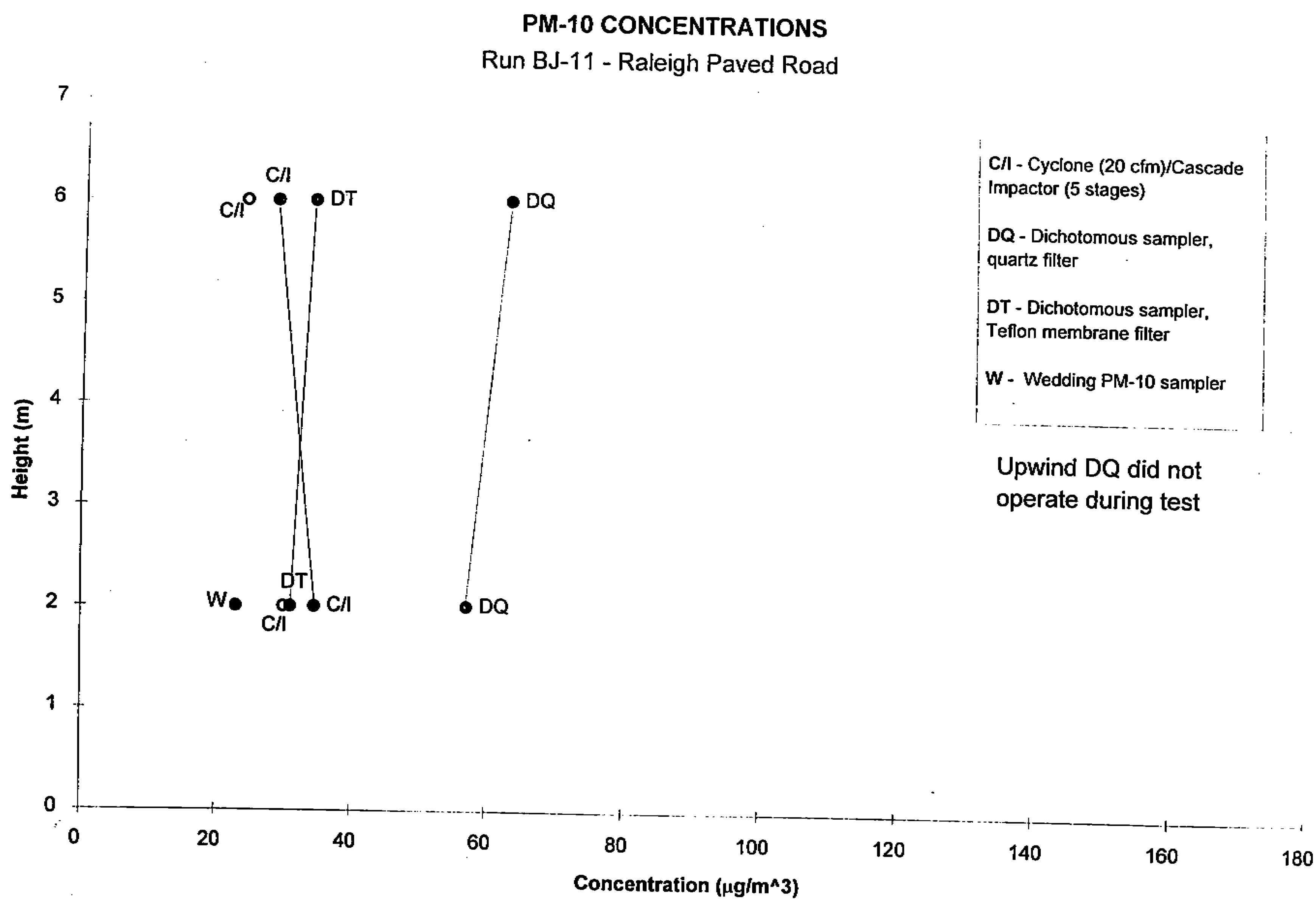


PM-10 CONCENTRATIONS
Run BJ-7 - Raleigh Paved Road
Height (m)
Concentration (µg/m^3)
0
1
2
3
4
5
6
7
0
20
40
60
80
100
120
140
160
180
W
C/I
DT
C/I
DQ
DQ
C/I
Two samplers reported similar concentrations
C/I-DT
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Upwind DQ at 3m blew down in 40+ mph wind after test

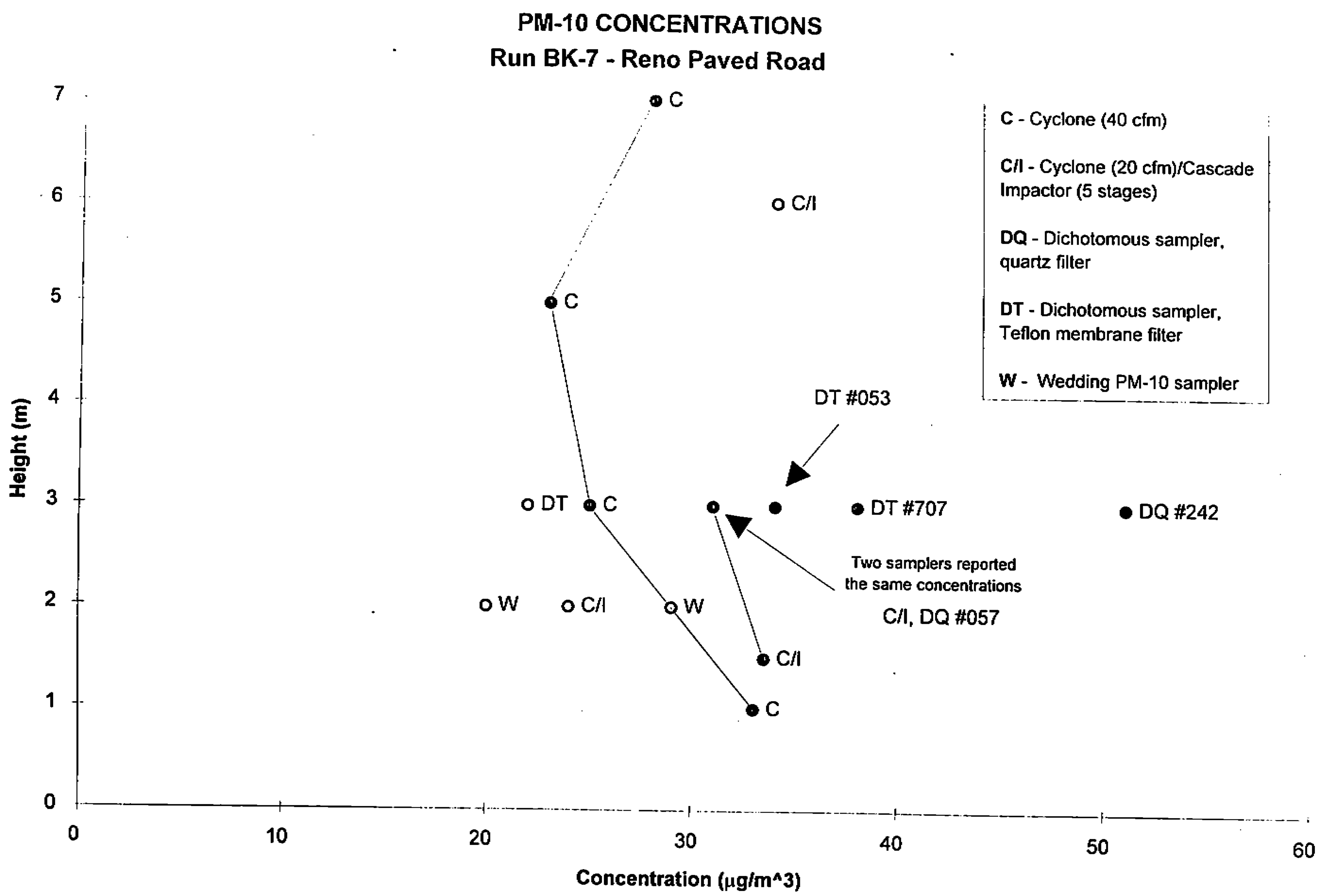

PM-10 CONCENTRATIONS
Run BJ-9 - Raleigh Paved Road
Height (m)
0
1
2
3
4
5
6
7
Concentration (µg/m^3)
0
20
40
60
80
100
120
140
160
180
DT
C/I
DQ
C/I
DQ
W
DQ
C/I
Two samplers reported
similar concentrations
DT-C/I
C/I - Cyclone (20 cfm)/Cascade
Impactor (5 stages)
DQ - Dichotomous sampler,
quartz filter
DT - Dichotomous sampler,
Teflon membrane filter
W - Wedding PM-10 sampler

PM-10 CONCENTRATIONS
Run BJ-10 - Raleigh Paved Road

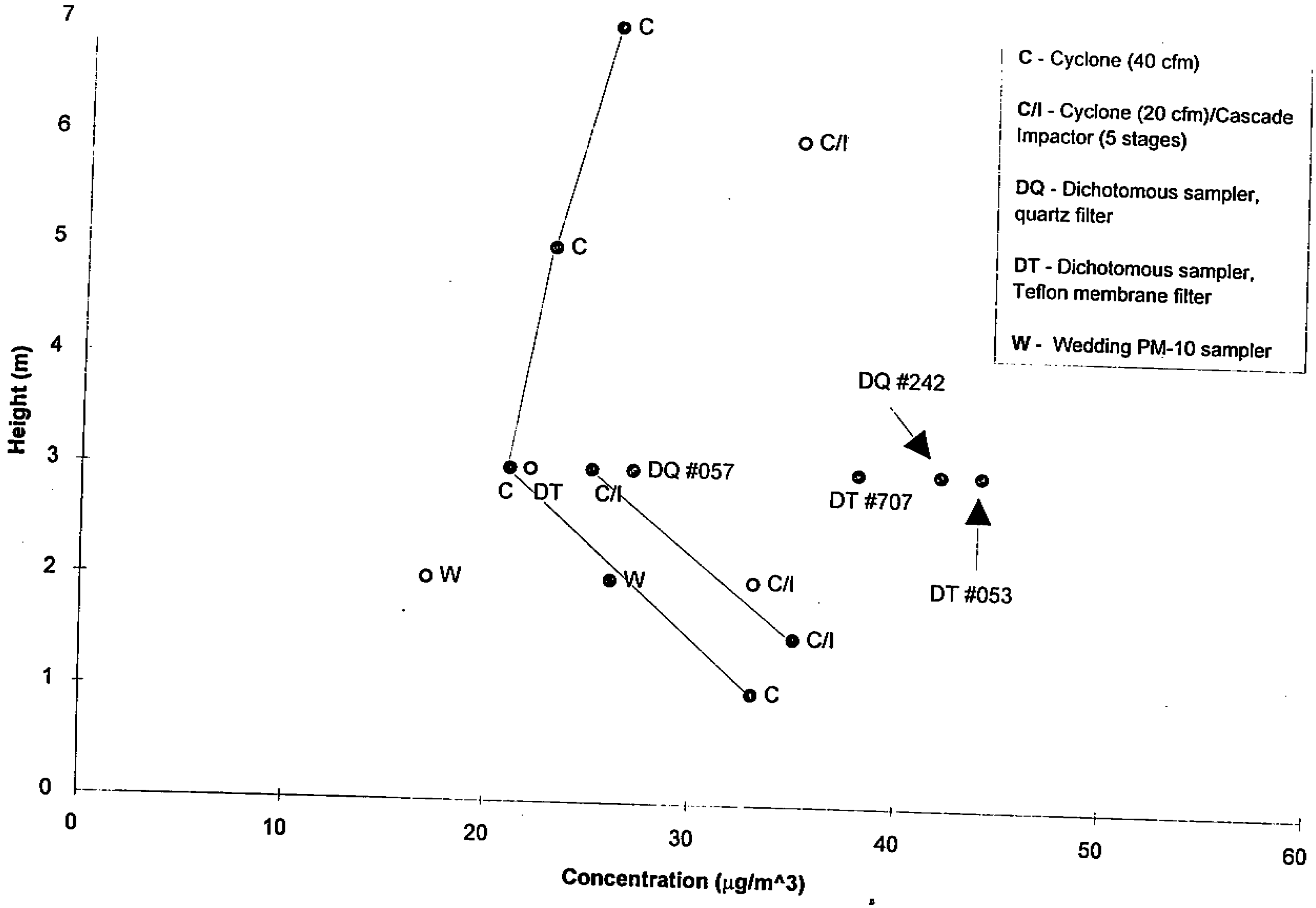




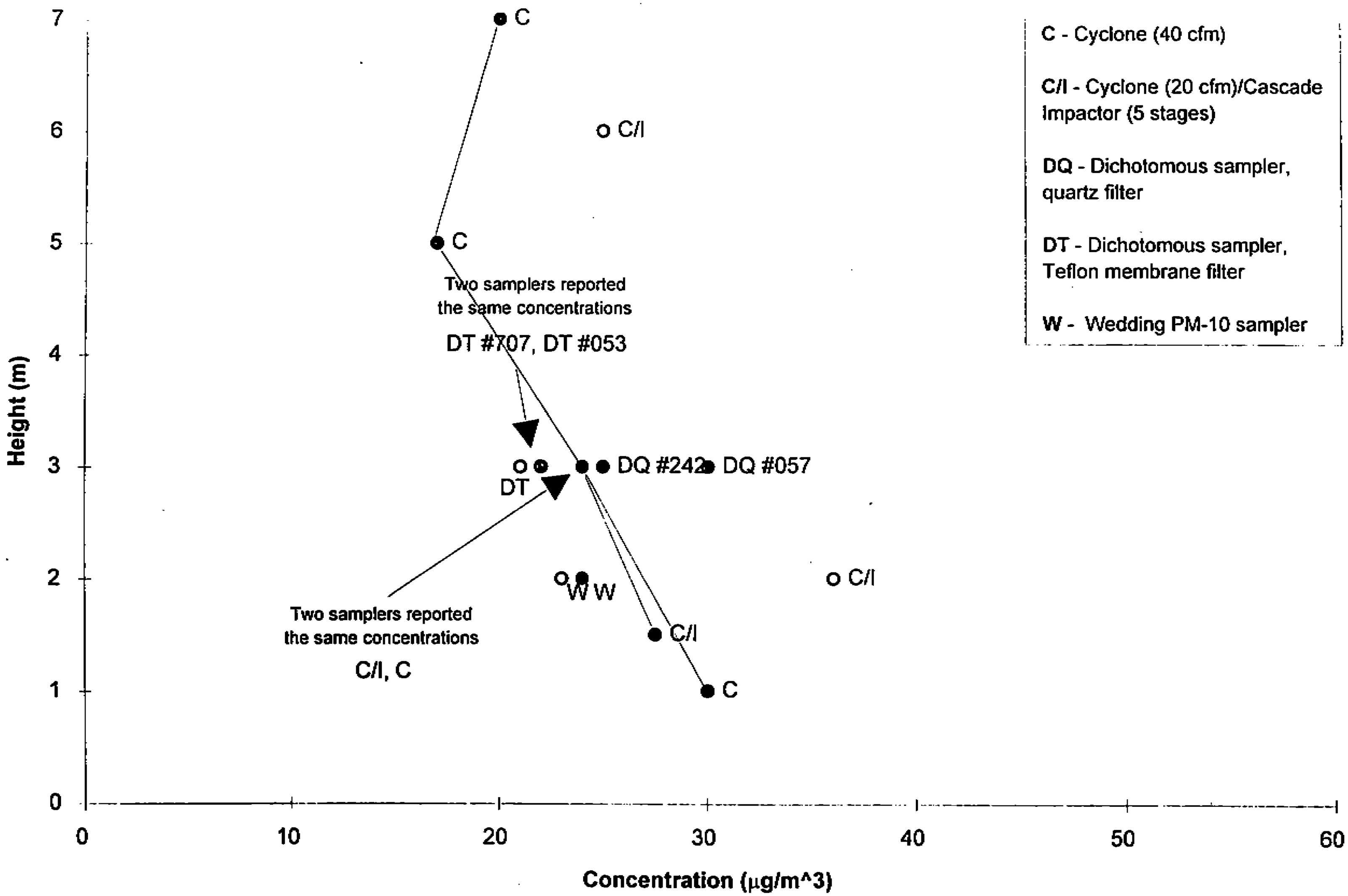
PM-10 CONCENTRATIONS
Run BJ-11 - Raleigh Paved Road
Height (m)
Concentration (µg/m^3)
C/I
DT
DQ
W
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
Upwind DQ did not operate during test


PM-10 CONCENTRATIONS
Run BK-7 - Reno Paved Road
Height (m)
Concentration (µg/m^3)
C - Cyclone (40 cfm)
C/I - Cyclone (20 cfm)/Cascade Impactor (5 stages)
DQ - Dichotomous sampler, quartz filter
DT - Dichotomous sampler, Teflon membrane filter
W - Wedding PM-10 sampler
DT #053
DT #707
DQ #242
Two samplers reported the same concentrations
C/I, DQ #057
C
C/I
DT
W

PM-10 CONCENTRATIONS
Run BK-8 - Reno Paved Road



PM-10 CONCENTRATIONS
Run BK-9 - Reno Paved Road



Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Aerosol Fraction	Flowrate (liter/min)
BH-1	02/28/96	Dichot/T 2m UW	421707	11:07	14:23	196	18	24.86	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m UW	174242	11:07	14:23	196	18	24.86	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	11:42	14:23	161	18	24.86	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	11:42	14:23	161	18	24.86	Coarse	1.67
									Fine	15.00
BH-2	03/01/96	Dichot/T 2m UW	421707	08:45	14:45	360	37	24.54	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m UW	174242	08:45	14:45	360	37	24.54	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	09:46	15:46	360	37	24.54	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	09:46	15:46	360	37	24.54	Coarse	1.67
									Fine	15.00
BH-3	03/02/96	Dichot/T 2m UW	421707	08:23	14:23	360	46	24.55	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m UW	174242	08:23	14:23	360	46	24.55	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	08:46	14:46	360	46	24.55	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	08:46	14:46	360	46	24.55	Coarse	1.67
									Fine	15.00
BH-6	03/16/96	Dichot/T 2m UW	421707	08:59	12:59	240	48	24.62	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m UW	174242	08:59	12:59	240	48	24.62	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	09:09	13:09	240	48	24.62	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	09:09	13:09	240	48	24.62	Coarse	1.67
									Fine	15.00

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction (mg)	PM2.5 Concentration (ug/m^3)	PM10 Concentration (ug/m^3)
BH-1	Dichot/T 2m UW	9559086	114.16	114.21	0.05	0.04	10.20	21.39
		9559087	117 12	117 16	0.04	0.03		
	Dichot/Q 2m UW	9550078	92.39	92.39	0.00	0.02	< 3.7	< 9.5
		9550081	93.34	93.31	-0.03	-0.01		
	Dichot/T 2m DW	9559093	111.61	111.71	0.10	0.09	8.28	40.91
		9559094	115.52	115.55	0.03	0 02		
	Dichot/Q 2m DW	9550076	92.32	92.38	0.06	0.08	4 14	33 47
		9550077	90.49	90.48	-0.01	0.01		
BH-2	Dichot/T 2m UW	9559088	114.42	114.51	0.09	0.08	3.70	16.63
		9559089	114.77	114.80	0.03	0.02		
	Dichot/Q 2m UW	9550072	92.52	92.50	-0.02	0.00	< 2.0	< 3.7
		9550073	92.18	92.14	-0.04	-0.02		
	Dichot/T 2m DW	9559090	112.39	112.49	0.10	0.09	7.41	21.62
		9559091	113.76	113.81	0.05	0.04		
	Dichot/Q 2m DW	9550074	91.10	91.19	0.09	0.11	< 2.0	< 20
		9550075	91.92	91.90	-0.02	0.00		
BH-3	Dichot/T 2m UW	9559057	115.55	115.57	0.02	0.01	5.58	6.65
		9559058	115.29	115.33	0.04	0.03		
	Dichot/Q 2m UW	9550043	91.51	91.54	0.03	0.05	7.41	14.97
		9550044	91.90	91.92	0.02	0.04		
	Dichot/T 2m DW	9559059	116.12	116.19	0.07	0.06	1.85	11.64
		9559092	115.89	115.91	0.02	0.01		
	Dichot/Q 2m DW	9550045	92.47	92.53	0.06	0.08	3.70	16.63
		9550046	89.84	89.84	0.00	0.02		
BH-6	Dichot/T 2m UW	9559041	122.79	122.95	0.16	0.15	5.58	42.42
		9559042	123.35	123.38	0.03	0.02		
	Dichot/Q 2m UW	9550025	91.64	91.82	0.18	0.18	< 3.1	< 48
		9550027	90.92	90.91	-0.01	-0.01		
	Dichot/T 2m DW	9559043	116.36	116.55	0.19	0.18	< 1.4	< 46
		9559044	123.95	123.96	0.01	0.00		
	Dichot/Q 2m DW	9550029	90.32	90.64	0.32	0.32	22.22	99.80
		9550028	92.35	92.43	0.08	0.08		

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

Values preceded by a < indicate instances where at least one blank corrected net filter weight is less than 1 standard deviation of the blank correction. The standard deviation of the blank correction is used in place of the net filter weight to calculate the concentration.

FIELD BLANKS

BH-4

9559053	117.59	117.59	0.00
9559054	115.53	115.54	0.01
9559055	117.00	117.01	0.01
9559056	116.32	116.32	0.00
9550039	92.10	92.09	-0.01
9550040	93.72	93.71	-0.01
9550041	92.24	92.23	-0.01
9550042	92.19	92.18	-0.01
9550081	93.34	93.31	-0.03
9550077	90.49	90.48	-0.01
9550072	92.52	92.50	-0.02
9550073	92.18	92.14	-0.04
9550075	91.92	91.90	-0.02

I-225 Teflon blank average = 0.01, Sx = 0.0058
I-225 quartz blank average = -0.02, Sx = 0.011

BH-5

9559049	121.18	121.19	0.01
9559050	113.61	113.62	0.01
9559051	117.65	117.66	0.01
9559052	117.17	117.17	0.00
9550034	92.21	92.20	-0.01
9550035	90.88	90.89	0.01
9550036	90.95	90.96	0.01
9550037	92.38	92.38	0.00
9550027	90.92	90.91	-0.01

Botanic garden Teflon blank average = 0.01, Sx = 0.005
Botanic garden quartz blank average = 0.00, Sx = 0.012

S8=R8-Q8
T8=S8-appropriate blank average
V8=T9*1000/(15*0.001*H8)
W8=(T8+T9)*1000/(16.7*0.001*H8)

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Flowrate (ft^3/min)
BH-1	02/28/96	Cyc/Imp 2m UW	731	11:21	14:23	182	18	24.86	20
		Cyc/Imp 2m DW	73	11:40	14:23	163	18	24.86	20
BH-2	03/01/96	Cyc/Imp 2m UW	731	08:45	14:45	360	37	24.54	20
		Cyc/Imp 2m DW	73	09:46	15:46	360	37	24.54	20
BH-3	03/02/96	Cyc/Imp 2m UW	731	08:23	14:23	360	46	24.55	20
		Cyc/Imp 2m DW	73	08:46	14:46	360	46	24.55	20
BH-6	03/16/96	Cyc/Imp 2m UW	731	08:59	12:59	240	48	24.62	20
		Cyc/Imp 2m DW	73	09:09	13:09	240	48	24.62	20

Run	Sampler Location	Stage Number	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction
BH-1	Cyc/Imp 2m UW	S-1	9558112	1522.40	1520.70	-1.70	-0.66
		S-2	9558113	1510.55	1509.40	-1.15	-0.11
		S-3	9558114	1515.20	1513.95	-1.25	-0.21
		Backup	9551027	4488.80	4491.35	2.55	3.40
	Cyc/Imp 2m DW	S-1	9558169	1510.40	1510.00	-0.40	0.64
		S-2	9558170	1513.70	1513.60	-0.10	0.94
		S-3	9558171	1510.95	1510.45	-0.50	0.54
		Backup	9558028	4421.40	4423.05	1.65	2.50
BH-2	Cyc/Imp 2m UW	S-1	9558164	1519.45	1519.00	-0.45	0.59
		S-2	9558167	1489.50	1489.00	-0.50	0.54
		S-3	9558168	1509.15	1508.15	-1.00	0.04
		Backup	9551029	4442.10	4442.50	0.40	1.25
	Cyc/Imp 2m DW	S-1	9558162	1523.15	1523.20	0.05	1.09
		S-2	9558163	1511.70	1511.45	-0.25	0.79
		S-3	9558166	1499.65	1499.10	-0.55	0.49
		Backup	9551030	4444.50	4445.55	1.05	1.90
BH-3	Cyc/Imp 2m UW	S-1	9558172	1533.50	1532.45	-1.05	-0.01
		S-2	9558173	1511.15	1510.15	-1.00	0.04
		S-3	9558174	1517.35	1515.95	-1.40	-0.36
		Backup	9551037	4505.50	4505.70	0.20	1.05
	Cyc/Imp 2m DW	S-1	9558175	1498.70	1497.95	-0.75	0.29
		S-2	9558177	1519.90	1519.70	-0.20	0.84
		S-3	9558178	1537.05	1536.35	-0.70	0.34
		Backup	9551036	4478.75	4479.20	0.45	1.30
BH-6	Cyc/Imp 2m UW	S-1	9558190	1522.60	1523.45	0.85	2.12
		S-2	9558191	1517.60	1519.20	1.60	2.87
		S-3	9558192	1528.35	1528.55	0.20	1.47
		Backup	9551056	4583.25	4585.25	2.00	2.75
	Cyc/Imp 2m DW	S-1	9558111	1533.55	1534.20	0.65	1.92
		S-2	9558124	1493.20	1495.55	2.35	3.62
		S-3	9558125	1509.35	1510.80	1.45	2.72
		Backup	9551057	4580.70	4583.15	2.45	3.20

FIELD BLANKS

BH-4	Cyc/Imp 2m UW	S-1	9558181	1524.50	1523.55	-0.95
		S-2	9558182	1531.10	1530.10	-1.00
		S-3	9558183	1523.40	1521.60	-1.80
		Backup	9551042	4514.90	4514.00	-0.90
	Cyc/Imp 2m DW	S-1	9558188	1515.80	1515.15	-0.65
		S-2	9558189	1525.75	1524.75	-1.00
		S-3	9558180	1516.60	1515.75	-0.85
		Backup	9551043	4548.00	4547.20	-0.80

I-225 4 X 5 blank average = -1.04, Sx = 0.39
I-225 8 X 10 blank average = -0.85, Sx = 0.071

BH-5	Cyc/Imp 2m UW	S-1	9558185	1547.20	1545.90	-1.30
		S-2	9558186	1546.45	1545.15	-1.30
		S-3	9558187	1536.30	1535.10	-1.20
		Backup	9551052	4531.25	4530.50	-0.75
	Cyc/Imp 2m DW	S-1	9558193	1514.95	1513.60	-1.35
		S-2	9558194	1504.30	1503.10	-1.20
		S-3	9558184	1525.05	1523.80	-1.25
		Backup	9551053	4548.05	4547.30	-0.75

Botanic garden 4 X 5 blank average = -1.27, Sx = 0.061
Botanic garden 8 X 10 blank average = -0.75, Sx = 0.0

S8=R8-Q8
T8=S8+1.04 for I-225 4 X 5, =S8+0.85 for I-225 8 X 10, =S8+1.27 for botanic garden 4 X 5, and =S8+.85 for botanic garden 8 X 10

Run	Sampler Location	Particulate Concentration (ug/m^3) less than stated size	
		2.1 um	10.2 um
BH-1	Cyc/Imp 2m UW	33	< 41
	Cyc/Imp 2m DW	27	43
BH-2	Cyc/Imp 2m UW	6.1	< 11
	Cyc/Imp 2m DW	9.3	16
BH-3	Cyc/Imp 2m UW	5.1	< 9.0
	Cyc/Imp 2m DW	6.4	<12
BH-6	Cyc/Imp 2m UW	20	52
	Cyc/Imp 2m DW	24	70

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

Values preceded by a < indicate instances where at least one blank corrected net filter weight is less than 1 standard deviation of the blank correction. The standard deviation of the blank correction is used in place of the net filter weight to calculate the concentration.

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Avg. Filter Pressure (in. H2O)	Flowrate (ft^3/min)
BH-1	02/28/96	Cyclone 1m DW	68	11:40	14:23	163	18	24.86	15.82	38.97
		Cyclone 3m DW	69	11:40	14:23	163	18	24.86	15.93	39.25
		Cyclone 5m DW	77	11:40	14:23	163	18	24.86	15.97	39.27
		Cyclone 7m DW	74	11:40	14:23	163	18	24.86	15.65	39.39
		Wedding 2m DW	1598	11:40	14:23	163	18	24.86	15.85	39.54
BH-2	03/01/96	Cyclone 1m DW	77	09:46	15:46	360	37	24.54	17.12	39.78
		Cyclone 3m DW	68	09:46	15:46	360	37	24.54	17.20	39.48
		Cyclone 5m DW	69	09:46	15:46	360	37	24.54	17.49	39.72
		Cyclone 7m DW	74	09:46	15:46	360	37	24.54	16.93	39.86
		Wedding 2m DW	1598	09:46	15:46	360	37	24.54	16.78	40.13
BH-3	03/02/96	Cyclone 1m DW	77	08:46	14:46	360	46	24.55	16.64	40.14
		Cyclone 3m DW	68	08:46	14:46	360	46	24.55	17.29	39.75
		Cyclone 5m DW	69	08:46	14:46	360	46	24.55	18.13	39.94
		Cyclone 7m DW	74	08:46	14:46	360	46	24.55	17.78	40.09
		Wedding 2m DW	1598	08:46	14:46	360	46	24.55	16.55	40.45
BH-6	03/16/96	Cyclone 1m DW	68	09:18	13:18	240	48	24.62	17.15	39.86
		Cyclone 3m DW	74	09:09	13:09	240	48	24.62	17.53	40.21
		Cyclone 5m DW	69	09:09	13:09	240	48	24.62	17.12	40.15
		Cyclone 7m DW	78	09:09	13:09	240	48	24.62	16.84	40.21
		Wedding 2m DW	1598	09:09	13:09	240	48	24.62	18.14	40.29
		Cyclone 2m UW	77	08:59	12:59	240	48	24.62	16.59	40.21
		Cyclone 7m UW	76	08:59	12:59	240	48	24.62	16.63	40.29

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction	PM10 Concentration (ug/m^3)	PM10 Concentration (upwind corrected)	Mean Wind Speed (mph)	IFR	PM10 Exposure (mg/cm^2)
BH-1	Cyclone 1m DW	9551021	4516.65	4529.00	12.35	13.29	74	33	4.0	2.5	0.0575
	Cyclone 3m DW	9551022	4526.05	4536.45	10.40	11.34	63	22	2.9	3.5	0.0274
	Cyclone 5m DW	9551023	4516.45	4557.70	41.25	42.19	233	192	2.4	4.3	0.2012
	Cyclone 7m DW	9551024	4498.20	4530.50	32.30	33.24	183	142	2.1	4.9	0.1302
	Wedding 2m DW	9552011	4163.90	4169.90	6.00	6.00	33		3.3		
BH-2	Cyclone 1m DW	9551031	4596.25	4606.95	10.70	11.64	29	18	13.4	1.0	0.2290
	Cyclone 3m DW	9551032	4455.00	4460.35	5.35	6.29	16	4.6	16.3	0.9	0.0728
	Cyclone 5m DW	9551033	4477.45	4481.70	4.25	5.19	13	1.8	17.7	1.1	0.0310
	Cyclone 7m DW	9551034	4493.90	4503.80	9.90	10.84	27	16	18.6	1.0	0.2815
	Wedding 2m DW	9552012	4168.25	4174.20	5.95	5.95	15		15.2		
BH-3	Cyclone 1m DW	9551038	4557.30	4561.60	4.30	5.24	13	3.8	13.1	1.1	0.0481
	Cyclone 3m DW	9551039	4491.95	4496.20	4.25	5.19	13	3.8	16.5	0.9	0.0404
	Cyclone 5m DW	9551040	4528.90	4532.20	3.30	4.24	10	1.4	18.1	1.1	0.0165
	Cyclone 7m DW	9551041	4523.20	4525.75	2.55	3.49	9	0.0	19.2	1.0	0.0000
	Wedding 2m DW	9552013	4152.65	4157.20	4.55	4.55	11		15.3		
BH-6	Cyclone 1m DW	9551067	4471.45	4550.55	79.10	79.93	295	252	1.4	7.4	0.2275
	Cyclone 3m DW	9551066	4461.70	4553.25	91.55	92.38	338	301	2.8	3.7	0.5419
	Cyclone 5m DW	9551065	4455.70	4472.45	16.75	17.58	64	32	3.4	3.1	0.0705
	Cyclone 7m DW	9551064	4445.10	4456.80	11.70	12.53	46	19	3.8	2.8	0.0461
	Wedding 2m DW	9552016	4455.35	4469.95	14.60	14.50	53		2.3		
	Cyclone 2m UW	9551069	4538.35	4548.35	10.00	10.83	40		2.3	4.5	
	Cyclone 7m UW	9551068	4524.85	4531.35	6.50	7.33	27		3.8	2.8	

FIELD BLANKS

Run	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)
BH-4	9551044	4543.85	4542.75	-1.10
	9551045	4515.10	4514.35	-0.75
	9551046	4490.05	4488.95	-1.10
	9551047	4493.60	4492.80	-0.80
	9552014	4148.55	4148.55	0.00

I-225 glass fiber blank average = -0.94, Sx = 0.19
I-225 quartz blank average = 0.00

Run	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)
BH-5	9551048	4527.60	4526.80	-0.80
	9551049	4525.70	4525.15	-0.55
	9551050	4496.65	4495.80	-0.85
	9551051	4506.25	4505.15	-1.10
	9552015	4386.80	4386.90	0.10

Botanic garden glass fiber blank average = -0.83, Sx = 0.23
Botanic garden quartz blank average = 0.10

S8=R8-Q8
T8=S8+0.94 for BH-1-3 glass fiber,=S8 +0.00 for BH-1-3 quartz, =S8+0.83 for BH-6 glass fiber, =S8-0.10 for BH-6 quartz
V8=(T8*1000)/(L8*H8*0.02832)
Z8=W8*1E-07*X8*H8*0.44704*60

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P (in. Hg)	Aerosol Fraction	Flowrate (liter/min)
BJ-1.2	04/22/96	Dichot/Q 2m UW	174046	13:54	18:32	278	83	29.87	Coarse	1.67
									Fine	15.00
		Dichot/T 1m DW	421707	13:58	17:51	233	83	29.87	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	933053	13:58	17:51	233	83	29.87	Coarse	1.67
									Fine	15.00
		Dichot/Q 1m DW	933057	13:58	17:51	233	83	29.87	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	174242	13:58	17:51	233	83	29.87	Coarse	1.67
									Fine	15.00
BJ-3	04/23/96	Dichot/Q 2m UW	174046	10:16	16:37	381	77	29.71	Coarse	1.67
									Fine	15.00
		Dichot/T 1m DW	421707	10:56	12:51	115	75	29.78	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	933053	10:56	16:27 (a)	197	79	29.68	Coarse	1.67
									Fine	15.00
		Dichot/Q 1m DW	933057	10:56	12:51	115	75	29.78	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	174242	10:56	16:27 (a)	197	79	29.68	Coarse	1.67
									Fine	15.00
BJ-4 (b)	04/23/96	Dichot/T 1m DW	421707	15:05	16:27	82	82	29.63	Coarse	1.67
									Fine	15.00
		Dichot/Q 1m DW	933057	15:05	16:27	82	82	29.63	Coarse	1.67
									Fine	15.00
BJ-6	04/25/96	Dichot/Q 3m UW	174046	09:50	17:52	482	70	29.77	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	421707	10:12	17:42	450	70	29.77	Coarse	1.67
									Fine	15.00
		Dichot/T 6m DW	933053	10:12	17:42	450	70	29.77	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	10:12	17:42	450	70	29.77	Coarse	1.67
									Fine	15.00
		Dichot/Q 6m DW	174242	10:12	17:42	450	70	29.77	Coarse	1.67
									Fine	15.00
BJ-7 (c)	04/26/96	Dichot/Q 3m UW	174046	08:50	11:35	165	68	29.42	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	421707	09:00	11:33	153	68	29.42	Coarse	1.67
									Fine	15.00
		Dichot/T 6m DW	933053	09:00	11:33	153	68	29.42	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	09:00	11:33	153	68	29.42	Coarse	1.67
									Fine	15.00
		Dichot/Q 6m DW	174242	09:00	11:33	153	68	29.42	Coarse	1.67
									Fine	15.00
BJ-9	04/29/96	Dichot/Q 3m UW	174046	09:27	12:34	187	71	29.87	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	421707	09:34	12:32	178	71	29.87	Coarse	1.67
									Fine	15.00
		Dichot/T 6m DW	933053	09:34	12:32	178	71	29.87	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	09:34	12:32	178	71	29.87	Coarse	1.67
									Fine	15.00
		Dichot/Q 6m DW	174242	09.34	12:32	178	71	29.87	Coarse	1.67
									Fine	15.00
BJ-10	05/01/96	Dichot/Q 3m UW	174046	12:30	17:52	322	68	29.83	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	421707	12:51	17:39	288	68	29.83	Coarse	1.67
									Fine	15.00
		Dichot/T 6m DW	933053	12:51	17:39	288	68	29.83	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	12:51	17:39	288	68	29.83	Coarse	1.67
									Fine	15.00
		Dichot/Q 6m DW	174242	12:51	17:39	288	68	29.83	Coarse	1.67
									Fine	15.00
BJ-11 (d)	05/03/96	Dichot/T 2m DW	421707	08:54	15:21	387	75	29.83	Coarse	1.67
									Fine	15.00
		Dichot/T 6m DW	933053	08:54	15:21	387	75	29.83	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	08:54	15.21	387	75	29.83	Coarse	1.67
									Fine	15.00
		Dichot/Q 6m DW	174242	08:54	15:21	387	75	29.83	Coarse	1.67
									Fine	15.00

(a) 3m dichots were shut off between BJ-3 and BJ-4.
(b) Only the 1m dichot filters were changed before BJ-4.
(c) Upwind dichot blew down after the run in 40+ mph wind. Filters were torn
(d) Upwind dichot did not operate

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction (mg)	PM2.5 Concentration (ug/m^3)	PM10 Concentration (ug/m^3)
BJ-1.2	Dichot/Q 2m UW	9550114	90.29	90.38	0.09	0.13	26.38	51.70
		9550115	91.72	91.79	0.07	0.11		
	Dichot/T 1m DW	9559119	114.85	118.16	3.31	3.30	114.45	950.89
		9559120	113.44	113.85	0.41	0.40		
	Dichot/T 3m DW	9559121	114.62	115.50	0.88	0.87	48.64	267.28
		9559122	115.10	115.28	0.18	0.17		
	Dichot/Q 1m DW	9550116	91.77	95.59	3.82	3.86	100.14	1081.96
		9550117	92.12	92.43	0.31	0.35		
	Dichot/Q 3m DW	9550118	91.46	92.42	0.96	1.00	51.50	303.26
		9550119	91.40	91.54	0.14	0.18		
BJ-3	Dichot/Q 2m UW	9550108	92.69	93.12	0.43	0.47	19.25	91.16
		9550109	92.05	92.12	0.07	0.11		
	Dichot/T 1m DW	9559115	114.07	115.48	1.41	1.40	69.57	791.48
		9559116	116.25	116.38	0.13	0.12		
	Dichot/T 3m DW	9559117	118.52	119.48	0.96	0.95	60.91	343.48
		9559118	117.71	117.90	0.19	0.18		
	Dichot/Q 1m DW	9550110	90.55	91.85	1.30	1.34	121.74	807.08
		9550111	90.91	91.08	0.17	0.21		
	Dichot/Q 3m DW	9550112	91.24	92.44	1.20	1.24	47.38	419.47
		9550113	90.68	90.78	0.10	0.14		
BJ-4	Dichot/T 1m DW	9559111	115.36	117.29	1.93	1.92	130.08	1518.91
		9559112	118.18	118.35	0.17	0.16		
	Dichot/Q 1m DW	9550104	92.50	94.46	1.96	2.00	105.69	1555.43
		9550105	91.86	91.95	0.09	0.13		
BJ-6	Dichot/Q 3m UW	9550098	92.37	92.54	0.17	0.19	6.92	29.82
		9550099	92.21	92.24	0.03	0.05		
	Dichot/T 2m DW	9559095	116.18	116.39	0.21	0.21	10.37	37.26
		9559096	117.15	117.22	0.07	0.07		
	Dichot/T 6m DW	9559097	118.33	118.48	0.15	0.15	10.37	29.27
		9559098	115.97	116.04	0.07	0.07		
	Dichot/Q 2m DW	9550094	94.28	94.41	0.13	0.15	13.33	31.94
		9550095	91.80	91.87	0.07	0.09		
	Dichot/Q 6m DW	9550096	91.61	92.11	0.50	0.52	13.33	81.17
		9550097	92.51	92.58	0.07	0.09		
BJ-7	Dichot/Q 3m UW	9550088	90.42	90.27	-0.15	-0.13	(a)	(a)
		9550089	90.13	90.05	-0.08	-0.06		
	Dichot/T 2m DW	9559099	117.21	117.34	0.13	0.13	21.79	70.45
		9559100	115.95	116.00	0.05	0.05		
	Dichot/T 6m DW	9559101	119.45	119.54	0.09	0.09	26.14	58.71
		9559102	117.20	117.26	0.06	0.06		
	Dichot/Q 2m DW	9550090	90.40	90.52	0.12	0.14	34.86	86.10
		9550091	91.25	91.31	0.06	0.08		
	Dichot/Q 6m DW	9550092	91.76	91.92	0.16	0.18	39.22	105.67
		9550093	92.60	92.67	0.07	0.09		
BJ-9	Dichot/Q 3m UW	9550144	91.12	91.20	0.08	0.10	28.52	57.64
		9550145	90.31	90.37	0.06	0.08		
	Dichot/T 2m DW	9559107	113.29	113.40	0.11	0.11	14.98	50.46
		9559108	114.44	114.48	0.04	0.04		
	Dichot/T 6m DW	9559140	115.67	115.74	0.07	0.07	3.75	26.91
		9559141	115.24	115.25	0.01	0.01		
	Dichot/Q 2m DW	9550146	92.07	92.15	0.08	0.10	14.98	47.10
		9550147	90.52	90.54	0.02	0.04		
	Dichot/Q 6m DW	9550148	91.97	92.14	0.17	0.19	26.22	87.47
		9550149	90.41	90.46	0.05	0.07		
BJ-10	Dichot/Q 3m UW	9550138	92.56	92.78	0.22	0.24	18.63	61.37
		9550139	92.37	92.44	0.07	0.09		
	Dichot/T 2m DW	9559138	117.55	117.61	0.06	0.06	9.28	20.79
		9559139	114.08	114.12	0.04	0.04		
	Dichot/T 6m DW	9559142	112.29	112.36	0.07	0.07	6.94	20.79
		9559143	111.60	111.63	0.03	0.03		
	Dichot/Q 2m DW	9550140	92.65	92.75	0.10	0.12	46.30	66.53
		9550141	90.07	90.25	0.18	0.20		
	Dichot/Q 6m DW	9550142	89.81	89.94	0.13	0.15	< 3.7	< 35
		9550143	90.77	90.51	-0.26	-0.24		
BJ-11	Dichot/T 2m DW	9559133	115.11	115.19	0.08	0.08	20.67	30.95
		9559135	120.25	120.37	0.12	0.12		
	Dichot/T 6m DW	9559136	115.65	115.78	0.13	0.13	15.50	34.04
		9559137	114.93	115.02	0.09	0.09		
	Dichot/Q 2m DW	9550134	93.56	93.75	0.19	0.21	27.58	57.25
		9550135	92.76	92.90	0.14	0.16		
	Dichot/Q 6m DW	9550136	93.15	93.36	0.21	0.23	31.01	63.44
		9550137	91.35	91.51	0.16	0.18		

(a) Upwind dichot blew down after the run in 40+ mph wind. Filters were torn.

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

Values preceded by a < indicate instances where at least one blank corrected net filter weight is less than 1 standard deviation of the blank correction. The standard deviation of the blank correction is used in place of the net filter weight to calculate the concentration.

FIELD BLANKS

BJ-5	Quartz	9550102	91.37	91.35	-0.02
	Quartz	9550103	92.76	92.74	-0.02
	Quartz	9550100	92.36	92.19	-0.17
	Quartz	9550101	91.95	91.92	-0.03
	Quartz	9550106	92.99	92.97	-0.02
	Quartz	9550107	89.40	89.41	0.01
	Teflon	9559109	117.58	117.57	-0.01
	Teflon	9559110	116.60	116.62	0.02
	Teflon	9559113	116.42	116.42	0.00
	Teflon	9559114	113.41	113.42	0.01

Unpaved quartz blank average = -0.04, Sx = 0.064
Unpaved Teflon blank average = 0.01, Sx = 0.013

BJ-8	Quartz	9550082	92.62	92.61	-0.01
	Quartz	9550083	90.81	90.79	-0.02
	Quartz	9550084	92.79	92.77	-0.02
	Quartz	9550085	92.71	92.67	-0.04
	Quartz	9550086	92.95	92.93	-0.02
	Quartz	9550087	92.02	92.03	0.01
	Teflon	9559104	115.83	115.83	0.00
	Teflon	9559103	117.79	117.80	0.01
	Teflon	9559105	117.86	117.86	0.00
	Teflon	9559106	118.82	118.82	0.00

Paved quartz blank average = -0.02, Sx = 0.016
Paved Teflon blank average = 0.00, Sx = 0.005

S8=R8-Q8
T8=S8+0.04 for BJ-1-4 quartz, =S8+0.01 for BJ-1-4 teflon, =S8+0.02 for BJ-6-11 quartz, =S8-0.00 for BJ-6-11 teflon
V8=T9*1000/(15*0.001*H8)
W8=(T8+T9)*1000/(16.7*0.001*H8)

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Flowrate (ft^3/min)
BJ-1	04/22/96	Cyc/Imp 2m UW	1	13:54	18:32	278	83	29.87	20
		Cyc/Imp 1m DW	73	13:58	15:27	89	84	29.89	20
		Cyc/Imp 3m DW	731	13:58	15:27	89	84	29.89	20
BJ-2 (a)	04/22/96	Cyc/Imp 1m DW	73	15:56	17:51	115	84	29.86	20
		Cyc/Imp 3m DW	731	15:56	17:51	115	84	29.86	20
BJ-3	04/23/96	Cyc/Imp 2m UW	1	10:16	16:38	382	77	29.71	20
		Cyc/Imp 1m DW	73	10:56	12:51	115	75	29.78	20
		Cyc/Imp 3m DW	731	10:56	12:51	115	75	29.78	20
BJ-4 (b)	04/23/96	Cyc/Imp 1m DW	73	15:05	16:27	82	82	29.63	20
		Cyc/Imp 3m DW	731	15:05	16:27	82	82	29.63	20
BJ-6	04/25/96	Cyc/Imp 2m UW	70	09:50	17:52	542	71	29.74	20
		Cyc/Imp 6m UW	67	09:50	17:52	542	71	29.74	20
		Cyc/Imp 2m DW	69	10:12	17:42	450	71	29.74	20
		Cyc/Imp 6m DW	75	10:12	17:42	450	71	29.74	20
BJ-7	04/26/96	Cyc/Imp 2m UW	70	08:50	11:35	165	68	29.42	20
		Cyc/Imp 6m UW	67	08:50	11:35	165	68	29.42	20
		Cyc/Imp 2m DW	69	09:00	11:33	153	68	29.42	20
		Cyc/Imp 6m DW	75	09:00	11:33	153	68	29.42	20
BJ-9	04/29/96	Cyc/Imp 2m UW	70	09:27	12:34	187	71	29.87	20
		Cyc/Imp 6m UW	67	09:27	12:34	187	71	29.87	20
		Cyc/Imp 2m DW	69	09:34	12:32	178	71	29.87	20
		Cyc/Imp 6m DW	75	09:34	12:32	178	71	29.87	20
BJ-10	05/01/96	Cyc/Imp 2m UW	70	12:30	17:52	322	68	29.83	20
		Cyc/Imp 6m UW	67	12:30	17:52	322	68	29.83	20
		Cyc/Imp 2m DW	69	12:51	17:39	288	68	29.83	20
		Cyc/Imp 6m DW	75	12:51	17:39	288	68	29.83	20
BJ-11	05/03/96	Cyc/Imp 2m UW	70	08:46	15:52	426	75	29.83	20
		Cyc/Imp 6m UW	67	08:46	15:52	426	75	29.83	20
		Cyc/Imp 2m DW	69	08:54	15:21	387	75	29.83	20
		Cyc/Imp 6m DW	75	08:54	15:21	387	75	29.83	20

(a) Upwind is the same as BJ-1
(b) Upwind is the same as BJ-3

Run	Sampler Location	Stage Number	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction
BJ-1	Cyc/Imp 2m UW	S-1	9558341	1558.90	1559.95	1.05	1.15
		S-2	9558340	1544.80	1545.95	1.15	1.25
		S-3	9558339	1527.40	1528.15	0.75	0.85
		S-4	9558338	1501.75	1503.05	1.30	1.40
		S-5	9558337	1523.45	1525.00	1.55	1.65
		Backup	9551085	4550.75	4551.60	0.85	1.12
	Cyc/Imp 1m DW	S-1	9558362	1531.20	1542.35	11.15	11.25
		S-2	9558345	1511.55	1531.50	19.95	20.05
		S-3	9558344	1510.80	1522.10	11.30	11.40
		S-4	9558343	1530.20	1536.50	6.30	6.40
		S-5	9558342	1514.65	1516.85	2.20	2.30
		Backup	9551086	4555.55	4556.80	1.25	1.52
	Cyc/Imp 3m DW	S-1	9558367	1517.10	1520.30	3.20	3.30
		S-2	9558366	1522.80	1527.90	5.10	5.20
		S-3	9558365	1502.80	1505.90	3.10	3.20
		S-4	9558364	1494.05	1495.95	1.90	2.00
		S-5	9558363	1508.50	1509.05	0.55	0.65
		Backup	9551087	4576.50	4577.65	1.15	1.42
BJ-2	Cyc/Imp 1m DW	S-1	9558372	1507.20	1519.75	12.55	12.65
		S-2	9558371	1518.15	1542.85	24.70	24.80
		S-3	9558370	1518.75	1531.75	13.00	13.10
		S-4	9558369	1483.25	1491.35	8.10	8.20
		S-5	9558368	1515.00	1518.00	3.00	3.10
		Backup	9551091	4516.45	4518.80	2.35	2.62
	Cyc/Imp 3m DW	S-1	9558377	1537.65	1540.20	2.55	2.65
		S-2	9558376	1541.15	1545.65	4.50	4.60
		S-3	9558375	1537.10	1540.05	2.95	3.05
		S-4	9558374	1538.50	1540.15	1.65	1.75
		S-5	9558373	1516.40	1517.45	1.05	1.15
		Backup	9551092	4511.20	4513.25	2.05	2.32
BJ-3	Cyc/Imp 2m UW	S-1	9558382	1504.10	1506.30	2.20	2.30
		S-2	9558381	1542.75	1546.35	3.60	3.70
		S-3	9558380	1539.95	1541.20	1.25	1.35
		S-4	9558379	1549.00	1549.80	0.80	0.90
		S-5	9558378	1540.65	1541.55	0.90	1.00
		Backup	9551093	4519.20	4519.90	0.70	0.97
	Cyc/Imp 1m DW	S-1	9558276	1511.35	1523.00	11.65	11.75
		S-2	9558386	1534.40	1557.40	23.00	23.10
		S-3	9558385	1503.60	1515.65	12.05	12.15
		S-4	9558384	1532.25	1538.95	6.70	6.80
		S-5	9558383	1533.50	1536.35	2.85	2.95
		Backup	9551094	4542.50	4544.55	2.05	2.32
	Cyc/Imp 3m DW	S-1	9558281	1535.35	1537.00	1.65	1.75
		S-2	9558280	1523.95	1527.65	3.70	3.80
		S-3	9558279	1542.65	1544.80	2.15	2.25
		S-4	9558278	1511.20	1512.15	0.95	1.05
		S-5	9558277	1512.45	1512.80	0.35	0.45
		Backup	9551095	4553.10	4553.95	0.85	1.12
BJ-4	Cyc/Imp 1m DW	S-1	9558286	1537.35	1552.30	14.95	15.05
		S-2	9558285	1527.90	1553.00	25.10	25.20
		S-3	9558284	1521.40	1534.70	13.30	13.40
		S-4	9558283	1493.65	1501.45	7.80	7.90
		S-5	9558282	1524.65	1527.35	2.70	2.80
		Backup	9551099	4544.75	4548.70	3.95	4.22
	Cyc/Imp 3m DW	S-1	9558291	1499.90	1501.55	1.65	1.75
		S-2	9558290	1497.00	1500.85	3.85	3.95
		S-3	9558289	1514.95	1517.00	2.05	2.15
		S-4	9558288	1532.85	1533.85	1.00	1.10
		S-5	9558287	1512.85	1513.05	0.20	0.30
		Backup	9551100	4539.30	4540.05	0.75	1.02

BJ-6	Cyc/Imp 2m UW	S-1	9558356	1491.35	1491.90	0.55	0.14
		S-2	9558355	1515.00	1515.60	0.60	0.19
		S-3	9558354	1520.45	1520.50	0.05	-0.36
		S-4	9558353	1523.50	1523.85	0.35	-0.06
		S-5	9558352	1536.15	1536.15	0.00	-0.41
		Backup	9551110	4305.40	4307.85	2.45	2.55
	Cyc/Imp 6m UW	S-1	9558361	1523.25	1523.85	0.60	0.19
		S-2	9558360	1510.70	1511.20	0.50	0.09
		S-3	9558359	1532.00	1532.20	0.20	-0.21
		S-4	9558358	1505.15	1505.45	0.30	-0.11
		S-5	9558357	1515.65	1515.70	0.05	-0.36
		Backup	9551111	4362.65	4365.45	2.80	2.90
	Cyc/Imp 2m DW	S-1	9558237	1535.00	1535.00	0.00	-0.41
		S-2	9558236	1535.20	1535.95	0.75	0.34
		S-3	9558235	1526.55	1526.80	0.25	-0.16
		S-4	9558234	1541.85	1542.25	0.40	-0.01
		S-5	9558233	1535.75	1536.85	1.10	0.69
		Backup	9551112	4364.50	4369.20	4.70	4.80
	Cyc/Imp 6m DW	S-1	9558242	1505.30	1504.00	-1.30	-1.71
		S-2	9558241	1511.95	1511.60	-0.35	-0.76
		S-3	9558240	1504.25	1503.40	-0.85	-1.26
		S-4	9558239	1510.35	1509.45	-0.90	-1.31
		S-5	9558238	1508.30	1507.00	-1.30	-1.71
		Backup	9551113	4288.20	4292.15	3.95	4.05
BJ-7	Cyc/Imp 2m UW	S-1	9558247	1508.45	1507.70	-0.75	-1.16
		S-2	9558246	1519.30	1518.65	-0.65	-1.06
		S-3	9558245	1511.35	1511.05	-0.30	-0.71
		S-4	9558244	1497.60	1497.00	-0.60	-1.01
		S-5	9558243	1490.85	1490.70	-0.15	-0.56
		Backup	9551114	4344.50	4346.45	1.95	2.05
	Cyc/Imp 6m UW	S-1	9558252	1503.60	1502.50	-1.10	-1.51
		S-2	9558251	1490.00	1489.55	-0.45	-0.86
		S-3	9558250	1505.85	1505.35	-0.50	-0.91
		S-4	9558249	1492.35	1491.55	-0.80	-1.21
		S-5	9558248	1509.95	1509.45	-0.50	-0.91
		Backup	9551115	4259.75	4261.70	1.95	2.05
	Cyc/Imp 2m DW	S-1	9558257	1509.15	1508.55	-0.60	-1.01
		S-2	9558256	1496.75	1496.45	-0.30	-0.71
		S-3	9558255	1493.30	1493.10	-0.20	-0.61
		S-4	9558254	1504.40	1504.45	0.05	-0.36
		S-5	9558253	1515.45	1515.15	-0.30	-0.71
		Backup	9551116	4256.80	4259.95	3.15	3.25
	Cyc/Imp 6m DW	S-1	9558262	1506.65	1506.40	-0.25	-0.66
		S-2	9558261	1508.30	1508.35	0.05	-0.36
		S-3	9558260	1520.35	1520.25	-0.10	-0.51
		S-4	9558259	1512.20	1512.25	0.05	-0.36
		S-5	9558258	1504.05	1503.90	-0.15	-0.56
		Backup	9551117	4281.20	4286.95	5.75	5.85
BJ-9	Cyc/Imp 2m UW	S-1	9558213	1518.15	1519.95	1.80	1.39
		S-2	9558212	1498.60	1500.75	2.15	1.74
		S-3	9558211	1514.55	1517.00	2.45	2.04
		S-4	9558210	1520.60	1522.65	2.05	1.64
		S-5	9558209	1496.25	1497.90	1.65	1.24
		Backup	9551124	4315.55	4317.00	1.45	1.55
	Cyc/Imp 6m UW	S-1	9558208	1505.75	1507.15	1.40	0.99
		S-2	9558207	1515.75	1517.55	1.80	1.39
		S-3	9558206	1518.70	1519.85	1.15	0.74
		S-4	9558205	1500.75	1502.00	1.25	0.84
		S-5	9558204	1499.00	1499.85	0.85	0.44
		Backup	9551123	4329.40	4343.15	13.75	13.85
	Cyc/Imp 2m DW	S-1	9558202	1516.10	1516.00	-0.10	-0.51
		S-2	9558201	1522.15	1522.55	0.40	-0.01
		S-3	9558200	1508.60	1509.05	0.45	0.04
		S-4	9558199	1503.50	1503.95	0.45	0.04
		S-5	9558198	1517.90	1518.15	0.25	-0.16
		Backup	9551122	4253.70	4255.35	1.65	1.75
	Cyc/Imp 6m DW	S-1	9558218	1512.60	1514.55	1.95	1.54
		S-2	9558217	1521.20	1523.35	2.15	1.74
		S-3	9558216	1523.20	1525.15	1.95	1.54
		S-4	9558215	1525.00	1527.10	2.10	1.69
		S-5	9558214	1505.65	1507.65	2.00	1.59
		Backup	9551125	4249.25	4250.65	1.40	1.50

BJ-10	Cyc/Imp 2m UW	S-1	9558092	1511.20	1510.90	-0.30	-0.71
		S-2	9558232	1535.50	1534.05	-1.45	-1.86
		S-3	9558231	1529.80	1528.40	-1.40	-1.81
		S-4	9558230	1533.75	1531.60	-2.15	-2.56
		S-5	9558229	1533.75	1532.20	-1.55	-1.96
		Backup	9551128	4266.85	4267.65	0.80	0.90
	Cyc/Imp 6m UW	S-1	9558097	1524.35	1523.95	-0.40	-0.81
		S-2	9558096	1506.30	1506.05	-0.25	-0.66
		S-3	9558095	1515.20	1515.45	0.25	-0.16
		S-4	9558094	1510.90	1511.00	0.10	-0.31
		S-5	9558093	1501.75	1501.90	0.15	-0.26
		Backup	9551129	4254.65	4256.00	1.35	1.45
	Cyc/Imp 2m DW	S-1	9558223	1513.20	1512.60	-0.60	-1.01
		S-2	9558222	1521.90	1522.50	0.60	0.19
		S-3	9558221	1527.95	1526.60	-1.35	-1.76
		S-4	9558220	1503.40	1502.55	-0.85	-1.26
		S-5	9558219	1527.05	1525.75	-1.30	-1.71
		Backup	9551126	4279.60	4281.75	2.15	2.25
	Cyc/Imp 6m DW	S-1	9558228	1530.10	1528.85	-1.25	-1.66
		S-2	9558227	1518.35	1517.20	-1.15	-1.56
		S-3	9558226	1493.95	1492.65	-1.30	-1.71
		S-4	9558225	1498.25	1496.90	-1.35	-1.76
		S-5	9558224	1516.60	1515.15	-1.45	-1.86
		Backup	9551127	4322.65	4323.80	1.15	1.25
BJ-11	Cyc/Imp 2m UW	S-1	9558116	1506.70	1507.45	0.75	0.34
		S-2	9558115	1510.20	1511.65	1.45	1.04
		S-3	9558110	1485.10	1485.85	0.75	0.34
		S-4	9558109	1501.60	1502.00	0.40	-0.01
		S-5	9558108	1514.25	1514.15	-0.10	-0.51
		Backup	9551131	4288.55	4292.30	3.75	3.85
	Cyc/Imp 6m UW	S-1	9558128	1502.85	1504.25	1.40	0.99
		S-2	9558127	1527.55	1528.90	1.35	0.94
		S-3	9558126	1504.60	1505.55	0.95	0.54
		S-4	9558123	1493.60	1494.40	0.80	0.39
		S-5	9558122	1516.35	1517.25	0.90	0.49
		Backup	9551133	4296.85	4299.15	2.30	2.40
	Cyc/Imp 2m DW	S-1	9558107	1494.40	1494.90	0.50	0.09
		S-2	9558101	1515.60	1516.75	1.15	0.74
		S-3	9558100	1523.35	1523.50	0.15	-0.26
		S-4	9558099	1521.80	1521.90	0.10	-0.31
		S-5	9558098	1523.25	1523.40	0.15	-0.26
		Backup	9551130	4305.80	4309.80	4.00	4.10
	Cyc/Imp 6m DW	S-1	9558121	1522.55	1523.65	1.10	0.69
		S-2	9558120	1513.35	1514.65	1.30	0.89
		S-3	9558119	1518.45	1519.45	1.00	0.59
		S-4	9558118	1516.55	1517.55	1.00	0.59
		S-5	9558117	1518.45	1519.20	0.75	0.34
		Backup	9551132	4209.00	4211.65	2.65	2.75

FIELD BLANKS

BJ-5	Cyc/Imp 2m UW	S-1	9558351	1533.10	1533.30	0.20
		S-2	9558350	1539.10	1539.15	0.05
		S-3	9558349	1529.00	1528.95	-0.05
		S-4	9558348	1535.65	1535.80	0.15
		S-5	9558347	1540.55	1540.70	0.15
		Backup	9551109	4250.35	4250.20	-0.15
	Cyc/Imp 1m DW	S-1	9558346	1512.50	1512.90	0.40
		S-2	9558300	1507.50	1507.35	-0.15
		S-3	9558299	1514.05	1513.50	-0.55
		S-4	9558298	1516.50	1516.50	0.00
		S-5	9558297	1505.35	1505.15	-0.20
		Backup	9551108	4284.20	4284.15	-0.05
	Cyc/Imp 3m DW	S-1	9558296	1504.75	1504.55	-0.20
		S-2	9558295	1518.65	1518.20	-0.45
		S-3	9558294	1506.20	1505.50	-0.70
		S-4	9558293	1505.30	1505.00	-0.30
		S-5	9558292	1510.20	1510.40	0.20
		Backup	9558107	4321.80	4321.20	-0.60

Unpaved 4 X 5 blank average = -0.10, Sx = 0.31
Unpaved 8 X 10 blank average = -0.27, Sx = 0.29

BJ-8	Cyc/Imp 2m UW	S-1	9558272	1505.85	1504.80	-1.05
		S-2	9558271	1514.70	1513.75	-0.95
		S-3	9558270	1525.65	1524.90	-0.75
		S-4	9558269	1523.70	1523.00	-0.70
		S-5	9558268	1516.35	1515.70	-0.65
		Backup	9551119	4250.15	4250.00	-0.15
	Cyc/Imp 6m UW	S-1	9558267	1519.50	1519.25	-0.25
		S-2	9558266	1513.70	1512.70	-1.00
		S-3	9558265	1535.35	1534.25	-1.10
		S-4	9558264	1500.90	1500.20	-0.70
		S-5	9558263	1487.85	1487.25	-0.60
		Backup	9551118	4308.65	4308.50	-0.15
	Cyc/Imp 2m DW	S-1	9558197	1522.45	1524.00	1.55
		S-2	9558196	1528.10	1529.35	1.25
		S-3	9558176	1535.65	1538.30	2.65
		S-4	9558165	1499.60	1502.45	2.85
		S-5	9558161	1514.60	1518.30	3.70
		Backup	9551121	4324.60	4324.55	-0.05
	Cyc/Imp 6m DW	S-1	9558160	1512.80	1515.90	3.10
		S-2	9558159	1500.05	1502.85	2.80
		S-3	9558275	1524.60	1523.60	-1.00
		S-4	9558274	1509.25	1509.05	-0.20
		S-5	9558273	1512.00	1511.25	-0.75
		Backup	9551120	4291.65	4291.60	-0.05

Paved 4 X 5 blank average = 0.41, Sx = 1.70
Paved 8 X 10 blank average = -0.10, Sx = 0.058

S8=R8-Q8
T8=S8+.10 for unpaved 4 X 5, =S8+.27 for unpaved 8 X 10, =S8-.41 for paved 4 X 5, and =S8+.10 for paved 8 X 10

Run	Sampler Location	Particulate Concentration (ug/m^3) less than stated size 2.1 um	10.2 um
BJ-1	Cyc/Imp 2m UW	26	40
	Cyc/Imp 1m DW	203	827
	Cyc/Imp 3m DW	81	247
BJ-2 (a)	Cyc/Imp 1m DW	214	796
	Cyc/Imp 3m DW	80	198
BJ-3	Cyc/Imp 2m UW	13	37
	Cyc/Imp 1m DW	185	729
	Cyc/Imp 3m DW	40	133
BJ-4 (b)	Cyc/Imp 1m DW	321	1152
	Cyc/Imp 3m DW	< 52	< 184
BJ-6	Cyc/Imp 2m UW	< 19	< 30
	Cyc/Imp 6m UW	< 21	< 32
	Cyc/Imp 2m DW	< 32	< 46
	Cyc/Imp 6m DW	< 29	< 43
BJ-7	Cyc/Imp 2m UW	< 58	< 95
	Cyc/Imp 6m UW	< 58	< 95
	Cyc/Imp 2m DW	< 77	< 116
	Cyc/Imp 6m DW	< 107	< 146
BJ-9	Cyc/Imp 2m UW	< 47	< 82
	Cyc/Imp 6m UW	< 163	< 195
	Cyc/Imp 2m DW	< 51	< 85
	Cyc/Imp 6m DW	< 48	< 83
BJ-10	Cyc/Imp 2m UW	< 24	< 42
	Cyc/Imp 6m UW	< 27	< 45
	Cyc/Imp 2m DW	< 35	< 55
	Cyc/Imp 6m DW	< 29	< 49
BJ-11	Cyc/Imp 2m UW	< 30	< 44
	Cyc/Imp 6m UW	< 24	< 38
	Cyc/Imp 2m DW	< 34	< 50
	Cyc/Imp 6m DW	< 28	< 44

(a) Upwind is the same as BJ-1
(b) Upwind is the same as BJ-3

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

Values preceded by a < indicate instances where at least one blank corrected net filter weigh is less than 1 standard deviation of the blank correction. The standard deviation of the blank correction is used in place of the net filter weight to calculate the concentration.

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Avg. Filter Pressure (in. H2O)	Flowrate (ft^3/min)
BJ-1	04/22/96	Cyclone 1m DW	68	13:55	15:27	92.	84	29.89	20.23	41.14
		Cyclone 3m DW	77	13:55	15:27	92	84	29.89	20.16	41.46
		Cyclone 5m DW	76	13:55	15:27	92	84	29.89	19.65	41.63
		Wedding 2m DW	1598	13:58	15:27	89	84	29.89	17.74	42.35
BJ-2	04/22/96	Cyclone 1m DW	68	15:56	17:51	115	84	29.86	20.02	41.19
		Cyclone 3m DW	77	15:56	17:51	115	84	29.86	19.36	41.55
		Cyclone 5m DW	76	15:56	17:51	115	84	29.86	19.13	41.68
		Wedding 2m DW	1598	15:56	17:51	115	84	29.86	18.08	42.35
BJ-3	04/23/96	Cyclone 1m DW	68	10:56	12:51	115	75	29.78	18.32	41.06
		Cyclone 3m DW	77	10:56	12:51	115	75	29.78	18.37	41.38
		Cyclone 5m DW	76	10:56	12:51	115	75	29.78	18.08	41.46
		Wedding 2m DW	1598	10:56	12:51	115	75	29.78	18.31	41.95
BJ-4	04/23/96	Cyclone 1m DW	68	15:05	16:27	82	82	29.63	15.92	41.58
		Cyclone 3m DW	77	15:05	16:27	82	82	29.63	15.48	41.95
		Cyclone 5m DW	76	15:05	16:27	82	82	29.63	16.20	41.93
		Wedding 2m DW	1598	15:05	16:27	82	82	29.63	19.99	41.87
BJ-6	04/25/96	Wedding 2m DW	1598	10:12	17:42	450	71	29.74	17.33	41.93
BJ-7	04/26/96	Wedding 2m DW	1598	09:10	11:33	143	68	29.42	17.44	41.73
BJ-9	04/29/96	Wedding 2m DW	1598	09:34	12:32	178	71	29.87	17.65	41.93
BJ-10	05/01/96	Wedding 2m DW	1598	12:51	17:39	288	68	29.83	17.82	41.73
BJ-11	05/03/96	Wedding 2m DW	1598	08:54	15:21	387	75	29.83	18.13	41.95

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction	PM10 Concentration (ug/m^3)	PM10 Concentration (upwind corrected)	Mean Wind Speed (mph)	IFR	PM10 Exposure (mg/cm^2)
BJ-1	Cyclone 1m DW	9551082	4513.55	4760.40	246.85	247.17	2306		8.6	1.2	0.0000
	Cyclone 3m DW	9551083	4536.90	4554.50	17.60	17.92	166		10.7	1.0	0.0000
	Cyclone 5m DW	9551084	4529.70	4532.40	2.70	3.02	28		11.4	1.0	0.0000
	Wedding 2m DW	9552051	4173.15	4213.40	40.25	39.60	371				
BJ-2	Cyclone 1m DW	9551088	4561.00	4818.15	257.15	257.47	1919		8.6	1.2	0.0000
	Cyclone 3m DW	9551089	4549.20	4572.80	23.60	23.92	177		10.7	1.0	0.0000
	Cyclone 5m DW	9551090	4396.80	4399.75	2.95	3.27	24		12.3	0.9	0.0000
	Wedding 2m DW	9552052	4169.45	4216.00	46.55	45.90	333				
BJ-3	Cyclone 1m DW	9551096	4567.05	4667.40	100.35	100.67	753		12.7	0.8	0.0000
	Cyclone 3m DW	9551097	4552.60	4570.25	17.65	17.97	133		15.1	1.0	0.0000
	Cyclone 5m DW	9551098	4519.80	4524.60	4.80	5.12	38		16.1	1.2	0.0000
	Wedding 2m DW	9552053	4167.55	4208.50	40.95	40.30	295				
BJ-4	Cyclone 1m DW	9551103	4203.05	4368.20	165.15	165.47	1714		13.6	0.8	0.0000
	Cyclone 3m DW	9551102	4268.60	4281.15	12.55	12.87	132		17.1	0.9	0.0000
	Cyclone 5m DW	9551101	4296.45	4299.90	3.45	3.77	39		18.6	1.1	0.0000
	Wedding 2m DW	9552054	4449.20	4491.20	42.00	41.35	425				
BJ-6	Wedding 2m DW	9552056	4132.10	4141.50	9.40	9.25	17		5.4		
BJ-7	Wedding 2m DW	9552057	4154.65	4158.25	3.60	3.45	20		5.4		
BJ-9	Wedding 2m DW	9552059	4141.50	4146.25	4.75	4.60	22		5.5		
BJ-10	Wedding 2m DW	9552060	4155.70	4161.45	5.75	5.60	16		6.6		
BJ-11	Wedding 2m DW	9552061	4165.60	4176.30	10.70	10.55	23		3.4		

<u>FIELD BLANKS</u>

Run	Sampler	Filter Number	Tare Wt.	Final Wt.	Net Wt.
BJ-5	Cyclone	9551104	4284.25	4284.15	-0.10
	Cyclone	9551105	4325.60	4325.00	-0.60
	Cyclone	9551106	4254.45	4254.20	-0.25
	Wedding	9552055	4152.20	4152.85	0.65

Unpaved glass fiber blank average = -0.32, Sx = 0.26
Unpaved quartz blank average = 0.65

Run	Sampler	Filter Number	Tare Wt.	Final Wt.	Net Wt.
BJ-8	Wedding	9552058	4138.50	4138.65	0.15

Paved quartz blank average = 0.15

S8=R8-Q8
T8=S8+0.32 for BJ-1-4 cyclones, =S8-0.65 for BJ-1-4 Wedding, =S8-0.15 for BJ-6-11 Wedding
V8=(T8*1000)/(L8*H8*0.02832)
Y8=L8/(nozzle area*W8*88)
Z8=W8*0.0000001*X8*H8*0.44704*60

Reno

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Aerosol Fraction	Flowrate (liter/min)
BK-1,2	05/28/96	Dichot/T 2m DW	421707	16:20	18:04	104	71	25.48	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	16:20	18:04	104	71	25.48	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	16:20	18:04	104	71	25.48	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	174242	16:20	18:04	104	71	25.48	Coarse	1.67
									Fine	15.00
BK-3,4	05/29/96	Dichot/T 2m DW	421707	15:33	17:07	94	70	25.45	Coarse	1.67
									Fine	15.00
		Dichot/T 2m DW	933053	15:33	17:07	94	70	25.45	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	933057	15:33	17:07	94	70	25.45	Coarse	1.67
									Fine	15.00
		Dichot/Q 2m DW	174242	15:33	17:07	94	70	25.45	Coarse	1.67
									Fine	15.00
BK-7	06/03/96	Dichot/T 3m UW	174046	11:53	19:37	464	89	25.37	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	421707	12:17	19:17	420	89	25.37	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	933053	12:17	19:17	420	89	25.37	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	933057	12:17	19:17	420	89	25.37	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	174242	12:17	19:17	420	89	25.37	Coarse	1.67
									Fine	15.00
BK-8	06/04/96	Dichot/T 3m UW	174046	14:42	19:43	301	87	25.28	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	421707	14:47	19:17	270	87	25.28	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	933053	14:47	19:17	270	87	25.28	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	933057	14:47	19:17	270	87	25.28	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	174242	14:47	19:17	270	87	25.28	Coarse	1.67
									Fine	15.00
BK-9	06/06/96	Dichot/T 3m UW	174046	14:37	18:56	259	90	25.28	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	421707	14:45	18:45	240	90	25.28	Coarse	1.67
									Fine	15.00
		Dichot/T 3m DW	933053	14:45	18:45	240	90	25.28	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	933057	14:45	18:45	240	90	25.28	Coarse	1.67
									Fine	15.00
		Dichot/Q 3m DW	174242	14:45	18:45	240	90	25.28	Coarse	1.67
									Fine	15.00

M	N	O	P	Q	R	S	T	U	V	W
	Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction (mg)		PM2.5 Concentration (ug/m^3)	PM10 Concentration (ug/m^3)
	BK-1,2	Dichot/T 2m DW	9559200	117.53	118.50	0.97	0.94		45	582
			9559201	116.39	116.49	0.10	0.07			
		Dichot/T 2m DW	9559202	117.01	118.15	1.14	1.11		90	720
			9559203	118.08	118.25	0.17	0.14			
		Dichot/Q 2m DW	9550216	91.17	92.50	1.33	1.35		77	846
			9550217	91.61	91.71	0.10	0.12			
		Dichot/Q 2m DW	9550218	92.19	93.73	1.54	1.56		58	950
			9550219	91.27	91.34	0.07	0.09			
	BK-3,4	Dichot/T 2m DW	9559194	115.51	118.48	2.97	2.94		177	2032
			9559195	113.92	114.20	0.28	0.25			
		Dichot/T 2m DW	9559196	117.90	121.21	3.31	3.28		158	2230
			9559197	117.26	117.51	0.25	0.22			
		Dichot/Q 2m DW	9550212	90.77	94.35	3.58	3.60		199	2472
			9550213	92.54	92.80	0.26	0.28			
		Dichot/Q 2m DW	9550214	93.55	97.17	3.62	3.64		177	2478
			9550215	90.83	91.06	0.23	0.25			
	BK-7	Dichot/T 3m UW	9559174	119.01	119.15	0.14	0.12		7.2	22
			9559175	117.80	117.87	0.07	0.05			
		Dichot/T 3m DW	9559180	120.34	120.56	0.22	0.20		11	38
			9559181	121.32	121.41	0.09	0.07			
		Dichot/T 3m DW	9559182	117.98	118.17	0.19	0.17		11	34
			9559183	116.47	116.56	0.09	0.07			
		Dichot/Q 3m DW	9550198	90.94	91.10	0.16	0.16		9.5	31
			9550199	91.76	91.82	0.06	0.06			
		Dichot/Q 3m DW	9550201	90.63	90.96	0.33	0.33		4.8	51
			9550202	91.03	91.06	0.03	0.03			
	BK-8	Dichot/T 3m UW	9559168	113.76	113.86	0.10	0.08		6.8	22
			9559169	115.84	115.89	0.05	0.03			
		Dichot/T 3m DW	9559170	119.85	120.00	0.15	0.13		9.9	38
			9559171	116.04	116.10	0.06	0.04			
		Dichot/T 3m DW	9559172	119.61	119.77	0.16	0.14		15	44
			9559173	118.37	118.45	0.08	0.06			
		Dichot/Q 3m DW	9550194	91.09	91.16	0.07	0.07		12	27
			9550195	91.36	91.41	0.05	0.05			
		Dichot/Q 3m DW	9550196	92.20	92.36	0.16	0.16		7.4	42
			9550197	90.34	90.37	0.03	0.03			
	BK-9	Dichot/T 3m UW	9559166	113.59	113.67	0.08	0.06		7.7	21
			9559167	117.81	117.86	0.05	0.03			
		Dichot/T 3m DW	9559162	113.20	113.30	0.10	0.08		2.8	22
			9559163	114.22	114.25	0.03	0.01			
		Dichot/T 3m DW	9559164	115.45	115.53	0.08	0.06		8.3	22
			9559165	116.38	116.43	0.05	0.03			
		Dichot/Q 3m DW	9550190	90.85	90.92	0.07	0.07		14	30
			9550191	92.20	92.25	0.05	0.05			
		Dichot/Q 3m DW	9550192	92.66	92.71	0.05	0.05		14.	25
			9550193	91.91	91.96	0.05	0.05			

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

FIELD BLANKS

Run	Type	Filter Number	Tare Wt.	Final Wt.	Net Wt.
BK-5	Teflon	9559190	116.92	116.95	0.03
	Teflon	9559191	117.53	117.56	0.03
	Teflon	9559192	118.00	118.03	0.03
	Teflon	9559193	116.22	116.25	0.03
	Quartz	9550207	91.41	91.40	-0.01
	Quartz	9550209	91.66	91.64	-0.02
	Quartz	9550210	90.80	90.78	-0.02
	Quartz	9550211	90.64	90.63	-0.01

Unpaved Teflon blank average = 0.03, Sx = 0.00
Unpaved quartz blank average = -0.02, Sx = 0.0058

Run	Type	Filter Number	Tare Wt.	Final Wt.	Net Wt.
BK-6	Teflon	9559178	119.76	119.77	0.01
	Teflon	9559179	115.78	115.80	0.02
	Teflon	9559186	119.22	119.23	0.01
	Teflon	9559187	118.29	118.30	0.01
	Teflon	9559188	115.03	115.04	0.01
	Teflon	9559189	118.36	118.39	0.03
	Quartz	9550203	91.16	91.16	0.00
	Quartz	9550204	92.32	92.31	-0.01
	Quartz	9550205	90.56	90.55	-0.01
	Quartz	9550206	91.18	91.20	0.02

Paved Teflon blank average = 0.02, Sx = 0.0084
Paved quartz blank average = 0.00, Sx = 0.014

S8=R8-Q8
T8=S8-0.03 for BK-1-4 teflon, =S8+0.02 for BK-1-4 quartz, =S8-0.02 for BK-7-9 teflon, =S8-0.00 for BK-7-9 quartz
V8=T9*1000/(15*0.001*H8)
W8=(T8+T9)*1000/(16.7*0.001*H8)

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Flowrate (ft^3/min)
BK-1.2	05/28/96	Cyc/Imp 1m DW	1	16:20	18:04	104	71	25.48	20
		Cyc/Imp 3m DW	73	16:20	18:04	104	71	25.48	20
BK-3	05/29/96	Cyc/Imp 1m DW	1	15:33	16:20	47	70	25.45	20
		Cyc/Imp 3m DW	73	15:33	17:07	94	70	25.45	20
BK-4 (a)	05/29/96	Cyc/Imp 1m DW	1	16:40	17:07	27	71	25.45	20
BK-7	06/03/96	Cyc/Imp 2m UW	74	11:53	19:37	464	89	25.37	20
		Cyc/Imp 6m UW	67	11:53	19:37	464	89	25.37	20
		Cyc/Imp 1.5m DW	1	12:17	19:17	420	89	25.37	20
		Cyc/Imp 3m DW	73	12:17	19:17	420	89	25.37	20
BK-8	06/04/96	Cyc/Imp 2m UW	74	14:42	19:43	301	87	25.28	20
		Cyc/Imp 6m UW	67	14:42	19:43	301	87	25.28	20
		Cyc/Imp 1.5m DW	1	14:47	19:17	270	87	25.28	20
		Cyc/Imp 3m DW	73	14:47	19:17	270	87	25.28	20
BK-9	06/06/96	Cyc/Imp 2m UW	74	14:37	18:56	259	90	25.28	20
		Cyc/Imp 6m UW	67	14:37	18:56	259	90	25.28	20
		Cyc/Imp 1.5m DW	1	14:45	18:45	240	90	25.28	20
		Cyc/Imp 3m DW	73	14:45	18:45	240	90	25.28	20

(a) 3m sampler is the same as BK-3

Run	Sampler Location	Stage Number	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction
BK-1,2	Cyc/Imp 1m DW	S-1	9558561	1510.24	1541.23	30.99	31.01
		S-2	9559560	1493.90	1543.26	49.36	49.38
		S-3	9558559	1509.33	1536.34	27.01	27.03
		S-4	9558558	1504.17	1518.18	14.01	14.03
		S-5	9558557	1533.52	1539.61	6.09	6.11
		Backup	9541205	4235.10	4243.55	8.45	8.75
	Cyc/Imp 3m DW	S-1	9558556	1512.81	1516.56	3.75	3.77
		S-2	9558555	1510.30	1515.76	5.46	5.48
		S-3	9558554	1494.67	1498.09	3.42	3.44
		S-4	9558553	1514.57	1516.31	1.74	1.76
		S-5	9558552	1524.44	1524.98	0.54	0.56
		Backup	9541204	4246.25	4248.45	2.20	2.50
BK-3	Cyc/Imp 1m DW	S-1	9558517	1495.97	1529.72	33.75	33.77
		S-2	9558516	1507.04	1565.98	58.94	58.96
		S-3	9558515	1506.00	1533.73	27.73	27.75
		S-4	9558514	1506.80	1522.68	15.88	15.90
		S-5	9558513	1515.36	1521.85	6.49	6.51
		Backup	9541213	4243.15	4251.55	8.40	8.70
	Cyc/Imp 3m DW	S-1	9558512	1494.50	1507.00	12.50	12.52
		S-2	9558511	1513.38	1534.36	20.98	21.00
		S-3	9558564	1501.84	1514.02	12.18	12.20
		S-4	9558563	1527.76	1533.83	6.07	6.09
		S-5	9558562	1501.97	1504.18	2.21	2.23
		Backup	9541212	4287.95	4291.70	3.75	4.05
BK-4	Cyc/Imp 1m DW	S-1	9558532	1493.79	1524.75	30.96	30.98
		S-2	9558531	1481.71	1551.81	70.10	70.12
		S-3	9558530	1507.62	1540.85	33.23	33.25
		S-4	9558529	1495.51	1513.00	17.49	17.51
		S-5	9558528	1500.34	1507.30	6.96	6.98
		Backup	9541222	4322.00	4328.90	6.90	7.20
BK-7	Cyc/Imp 2m UW	S-1	9558506	1500.90	1501.68	0.78	1.14
		S-2	9558505	1492.00	1493.06	1.06	1.42
		S-3	9558504	1517.72	1518.27	0.55	0.91
		S-4	9558503	1514.28	1514.59	0.31	0.67
		S-5	9558502	1498.50	1498.52	0.02	0.38
		Backup	9541241	4273.00	4275.60	2.60	3.05
	Cyc/Imp 6m UW	S-1	9558422	1530.67	1531.72	1.05	1.41
		S-2	9558510	1522.34	1524.58	2.24	2.60
		S-3	9558509	1510.30	1511.48	1.18	1.54
		S-4	9558508	1506.85	1507.26	0.41	0.77
		S-5	9558507	1519.60	1519.78	0.18	0.54
		Backup	9541242	4237.55	4240.50	2.95	3.40
	Cyc/Imp 1.5m DW	S-1	9558486	1526.48	1527.40	0.92	1.28
		S-2	9558485	1501.30	1502.26	0.96	1.32
		S-3	9558484	1509.06	1509.78	0.72	1.08
		S-4	9558483	1487.62	1487.74	0.12	0.48
		S-5	9558482	1486.86	1486.72	-0.14	0.22
		Backup	9541233	4304.65	4309.15	4.50	4.95
	Cyc/Imp 3m DW	S-1	9558491	1521.78	1522.16	0.38	0.74
		S-2	9558490	1509.90	1510.75	0.85	1.21
		S-3	9558489	1513.67	1514.57	0.90	1.26
		S-4	9558488	1511.32	1511.91	0.59	0.95
		S-5	9558487	1495.35	1495.53	0.18	0.54
		Backup	9541234	4318.25	4321.15	2.90	3.35
BK-8	Cyc/Imp 2m UW	S-1	9558431	1314.57	1314.89	0.32	0.68
		S-2	9558430	1316.41	1317.40	0.99	1.35
		S-3	9558429	1328.87	1329.00	0.13	0.49
		S-4	9558424	1500.00	1500.24	0.24	0.60
		S-5	9558423	1499.80	1499.74	-0.06	0.30
		Backup	9541243	4292.85	4295.30	2.45	2.90
	Cyc/Imp 6m UW	S-1	9558436	1338.36	1338.91	0.55	0.91
		S-2	9558435	1325.74	1326.32	0.58	0.94
		S-3	9558434	1327.12	1327.60	0.48	0.84
		S-4	9558433	1330.61	1330.74	0.13	0.49
		S-5	9558432	1335.27	1335.34	0.07	0.43
		Backup	9541244	4304.45	4307.20	2.75	3.20
	Cyc/Imp 1.5m DW	S-1	9558441	1506.24	1506.67	0.43	0.79
		S-2	9558440	1516.50	1517.36	0.86	1.22
		S-3	9558439	1509.52	1510.03	0.51	0.87
		S-4	9558438	1508.35	1508.31	-0.04	0.32
		S-5	9558437	1532.39	1532.20	-0.19	0.17
		Backup	9541245	4268.85	4271.40	2.55	3.00
	Cyc/Imp 3m DW	S-1	9558446	1519.28	1518.76	-0.52	-0.16
		S-2	9558445	1561.07	1561.32	0.25	0.61
		S-3	9558444	1572.42	1572.09	-0.33	0.03
		S-4	9558443	1525.43	1524.92	-0.51	-0.15
		S-5	9558442	1523.85	1523.37	-0.48	-0.12
		Backup	9541246	4292.20	4294.50	2.30	2.75

BK-9	Cyc/Imp 2m UW	S-1	9558451	1507.00	1507.38	0.38	0.74
		S-2	9558450	1543.92	1544.70	0.78	1.14
		S-3	9558449	1523 87	1524.26	0.39	0.75
		S-4	9558448	1526.50	1526.50	0 00	0.36
		S-5	9558447	1529.14	1529 43	0.29	0 65
		Backup	9541251	4327.30	4329.20	1.90	2.25
	Cyc/Imp 6m UW	S-1	9558456	1526.85	1526.89	0.04	0.40
		S-2	9558455	1526.10	1526.25	0.15	0.51
		S-3	9558454	1516.78	1517.00	0.22	0.58
		S-4	9558453	1533.93	1534.03	0.10	0.46
		S-5	9558452	1525.70	1525.50	-0.20	0.16
		Backup	9541252	4267.85	4289.40	1.55	2.00
	Cyc/Imp 1.5m DW	S-1	9558461	1507.05	1506.28	-0.77	-0.41
		S-2	9558460	1489.55	1489.82	0.27	0.63
		S-3	9558459	1491.00	1490.58	-0.42	-0.06
		S-4	9558458	1527.86	1527.07	-0.79	-0.43
		S-5	9558457	1510.28	1510.08	-0.20	0.16
		Backup	9541257	4318.25	4320.50	2.25	2.70
	Cyc/Imp 3m DW	S-1	9558466	1496.05	1495.37	-0.68	-0.32
		S-2	9558465	1512.00	1512.73	0.73	1.09
		S-3	9558464	1511.23	1510.70	-0.53	-0.17
		S-4	9558463	1502.63	1502.20	-0.43	-0.07
		S-5	9558462	1514.71	1514.37	-0.34	0.02
		Backup	9541258	4316.60	4317.85	1.25	1.70

FIELD BLANKS

BK-5	Cyc/Imp 1m DW	S-1	9558522	1509.02	1508.83	-0.19
		S-2	9558521	1522.96	1522.90	-0.06
		S-3	9558520	1508.44	1508.26	-0.18
		S-4	9558519	1513.86	1513.75	-0.11
		S-5	9558518	1489.33	1489.25	-0.08
		Backup	9541217	4262.45	4262.35	-0.10
	Cyc/Imp 3m DW	S-1	9558527	1519.45	1519.44	-0.01
		S-2	9558526	1508.67	1508.62	-0.05
		S-3	9558525	1510.73	1510.84	0.11
		S-4	9558524	1497.96	1498.20	0.24
		S-5	9558523	1494.72	1494.83	0.11
		Backup	9541218	4292.15	4291.65	-0.50

Unpaved 4 X 5 blank average = -0.02. Sx = 0.14
Unpaved 8 X 10 blank average = -0.30, Sx = 0.28

BK-6	Cyc/Imp 2m UW	S-1	9558476	1530.00	1529.53	-0.47
		S-2	9558475	1525.74	1525.31	-0.43
		S-3	9558474	1508.42	1508.28	-0.14
		S-4	9558473	1530.72	1530.49	-0.23
		S-5	9558472	1539.67	1539.28	-0.39
		Backup	9541231	4280.75	4280.55	-0.20
	Cyc/Imp 6m UW	S-1	9558481	1521.38	1520.97	-0.41
		S-2	9558480	1521.47	1520.84	-0.63
		S-3	9558479	1498.05	1497.77	-0.28
		S-4	9558478	1538.32	1537.94	-0.38
		S-5	9558477	1513.19	1513.00	-0.19
		Backup	9541222	4298.05	4298.05	0.00
	Cyc/Imp 1.5m DW	S-1	9558548	1494.72	1494.56	-0.16
		S-2	9558547	1498 48	1498 42	-0.06
		S-3	9558546	1493.58	1493.60	0.02
		S-4	9558545	1507.31	1507.21	-0.10
		S-5	9558544	1514.59	1514.82	0.23
		Backup	9541225	4319.20	4318.50	-0.70
	Cyc/Imp 3m DW	S-1	9558471	1536.56	1535.65	-0.91
		S-2	9558470	1506.30	1505.62	-0.68
		S-3	9558469	1516.40	1515.88	-0.52
		S-4	9558550	1507.90	1507.08	-0.82
		S-5	9558549	1511.52	1510.80	-0.72
		Backup	9541226	4304.50	4303.60	-0.90

Paved 4 X 5 blank average = -0.36, Sx = 0.30
Paved 8 X 10 blank average = -0.45, Sx = 0.42

S8=R8-Q8
T8=S8+.10 for unpaved 4 X 5, =S8+.27 for unpaved 8 X 10, =S8-.41 for paved 4 X 5, and =S8+.10 for paved 8 X 10

Run	Sampler Location	Particulate Concentration (ug/m^3) less than stated size 2.1 um	10.2 um
BK-1.2	Cyc/Imp 1m DW	490	1788
	Cyc/Imp 3m DW	82	233
BK-3	Cyc/Imp 1m DW	1169	4426
	Cyc/Imp 3m DW	232	856
BK-4 (a)	Cyc/Imp 1m DW	2072	8832
BK-7	Cyc/Imp 2m UW	16	24
	Cyc/Imp 6m UW	18	34
	Cyc/Imp 1.5m DW	< 24	< 34
	Cyc/Imp 3m DW	20	31
BK-8	Cyc/Imp 2m UW	22	33
	Cyc/Imp 6m UW	24	35
	Cyc/Imp 1.5m DW	< 24	< 37
	Cyc/Imp 3m DW	< 22	< 28
BK-9	Cyc/Imp 2m UW	23	36
	Cyc/Imp 6m UW	< 19	< 26
	Cyc/Imp 1.5m DW	< 24	< 31
	Cyc/Imp 3m DW	< 17	< 27

(a) 3m sampler is the same as BK-3

Bold values indicate where blank corrected net filter weights are at least 3 times the standard deviation of the blank correction.

Values preceded by a < indicate instances where at least one blank corrected net filter weight is less than 1 standard deviation of the blank correction. The standard deviation of the blank correction is used in place of the net filter weight to calculate the concentration.

Run	Date	Sampler Location	Sampler ID	Sampler Start Time	Sampler Stop Time	Sampler Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Avg. Filter Pressure (in. H2O)	Flowrate (ft^3/min)
BK-1	05/28/96	Wedding 2m UW	1598	16:10	18:22	132	71	25.48	16.98	41.54
		Cyclone 1m DW	76	16:19	17:18	59	72	25.48	16.17	41.27
		Cyclone 3m DW	66	16:19	17:18	59	72	25.48	15.48	41.14
		Cyclone 5m DW	78	16:19	17:18	59	72	25.48	15.55	40.53
		Wedding 2m DW	1424	16:20	17:22	62	72	25.48	16.97	42.28
BK-2 (a)	05/28/96	Cyclone 1m DW	76	17:35	18:04	29	70	25.48	15.96	41.24
		Cyclone 3m DW	66	17:35	18:04	29	70	25.48	15.66	41.07
		Cyclone 5m DW	78	17:35	18:04	29	70	25.48	15.59	40.46
		Wedding 2m DW	1424	17:35	18:04	29	70	25.48	17.43	42.12
BK-3	05/29/96	Wedding 2m UW	1598	15:32	17:11	99	70	25.45	17.07	41.50
		Cyclone 1m DW	76	15:33	16:20	47	70	25.45	16.38	41.20
		Cyclone 3m DW	66	15:33	16:20	47	70	25.45	15.75	41.07
		Cyclone 5m DW	78	15:33	16:20	47	70	25.45	15.60	40.46
		Wedding 2m DW	1424	15:41	16:20	39	70	25.45	18.32	41.91
BK-4 (b)	05/29/96	Cyclone 1m DW	76	16:40	17:07	27	71	25.45	16.62	41.19
		Cyclone 3m DW	66	16:40	17:07	27	71	25.45	16.11	41.01
		Cyclone 5m DW	78	16:40	17:07	27	71	25.45	15.57	40.49
		Wedding 2m DW	1424	16:40	17:07	27	71	25.45	19.43	41.75
BK-7	06/03/96	Wedding 2m UW	1598	11:53	19:37	464	89	25.37	18.54	40.91
		Cyclone 1m DW	66	12:17	19:17	420	89	25.37	16.18	41.63
		Cyclone 3m DW	78	12:17	19:17	420	89	25.37	16.02	41.06
		Cyclone 5m DW	68	12:17	19:17	420	89	25.37	16.02	41.50
		Cyclone 7m DW	76	12:17	19:17	420	89	25.37	16.35	41.85
		Wedding 2m DW	1424	12:17	19:17	420	89	25.37	18.41	42.66
BK-8	06/04/96	Wedding 2m UW	1598	14:42	19:43	301	87	25.28	18.68	41.82
		Cyclone 1m DW	66	14:47	19:17	270	87	25.28	16.54	41.52
		Cyclone 3m DW	78	14:47	19:17	270	87	25.28	15.80	40.99
		Cyclone 5m DW	68	14:47	19:17	270	87	25.28	15.83	41.43
		Cyclone 7m DW	76	14:47	19:17	270	87	25.28	16.50	41.73
		Wedding 2m DW	1424	14:47	19:17	270	87	25.28	18.78	42.43
BK-9	06/06/96	Wedding 2m UW	1598	14:37	18:56	259	90	25.28	18.84	41.89
		Cyclone 1m DW	66	14:45	18:45	240	90	25.28	16.40	41.62
		Cyclone 3m DW	78	14:45	18:45	240	90	25.28	16.26	41.05
		Cyclone 5m DW	68	14:45	18:45	240	90	25.28	16.36	41.44
		Cyclone 7m DW	76	14:45	18:45	240	90	25.28	16.31	41.89
		Wedding 2m DW	1424	14:45	18:45	240	90	25.28	18.47	42.63

(a) Upwind is the same as BK-1
(b) Upwind is the same as BK-3

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction	PM10 Concentration (ug/m^3)	PM10 Concentration (upwind corrected)	Mean Wind Speed (mph)	IFR	PM10 Exposure (mg/cm^2)
BK-1	Wedding 2m UW	9552062	4148.50	4153.20	4.70	5.18	33				
	Cyclone 1m DW	9541201	4243.10	4349.90	106.80	106.95	1551		3.0	3.6	0.0000
	Cyclone 3m DW	9541202	4220.20	4228.80	8.60	8.75	127		6.0	1.8	0.0000
	Cyclone 5m DW	9541203	4225.35	4227.55	2.20	2.35	35		6.0	1.8	0.0000
	Wedding 2m DW	9552063	4145.25	4181.35	36.10	36.58	493		4.6		
BK-2	Cyclone 1m DW	9541206	4234.00	4335.25	101.25	101.40	2994		2.8	3.8	0.0000
	Cyclone 3m DW	9541207	4242.00	4249.15	7.15	7.30	216		6.5	1.6	0.0000
	Cyclone 5m DW	9541208	4278.55	4279.45	0.90	1.05	32		7.5	1.4	0.0000
	Wedding 2m DW	9552064	4163.25	4192.50	29.25	29.73	859		5.0		
BK-3	Wedding 2m UW	9552065	4160.10	4169.25	9.15	9.63	83				
	Cyclone 1m DW	9541209	4295.35	4530.25	234.90	235.05	4286		3.3	3.2	0.0000
	Cyclone 3m DW	9541210	4259.65	4293.20	33.55	33.70	616		6.6	1.6	0.0000
	Cyclone 5m DW	9541211	4266.45	4274.15	7.70	7.85	146		8.0	1.3	0.0000
	Wedding 2m DW	9552066	4235.35	4302.15	66.80	67.28	1453		5.4		
BK-4	Cyclone 1m DW	9541214	4247.50	4580.60	333.10	333.25	10581		3.3	3.2	0.0000
	Cyclone 3m DW	9541215	4265.70	4308.60	42.90	43.05	1373		6.6	1.6	0.0000
	Cyclone 5m DW	9541216	4262.70	4268.55	5.85	6.00	194		8.0	1.3	0.0000
	Wedding 2m DW	9552067	4313.05	4403.80	90.75	91.23	2858		5.4		
BK-7	Wedding 2m UW	9552075	4206.89	4217.75	10.86	10.51	20				
	Cyclone 1m DW	9541235	4288.75	4305.20	16.45	16.26	33		5.6	1.9	0.0000
	Cyclone 3m DW	9541236	4271.10	4283.55	12.45	12.26	25		6.9	1.5	0.0000
	Cyclone 5m DW	9541237	4300.90	4312.55	11.65	11.46	23		7.6	1.4	0.0000
	Cyclone 7m DW	9541238	4301.95	4315.90	13.95	13.76	28		8.0	1.4	0.0000
	Wedding 2m DW	9552073	4233.30	4248.40	15.10	14.75	29		6.4		
BK-8	Wedding 2m UW	9552076	4211.30	4217.65	6.35	6.00	17				
	Cyclone 1m DW	9541250	4329.25	4339.80	10.55	10.36	33		4.5	2.4	0.0000
	Cyclone 3m DW	9541249	4313.70	4320.45	6.75	6.56	21		5.8	1.8	0.0000
	Cyclone 5m DW	9541248	4296.60	4303.95	7.35	7.16	23		6.4	1.7	0.0000
	Cyclone 7m DW	9541247	4305.35	4313.75	8.40	8.21	26		6.8	1.6	0.0000
	Wedding 2m DW	9552077	4210.35	4219.00	8.65	8.30	26		5.3		
BK-9	Wedding 2m UW	9552078	4214.00	4221.40	7.40	7.05	23				
	Cyclone 1m DW	9541253	4302.65	4311.35	8.70	8.51	30		1.6	6.8	0.0000
	Cyclone 3m DW	9541254	4306.30	4313.25	6.95	6.76	24		2.4	4.4	0.0000
	Cyclone 5m DW	9541255	4298.45	4303.45	5.00	4.81	17		2.8	3.9	0.0000
	Cyclone 7m DW	9541256	4314.55	4320.30	5.75	5.56	20		3.0	3.6	0.0000
	Wedding 2m DW	9552079	4209.40	4216.70	7.30	6.95	24		2.1		

FIELD BLANKS

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)
BK-5	Wedding 2m UW	9552068	4317.75	4317.45	-0.30
	Cyclone 1m DW	9541219	4286.90	4286.90	0.00
	Cyclone 3m DW	9541220	4271.90	4271.95	0.05
	Cyclone 5m DW	9541221	4298.80	4298.30	-0.50
	Wedding 2m DW	9552069	4241.00	4240.35	-0.65

Unpaved glass fiber blank average = -0.15, Sx = 0.30
Unpaved quartz blank average = -0.48, Sx = 0.25

Run	Sampler Location	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)
BK-6	Wedding 2m UW	9552072	4243.20	4243.55	0.35
	Cyclone 1m DW	9541227	4296.30	4297.10	0.80
	Cyclone 3m DW	9541228	4286.25	4286.35	0.10
	Cyclone 5m DW	9541229	4281.75	4282.05	0.30
	Cyclone 7m DW	9541230	4338.45	4338.00	-0.45
	Wedding 2m DW	9552071	4236.25	4236.60	0.35

Paved glass fiber blank average = 0.19, Sx = 0.52
Paved quartz blank average = 0.35, Sx = 0.00

S8=R8-Q8
T8=S8+0.48 for BK-1-4 Weddings, =S8+0.15 for BK-1-4 cyclones, =S8-0.35 for BK-6-9 Weddings, =S8-0.19 for BK-6-9 cyclones
V8=(T8*1000)/(L8*H8*0.02832)
Y8=L8/(nozzle area*X8*88)
Z8=W8*0.0000001*X8*H8*0.44704*60

University and Community
College System of Nevada

desert research institute

Energy and Environmental
Engineering Center

May 16, 1996

Ms. Mary Ann Grelinger
Midwest Research Institute
425 Volker Boulevard
Kansas City, MO 64110

Dear Ms. Grelinger:

Enclosed are analysis results of the Teflon and quartz filter and silt samples from your paved and unpaved road tests. A total of 44 Teflon filters were analyzed by x-ray fluorescence (XRF) for 38 elements, 36 quartz filters were analyzed by thermal/optical reflectance (TOR) for organic and elemental carbon, 12 resuspension filters were prepared, and mass was determined on 40 samples. Acceptance test results, included in the number of samples listed here, were reported 3/12/96. These results complete the work specified in P.O. D02272. The resuspension and mass measurements have already been billed under a separate P.O.

Elemental concentrations of Teflon filter samples are listed in Table 1. Concentration units are μg/filter assuming deposit areas of 11.3 cm^2 for the 47 mm diameter filters and 6.4 cm^2 for the 37 mm diameter filters. Uncertainties are one standard deviation error estimates based on counting statistics and verified by replicate measurements. Note that XRF results of some of the 47 mm diameter filters are flagged 'g4' which indicates that some of the deposit had fallen off the filter before analysis. Table 1 also gives the exposed filter weight in mg.

Organic and elemental carbon concentrations of quartz filter samples are listed in Table 2. Concentrations are listed in μg/filter assuming the deposit areas stated above. Uncertainties are one standard deviation error estimates based on replicate measurements.

Table 3 shows concentrations in mass percent of resuspended silt samples. Uncertainties are one standard deviation error estimates based on analytical uncertainty and resuspension volume uncertainty of 5%.

Coarse particle Al, Si, P, Cl, K, and Ca values determined by XRF have been adjusted for large particle self-absorption using the theoretical formulation developed by Tom Dzubay (Dzubay and Nelson, "Self Absorption Corrections for X-Ray Fluorescence Analysis of Aerosols," Advances in X-Ray Analysis, 18, 619). This adjustment is a function of particle size distribution and composition. Since the actual particle size

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distribution and composition is unknown, the uncertainty of these adjustments is up to ± 25%, and is reflected in the reported uncertainty. Particle size effects for Na and Mg are so large and variable that we cannot make accurate corrections for these two elements. Their raw, uncorrected concentrations are included in the data files (but not the tables), but they should not be considered quantitative.

Field and analysis flags are defined in Tables 4 and 5. The enclosed disk contains Excel 5.0 files of the concentration data as shown below. Call me at 702-677-3181 if you have any questions.

MWCHR02X.XLS	Mass, XRF and TOR results for Teflon and quartz filter samples
MWPER02R.XLS	XRF and TOR results for resuspended silt samples

Sincerely,

Clifton A. Frazier
Assistant Research Chemist

enclosures

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

58 samples analyzed on X.XLS
12 samples analyzed on R.XLS
70

TSP id on Sheets 1-32

Table 1

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555035 Site: RM-21 Date: 12/21/95 Size: PM-2.5

Exposed Filter Weight (mg): 155.580± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	14.3265	±	0.3287
Si	93.6432	±	0.4144
P	0.5736	±	0.0996
S	5.0846	±	0.0939
Cl	1.8432	±	2.6027
K	9.1194	±	1.1664
Ca	487.8143	±	0.6293
Ti	1.6041	±	0.1716
V	0.0612	±	0.2189
Cr	0.0710	±	0.0195
Mn	1.0729	±	0.0245
Fe	16.3810	±	0.0711
Co	0.0000	±	0.2522
Ni	0.0836	±	0.0093
Cu	0.0313	±	0.0074
Zn	0.0670	±	0.0086
Ga	0.0000	±	0.0419
As	0.0057	±	0.0501
Se	0.0159	±	0.0275
Br	0.0000	±	0.0316
Rb	0.0412	±	0.0089
Sr	1.3758	±	0.0166
Y	0.0208	±	0.0327
Zr	0.0547	±	0.0661
Mo	0.0506	±	0.0677
Pd	0.0000	±	0.2347
Ag	0.0000	±	0.2623
Cd	0.0089	±	0.2626
In	0.0000	±	0.3076
Sn	0.0916	±	0.3733
Sb	0.0811	±	0.4348
Ba	0.5107	±	1.4820
La	0.0000	±	1.9327
Au	0.0000	±	0.0681
Hg	0.0305	±	0.0606
Tl	0.0000	±	0.0584
Pb	0.0092	±	0.0760
U	0.0394	±	0.0614
Sum	634.1130	±	3.9448

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555037 Site: RM-22 Date: 12/21/95 Size: PM-2.5

Exposed Filter Weight (mg): 158.150± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	17.8922	±	0.3859
Si	121.4555	±	0.4746
P	0.2000	±	0.3572
S	7.0599	±	0.1122
Cl	2.7867	±	3.5316
K	12.7410	±	1.5865
Ca	665.3011	±	0.7377
Ti	2.3914	±	0.1751
V	0.2138	±	0.2315
Cr	0.1131	±	0.0216
Mn	1.4434	±	0.0282
Fe	22.5984	±	0.0835
Co	0.0189	±	0.3461
Ni	0.1458	±	0.0105
Cu	0.0688	±	0.0078
Zn	0.1054	±	0.0089
Ga	0.0037	±	0.0429
As	0.0000	±	0.0537
Se	0.0072	±	0.0276
Br	0.0000	±	0.0326
Rb	0.0715	±	0.0094
Sr	1.9470	±	0.0190
Y	0.0377	±	0.0112
Zr	0.0771	±	0.0852
Mo	0.0000	±	0.0690
Pd	0.0528	±	0.2475
Ag	0.0651	±	0.2801
Cd	0.0000	±	0.2799
In	0.0000	±	0.3269
Sn	0.0770	±	0.3871
Sb	0.3730	±	0.4427
Ba	0.0000	±	1.5063
La	0.0000	±	1.9637
Au	0.0000	±	0.0691
Hg	0.0391	±	0.0618
Tl	0.0447	±	0.0603
Pb	0.0754	±	0.0791
U	0.0457	±	0.0639
Sum	857.4524	±	4.8060

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555040 Site: RM-23 Date: 12/21/95 Size: PM-2.5

Exposed Filter Weight (mg): 150.133± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	3.7816	±	0.1771
Si	27.9822	±	0.2272
P	0.0058	±	0.1583
S	1.6526	±	0.0553
Cl	0.2126	±	0.7024
K	2.6200	±	0.3083
Ca	124.9215	±	0.3171
Ti	0.4815	±	0.1425
V	0.0318	±	0.1767
Cr	0.0158	±	0.0418
Mn	0.2848	±	0.0142
Fe	4.3545	±	0.0370
Co	0.0000	±	0.0714
Ni	0.0150	±	0.0192
Cu	0.0277	±	0.0061
Zn	0.0309	±	0.0068
Ga	0.0165	±	0.0343
As	0.0000	±	0.0401
Se	0.0000	±	0.0218
Br	0.0006	±	0.0254
Rb	0.0102	±	0.0198
Sr	0.3487	±	0.0100
Y	0.0067	±	0.0259
Zr	0.0108	±	0.0336
Mo	0.0462	±	0.0544
Pd	0.0000	±	0.1737
Ag	0.0000	±	0.2011
Cd	0.0750	±	0.1997
In	0.0000	±	0.2375
Sn	0.0000	±	0.2962
Sb	0.0205	±	0.3476
Ba	0.0000	±	1.2271
La	0.0000	±	1.6040
Au	0.0211	±	0.0552
Hg	0.0143	±	0.0482
Tl	0.0000	±	0.0461
Pb	0.0282	±	0.0614
U	0.0102	±	0.0478
Sum	167.0273	±	2.3102

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555042 Site: RM-24 Date: 12/22/95 Size: PM-10

Exposed Filter Weight (mg): 155.791± 3.360 Flag: Field Mass XRF g4

Concentrations (µg/filter)

Al	44.1666	±	13.0477
Si	252.9569	±	79.0636
P	3.0517	±	1.3004
S	6.6011	±	0.1552
Cl	8.3516	±	10.8304
K	26.4117	±	6.4373
Ca	1573.5241	±	252.544
Ti	4.3502	±	0.1987
V	0.3876	±	0.0961
Cr	0.1859	±	0.0312
Mn	3.0772	±	0.0429
Fe	46.8552	±	0.1215
Co	0.0417	±	0.7126
Ni	0.0000	±	0.0507
Cu	0.0782	±	0.0096
Zn	0.1608	±	0.0110
Ga	0.0000	±	0.0505
As	0.0002	±	0.0604
Se	0.0000	±	0.0325
Br	0.0000	±	0.0399
Rb	0.0967	±	0.0112
Sr	3.3433	±	0.0244
Y	0.0261	±	0.0398
Zr	0.1078	±	0.1367
Mo	0.0804	±	0.0823
Pd	0.0000	±	0.2345
Ag	0.0511	±	0.2739
Cd	0.0000	±	0.2564
In	0.0000	±	0.2990
Sn	0.0000	±	0.3790
Sb	1.5244	±	0.1616
Ba	0.5566	±	1.6807
La	0.0000	±	2.1626
Au	0.0000	±	0.0819
Hg	0.0000	±	0.0747
Tl	0.0000	±	0.0717
Pb	0.0057	±	0.0918
U	0.0293	±	0.0766
Sum	1976.0221	±	265.272

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555043 Site: RM-25 Date: 12/21/95 Size: PM-10

	Field	Mass	XRF
Exposed Filter Weight (mg): 165.280± 3.360 Flag:			

Concentrations (μg/filter)

Al	23.5080	±	6.9142
Si	135.2129	±	42.2602
P	0.7940	±	0.3588
S	3.5898	±	0.0802
Cl	1.5261	±	2.8625
K	8.5010	±	1.9903
Ca	455.7852	±	73.1538
Ti	1.1984	±	0.1599
V	0.0791	±	0.2019
Cr	0.0411	±	0.0523
Mn	0.7989	±	0.0213
Fe	11.9348	±	0.0607
Co	0.0000	±	0.1852
Ni	0.0497	±	0.0082
Cu	0.0265	±	0.0070
Zn	0.0486	±	0.0080
Ga	0.0000	±	0.0391
As	0.0085	±	0.0473
Se	0.0033	±	0.0261
Br	0.0051	±	0.0301
Rb	0.0376	±	0.0084
Sr	1.0169	±	0.0147
Y	0.0177	±	0.0307
Zr	0.0397	±	0.0540
Mo	0.0394	±	0.0636
Pd	0.0119	±	0.2124
Ag	0.0000	±	0.2445
Cd	0.0000	±	0.2436
In	0.0212	±	0.2838
Sn	0.3184	±	0.3447
Sb	0.2780	±	0.4026
Ba	0.4419	±	1.3887
La	0.4452	±	1.8072
Au	0.0457	±	0.0654
Hg	0.0179	±	0.0568
Tl	0.0247	±	0.0542
Pb	0.0178	±	0.0715
U	0.0192	±	0.0572
Sum	645.9042	±	84.8726

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555044   Site: RM-26   Date: 12/22/95   Size: PM-10

Exposed Filter Weight (mg): 156.630± 3.360   Flag: Field   Mass   XRF

Concentrations (μg/filter)

Al	13.8015	±	4.0705
Si	71.0098	±	22.1967
P	0.2176	±	0.3268
S	1.9279	±	0.0606
Cl	0.3137	±	1.4781
K	4.2750	±	1.0104
Ca	232.9396	±	37.3885
Ti	0.6293	±	0.1463
V	0.0376	±	0.1819
Cr	0.0237	±	0.0440
Mn	0.4286	±	0.0162
Fe	5.8769	±	0.0428
Co	0.0000	±	0.0942
Ni	0.0169	±	0.0200
Cu	0.0207	±	0.0062
Zn	0.0205	±	0.0207
Ga	0.0000	±	0.0351
As	0.0112	±	0.0418
Se	0.0000	±	0.0232
Br	0.0000	±	0.0211
Rb	0.0123	±	0.0209
Sr	0.5156	±	0.0114
Y	0.0110	±	0.0275
Zr	0.0153	±	0.0385
Mo	0.0389	±	0.0576
Pd	0.0904	±	0.1845
Ag	0.0352	±	0.2134
Cd	0.0214	±	0.2118
In	0.0000	±	0.2501
Sn	0.0000	±	0.3116
Sb	0.0000	±	0.3557
Ba	0.0344	±	1.2850
La	0.0000	±	1.6856
Au	0.0186	±	0.0581
Hg	0.0048	±	0.0506
Tl	0.0040	±	0.0481
Pb	0.0000	±	0.0631
U	0.0066	±	0.0506
Sum	332.3590	±	43.7661

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555045 Site: RM-30 Date: 12/22/95 Size: TSP

Exposed Filter Weight (mg): 166.573± 3.360 Flag: Field Mass XRF g4

Concentrations (μg/filter)

Al	89.2351	±	26.2424
Si	489.8627	±	153.101
P	0.0000	±	1.4174
S	12.4582	±	0.2154
Cl	16.0303	±	21.1871
K	52.0919	±	12.6743
Ca	3094.8694	±	496.711
Ti	8.4037	±	0.2732
V	0.4988	±	0.5709
Cr	0.5099	±	0.0692
Mn	6.4129	±	0.0702
Fe	96.3789	±	0.1780
Co	0.3481	±	1.4614
Ni	0.0000	±	0.0924
Cu	0.2188	±	0.0133
Zn	0.4139	±	0.0139
Ga	0.0419	±	0.0649
As	0.0167	±	0.0853
Se	0.0307	±	0.0424
Br	0.0000	±	0.0618
Rb	0.3426	±	0.0158
Sr	8.7489	±	0.0378
Y	0.1390	±	0.0177
Zr	0.3849	±	0.1128
Mo	0.0000	±	0.1035
Pd	0.0000	±	0.3493
Ag	0.0000	±	0.3847
Cd	0.0768	±	0.3605
In	0.0000	±	0.3894
Sn	0.2227	±	0.4826
Sb	1.5175	±	0.1951
Ba	1.8478	±	2.0318
La	1.1166	±	2.6651
Au	0.0844	±	0.1061
Hg	0.0000	±	0.0975
Tl	0.0000	±	0.0942
Pb	0.1496	±	0.0388
U	0.1072	±	0.1132
Sum	3882.5599	±	521.034

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555046 Site: RM-31 Date: 12/22/95 Size: TSP

Exposed Filter Weight (mg): 171.808± 3.360 Flag: Field Mass XRF g4

Concentrations (µg/filter)

Al	24.9954	±	7.4160
Si	112.6138	±	35.2054
P	2.2757	±	0.9713
S	2.4812	±	0.1160
Cl	5.8006	±	7.3170
K	18.8223	±	4.4923
Ca	1056.3465	±	169.541
Ti	3.8071	±	0.1932
V	0.2366	±	0.2713
Cr	0.1271	±	0.0267
Mn	2.1871	±	0.0357
Fe	33.7267	±	0.1026
Co	0.0467	±	0.5143
Ni	0.0000	±	0.0357
Cu	0.0856	±	0.0095
Zn	0.1983	±	0.0112
Ga	0.0000	±	0.0477
As	0.0185	±	0.0571
Se	0.0019	±	0.0312
Br	0.0000	±	0.0362
Rb	0.0330	±	0.0101
Sr	1.2520	±	0.0168
Y	0.0141	±	0.0375
Zr	0.0435	±	0.0659
Mo	0.0000	±	0.0778
Pd	0.0000	±	0.2131
Ag	0.0334	±	0.2587
Cd	0.0304	±	0.2474
In	0.0000	±	0.2895
Sn	0.1873	±	0.3682
Sb	1.7097	±	0.1581
Ba	0.4361	±	1.6437
La	0.2627	±	2.1606
Au	0.0000	±	0.0781
Hg	0.0215	±	0.0692
Tl	0.0253	±	0.0661
Pb	0.0000	±	0.0862
U	0.0234	±	0.0695
Sum	1267.8435	±	173.555

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555048   Site: RM-32   Date: 12/22/95   Size: TSP

Exposed Filter Weight (mg): 158.291± 3.360   Flag: Field   Mass   XRF g4

Concentrations (μg/filter)

Al	89.4002	±	26.2702
Si	449.1640	±	140.380
P	1.0266	±	1.2793
S	10.5728	±	0.1977
Cl	10.7734	±	16.3553
K	41.6601	±	10.0239
Ca	2399.8738	±	385.169
Ti	6.6435	±	0.2294
V	0.5115	±	0.1214
Cr	0.3433	±	0.0413
Mn	4.7839	±	0.0561
Fe	71.2349	±	0.1515
Co	0.1826	±	1.0812
Ni	0.0000	±	0.0717
Cu	0.1501	±	0.0114
Zn	0.2763	±	0.0126
Ga	0.0250	±	0.0616
As	0.0029	±	0.0762
Se	0.0150	±	0.0400
Br	0.0000	±	0.0510
Rb	0.2574	±	0.0144
Sr	6.9507	±	0.0340
Y	0.0875	±	0.0165
Zr	0.2888	±	0.0904
Mo	0.0000	±	0.0987
Pd	0.0000	±	0.3120
Ag	0.0000	±	0.3480
Cd	0.0000	±	0.3364
In	0.0000	±	0.3621
Sn	0.0354	±	0.4478
Sb	1.5823	±	0.1877
Ba	0.7288	±	1.9215
La	0.0000	±	2.5208
Au	0.0000	±	0.0988
Hg	0.0000	±	0.0900
Tl	0.0000	±	0.0873
Pb	0.0817	±	0.1104
U	0.0728	±	0.1015
Sum	3096.7253	±	411.258

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9555049   Site: RM-36   Date: / /   Size:

Exposed Filter Weight (mg): 156.619± 3.360   Flag: Field   Mass   XRF

Concentrations (µg/filter)

Al	0.1844	±	0.0536
Si	0.0000	±	0.1064
P	0.1448	±	0.0236
S	0.1313	±	0.0253
Cl	0.0000	±	0.1134
K	0.0000	±	0.0991
Ca	0.0124	±	0.1177
Ti	0.0115	±	0.4491
V	0.0000	±	0.1851
Cr	0.0000	±	0.0426
Mn	0.0000	±	0.0309
Fe	0.0000	±	0.0258
Co	0.0038	±	0.0190
Ni	0.0000	±	0.0203
Cu	0.0042	±	0.0192
Zn	0.0000	±	0.0216
Ga	0.0006	±	0.0381
As	0.0044	±	0.0447
Se	0.0000	±	0.0243
Br	0.0000	±	0.0281
Rb	0.0000	±	0.0216
Sr	0.0000	±	0.0239
Y	0.0000	±	0.0292
Zr	0.0000	±	0.0339
Mo	0.0000	±	0.0612
Pd	0.1040	±	0.1675
Ag	0.0035	±	0.1948
Cd	0.0786	±	0.2016
In	0.0000	±	0.2393
Sn	0.0000	±	0.3046
Sb	0.0000	±	0.3578
Ba	0.0000	±	1.3212
La	0.0000	±	1.7564
Au	0.0000	±	0.0608
Hg	0.0228	±	0.0547
Tl	0.0126	±	0.0519
Pb	0.0000	±	0.0678
U	0.0000	±	0.0534
Sum	0.7189	±	2.3530

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559008 Site: BG-2&3 Date: / / Size: C

	Field	Mass	XRF
Exposed Filter Weight (mg): 113.269± 3.360 Flag:			

Concentrations (µg/filter)

Al	11.1776	±	3.2835
Si	26.5879	±	8.3120
P	0.2514	±	0.1125
S	0.8800	±	0.3050
Cl	0.0000	±	0.3111
K	2.1138	±	0.4237
Ca	42.2272	±	6.7790
Ti	0.2377	±	0.3116
V	0.0000	±	0.1986
Cr	0.0000	±	0.0706
Mn	0.1063	±	0.0129
Fe	3.5916	±	0.0260
Co	0.0000	±	0.0601
Ni	0.0071	±	0.0223
Cu	0.0176	±	0.0201
Zn	0.0451	±	0.0080
Ga	0.0112	±	0.0228
As	0.0000	±	0.0259
Se	0.0000	±	0.0147
Br	0.0000	±	0.0167
Rb	0.0104	±	0.0126
Sr	0.1314	±	0.0056
Y	0.0025	±	0.0163
Zr	0.0130	±	0.0198
Mo	0.0054	±	0.0339
Pd	0.0000	±	0.1124
Ag	0.0030	±	0.1265
Cd	0.0576	±	0.1247
In	0.0142	±	0.1547
Sn	0.0000	±	0.1871
Sb	0.1601	±	0.2235
Ba	0.1138	±	0.8164
La	0.9507	±	1.0809
Au	0.0160	±	0.0391
Hg	0.0166	±	0.0326
Tl	0.0096	±	0.0312
Pb	0.0339	±	0.0385
U	0.0006	±	0.0300
Sum	88.7933	±	11.3293

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559009   Site: BG-2&3   Date: / /   Size: F

Exposed Filter Weight (mg): 114.904± 3.360   Flag: Field   Mass   XRF

Concentrations (μg/filter)

Al	0.6064	±	0.0483
Si	0.8999	±	0.0401
P	0.0650	±	0.0213
S	1.5589	±	0.0309
Cl	0.0000	±	0.0932
K	0.3261	±	0.0271
Ca	1.5617	±	0.0365
Ti	0.0000	±	0.3153
V	0.0000	±	0.1994
Cr	0.0000	±	0.0697
Mn	0.0000	±	0.0348
Fe	0.3367	±	0.0112
Co	0.0000	±	0.0217
Ni	0.0031	±	0.0218
Cu	0.0336	±	0.0067
Zn	0.0441	±	0.0079
Ga	0.0048	±	0.0235
As	0.0055	±	0.0266
Se	0.0000	±	0.0149
Br	0.0055	±	0.0137
Rb	0.0039	±	0.0134
Sr	0.0025	±	0.0141
Y	0.0012	±	0.0169
Zr	0.0006	±	0.0194
Mo	0.0000	±	0.0351
Pd	0.0000	±	0.1104
Ag	0.0867	±	0.1257
Cd	0.0202	±	0.1229
In	0.0000	±	0.1534
Sn	0.0000	±	0.1915
Sb	0.0000	±	0.2252
Ba	0.0065	±	0.8365
La	0.7192	±	1.0956
Au	0.0000	±	0.0400
Hg	0.0005	±	0.0331
Tl	0.0000	±	0.0312
Pb	0.0210	±	0.0396
U	0.0114	±	0.0314
Sum	6.3250	±	1.4922

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559010 Site: BG-2 Date: / / Size: C

Exposed Filter Weight (mg): 111.088± 3.360 Flag: Field Mass XRF n3

Concentrations (µg/filter)

Al	2.7829	±	0.8330
Si	11.8296	±	3.7003
P	0.0126	±	0.1256
S	0.4053	±	0.1439
Cl	0.1659	±	0.3447
K	0.8701	±	0.2121
Ca	47.5459	±	7.6326
Ti	0.1518	±	0.2794
V	0.0000	±	0.1187
Cr	0.0057	±	0.0391
Mn	0.0875	±	0.0108
Fe	1.4966	±	0.0180
Co	0.0030	±	0.0325
Ni	0.0127	±	0.0223
Cu	0.0122	±	0.0199
Zn	0.0198	±	0.0237
Ga	0.0086	±	0.0220
As	0.0003	±	0.0241
Se	0.0000	±	0.0143
Br	0.0030	±	0.0128
Rb	0.0072	±	0.0121
Sr	0.0988	±	0.0052
Y	0.0149	±	0.0161
Zr	0.0134	±	0.0189
Mo	0.0153	±	0.0330
Pd	0.0000	±	0.1131
Ag	0.0199	±	0.1256
Cd	0.0698	±	0.1223
In	0.0995	±	0.1499
Sn	0.0000	±	0.1847
Sb	0.0112	±	0.2210
Ba	0.0000	±	0.8094
La	0.2728	±	1.0618
Au	0.0255	±	0.0382
Hg	0.0000	±	0.0308
Tl	0.0099	±	0.0301
Pb	0.0039	±	0.0364
U	0.0000	±	0.0288
Sum	66.0756	±	8.6533

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559011 Site: BG-2&3 Date: / / Size: F

Exposed Filter Weight (mg): 113.799± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	0.3757	±	0.0458
Si	0.6433	±	0.0310
P	0.0314	±	0.0475
S	0.2996	±	0.0197
Cl	0.0000	±	0.0872
K	0.0694	±	0.0708
Ca	1.6830	±	0.0369
Ti	0.0095	±	0.2810
V	0.0000	±	0.1192
Cr	0.0024	±	0.0389
Mn	0.0000	±	0.0294
Fe	0.1572	±	0.0098
Co	0.0000	±	0.0214
Ni	0.0095	±	0.0222
Cu	0.0165	±	0.0200
Zn	0.0110	±	0.0235
Ga	0.0000	±	0.0228
As	0.0000	±	0.0262
Se	0.0000	±	0.0146
Br	0.0000	±	0.0170
Rb	0.0032	±	0.0125
Sr	0.0000	±	0.0138
Y	0.0014	±	0.0167
Zr	0.0091	±	0.0193
Mo	0.0000	±	0.0349
Pd	0.0010	±	0.1131
Ag	0.0000	±	0.1242
Cd	0.0526	±	0.1215
In	0.0000	±	0.1486
Sn	0.0000	±	0.1869
Sb	0.0139	±	0.2238
Ba	0.0000	±	0.8203
La	0.2273	±	1.0858
Au	0.0036	±	0.0397
Hg	0.0209	±	0.0336
Tl	0.0134	±	0.0317
Pb	0.0258	±	0.0394
U	0.0043	±	0.0308
Sum	3.6850	±	1.4592

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559013 Site: BG-2 Date: / / Size: C

Exposed Filter Weight (mg): 119.096± 3.360 Flag: Field Mass XRF n3

Concentrations (µg/filter)

Al	9.2424	±	2.7225
Si	38.5490	±	12.0502
P	0.3045	±	0.1417
S	1.3825	±	0.4786
Cl	0.8526	±	1.0919
K	2.9399	±	0.7063
Ca	168.7974	±	27.0927
Ti	0.2630	±	0.3212
V	0.0000	±	0.2037
Cr	0.0000	±	0.0718
Mn	0.2720	±	0.0143
Fe	4.5446	±	0.0290
Co	0.0000	±	0.0739
Ni	0.0000	±	0.0228
Cu	0.0245	±	0.0068
Zn	0.0399	±	0.0080
Ga	0.0000	±	0.0236
As	0.0001	±	0.0266
Se	0.0000	±	0.0155
Br	0.0000	±	0.0176
Rb	0.0234	±	0.0046
Sr	0.4418	±	0.0077
Y	0.0054	±	0.0174
Zr	0.0216	±	0.0268
Mo	0.0207	±	0.0360
Pd	0.0000	±	0.1248
Ag	0.0259	±	0.1384
Cd	0.0354	±	0.1379
In	0.0000	±	0.1619
Sn	0.0000	±	0.2000
Sb	0.0000	±	0.2393
Ba	0.2958	±	0.8383
La	0.9218	±	1.1082
Au	0.0117	±	0.0412
Hg	0.0158	±	0.0344
Tl	0.0005	±	0.0320
Pb	0.0116	±	0.0399
U	0.0000	±	0.0322
Sum	229.0438	±	29.8471

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559014 Site: BG-2&3 Date: / / Size: F

Exposed Filter Weight (mg): 114.759± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	2.0154	±	0.0874
Si	9.8106	±	0.0995
P	0.0000	±	0.0784
S	1.3231	±	0.0310
Cl	0.0097	±	0.1847
K	1.1422	±	0.0751
Ca	26.6851	±	0.1123
Ti	0.1181	±	0.3175
V	0.0000	±	0.1987
Cr	0.0000	±	0.0697
Mn	0.0616	±	0.0122
Fe	1.4656	±	0.0178
Co	0.0000	±	0.0319
Ni	0.0000	±	0.0220
Cu	0.0156	±	0.0200
Zn	0.0490	±	0.0080
Ga	0.0027	±	0.0233
As	0.0027	±	0.0258
Se	0.0000	±	0.0146
Br	0.0061	±	0.0136
Rb	0.0072	±	0.0127
Sr	0.0700	±	0.0052
Y	0.0063	±	0.0169
Zr	0.0039	±	0.0197
Mo	0.0089	±	0.0352
Pd	0.0000	±	0.1139
Ag	0.0000	±	0.1267
Cd	0.0000	±	0.1267
In	0.0000	±	0.1510
Sn	0.0177	±	0.1893
Sb	0.0039	±	0.2277
Ba	0.0000	±	0.8418
La	0.4051	±	1.0966
Au	0.0000	±	0.0395
Hg	0.0000	±	0.0325
Tl	0.0014	±	0.0312
Pb	0.0024	±	0.0388
U	0.0000	±	0.0308
Sum	43.2343	±	1.5169

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559015 Site: BG-3 Date: / / Size: C

Field Mass XRF

Exposed Filter Weight (mg): 112.044± 3.360 Flag: B

Concentrations (µg/filter)

Al	0.2054	±	0.2396
Si	0.1108	±	0.1213
P	0.0803	±	0.0407
S	0.0150	±	0.0702
Cl	0.0000	±	0.1196
K	0.0000	±	0.0814
Ca	0.0156	±	0.0926
Ti	0.0000	±	0.2777
V	0.0000	±	0.1182
Cr	0.0000	±	0.0387
Mn	0.0000	±	0.0296
Fe	0.0116	±	0.0257
Co	0.0000	±	0.0213
Ni	0.0036	±	0.0224
Cu	0.0000	±	0.0199
Zn	0.0035	±	0.0237
Ga	0.0122	±	0.0230
As	0.0000	±	0.0248
Se	0.0000	±	0.0146
Br	0.0000	±	0.0131
Rb	0.0004	±	0.0123
Sr	0.0000	±	0.0136
Y	0.0065	±	0.0165
Zr	0.0054	±	0.0189
Mo	0.0061	±	0.0343
Pd	0.0164	±	0.1093
Ag	0.0229	±	0.1198
Cd	0.0678	±	0.1189
In	0.0000	±	0.1473
Sn	0.0000	±	0.1825
Sb	0.0915	±	0.2215
Ba	0.0000	±	0.8110
La	0.2935	±	1.0646
Au	0.0194	±	0.0393
Hg	0.0000	±	0.0323
Tl	0.0105	±	0.0313
Pb	0.0000	±	0.0374
U	0.0000	±	0.0299
Sum	0.9984	±	1.4661

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559016 Site: BG-3 Date: / / Size: C

Exposed Filter Weight (mg): 116.786± 3.360 Flag: Field Mass XRF

Concentrations (μg/filter)

Al	5.2771	±	1.5627
Si	22.5158	±	7.0399
P	0.3441	±	0.1504
S	0.7280	±	0.2538
Cl	0.6433	±	0.2609
K	1.6976	±	0.3903
Ca	83.1157	±	13.3413
Ti	0.2605	±	0.2886
V	0.0192	±	0.1227
Cr	0.0121	±	0.0400
Mn	0.1377	±	0.0115
Fe	2.3774	±	0.0218
Co	0.0000	±	0.0435
Ni	0.0020	±	0.0223
Cu	0.0081	±	0.0200
Zn	0.0000	±	0.0235
Ga	0.0056	±	0.0232
As	0.0005	±	0.0255
Se	0.0028	±	0.0148
Br	0.0000	±	0.0171
Rb	0.0108	±	0.0128
Sr	0.1935	±	0.0061
Y	0.0021	±	0.0167
Zr	0.0121	±	0.0211
Mo	0.0000	±	0.0347
Pd	0.0174	±	0.1187
Ag	0.0299	±	0.1344
Cd	0.0192	±	0.1283
In	0.0000	±	0.1528
Sn	0.0000	±	0.1939
Sb	0.0000	±	0.2323
Ba	0.0000	±	0.8361
La	0.0041	±	1.0976
Au	0.0088	±	0.0397
Hg	0.0149	±	0.0333
Tl	0.0107	±	0.0314
Pb	0.0023	±	0.0385
U	0.0000	±	0.0308
Sum	117.4733	±	15.2473

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559017 Site: BG-2&3 Date: / / Size:

Exposed Filter Weight (mg): 116.018± 3.360 Field Flag: B Mass XRF

Concentrations (µg/filter)

Al	0.0000	±	0.1003
Si	0.0055	±	0.0599
P	0.0000	±	0.0414
S	0.0000	±	0.0414
Cl	0.0000	±	0.0822
K	0.0000	±	0.0615
Ca	0.0000	±	0.0717
Ti	0.0042	±	0.2743
V	0.0000	±	0.1165
Cr	0.0000	±	0.0382
Mn	0.0000	±	0.0289
Fe	0.0000	±	0.0246
Co	0.0000	±	0.0206
Ni	0.0090	±	0.0219
Cu	0.0041	±	0.0195
Zn	0.0000	±	0.0230
Ga	0.0050	±	0.0222
As	0.0025	±	0.0244
Se	0.0054	±	0.0143
Br	0.0000	±	0.0167
Rb	0.0007	±	0.0119
Sr	0.0001	±	0.0133
Y	0.0117	±	0.0162
Zr	0.0094	±	0.0185
Mo	0.0176	±	0.0335
Pd	0.0000	±	0.1095
Ag	0.0000	±	0.1167
Cd	0.0000	±	0.1187
In	0.0000	±	0.1461
Sn	0.0471	±	0.1847
Sb	0.0000	±	0.2170
Ba	0.1105	±	0.8015
La	0.1157	±	1.0557
Au	0.0013	±	0.0378
Hg	0.0268	±	0.0324
Tl	0.0126	±	0.0302
Pb	0.0000	±	0.0364
U	0.0063	±	0.0295
Sum	0.3955	±	1.4264

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559018 Site: BG-2&3 Date: / / Size:

Exposed Filter Weight (mg): 117.858± 3.360 Field Flag: B Mass XRF

Concentrations (μg/filter)

Al	0.0405	±	0.0985
Si	0.1434	±	0.0170
P	0.0659	±	0.0143
S	0.0000	±	0.0446
Cl	0.0000	±	0.0824
K	0.0000	±	0.0632
Ca	0.0000	±	0.0728
Ti	0.0397	±	0.2809
V	0.0000	±	0.1189
Cr	0.0000	±	0.0380
Mn	0.0038	±	0.0291
Fe	0.0139	±	0.0248
Co	0.0033	±	0.0207
Ni	0.0075	±	0.0216
Cu	0.0055	±	0.0193
Zn	0.0000	±	0.0228
Ga	0.0000	±	0.0228
As	0.0000	±	0.0255
Se	0.0000	±	0.0145
Br	0.0000	±	0.0133
Rb	0.0034	±	0.0125
Sr	0.0002	±	0.0139
Y	0.0000	±	0.0167
Zr	0.0073	±	0.0194
Mo	0.0000	±	0.0350
Pd	0.0589	±	0.1099
Ag	0.0000	±	0.1223
Cd	0.0040	±	0.1212
In	0.0466	±	0.1500
Sn	0.0000	±	0.1837
Sb	0.0144	±	0.2215
Ba	0.0000	±	0.8177
La	0.0827	±	1.0728
Au	0.0000	±	0.0389
Hg	0.0000	±	0.0328
Tl	0.0008	±	0.0311
Pb	0.0000	±	0.0384
U	0.0042	±	0.0308
Sum	0.5460	±	1.4499

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559019 Site: BG-4&5 Date: / / Size: C

	Field	Mass	XRF
Exposed Filter Weight (mg): 112.840± 3.360	Flag:		

Concentrations (μg/filter)

Al	2.2583	±	0.6809
Si	8.4192	±	2.6348
P	0.0884	±	0.1377
S	4.9663	±	1.7083
Cl	0.0000	±	0.1644
K	0.6831	±	0.1376
Ca	5.6907	±	0.9156
Ti	0.0731	±	0.3080
V	0.0000	±	0.1942
Cr	0.0000	±	0.0687
Mn	0.0177	±	0.0356
Fe	1.1751	±	0.0164
Co	0.0000	±	0.0289
Ni	0.0086	±	0.0224
Cu	0.0039	±	0.0199
Zn	0.0335	±	0.0080
Ga	0.0039	±	0.0224
As	0.0069	±	0.0250
Se	0.0045	±	0.0144
Br	0.0000	±	0.0129
Rb	0.0058	±	0.0128
Sr	0.0171	±	0.0046
Y	0.0000	±	0.0161
Zr	0.0128	±	0.0188
Mo	0.0141	±	0.0339
Pd	0.0000	±	0.1100
Ag	0.0249	±	0.1232
Cd	0.0657	±	0.1212
In	0.0000	±	0.1460
Sn	0.0000	±	0.1857
Sb	0.0000	±	0.2217
Ba	0.0000	±	0.8148
La	0.5911	±	1.0690
Au	0.0000	±	0.0382
Hg	0.0000	±	0.0314
Tl	0.0103	±	0.0304
Pb	0.0094	±	0.0375
U	0.0128	±	0.0301
Sum	24.1972	±	3.6511

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559020 Site: BG-4&5 Date: / / Size: F

Exposed Filter Weight (mg): 112.318± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	0.3180	±	0.0609
Si	0.6480	±	0.0531
P	0.0000	±	0.1233
S	12.6700	±	0.0727
Cl	0.0000	±	0.2461
K	0.5061	±	0.0283
Ca	0.4989	±	0.0287
Ti	0.0000	±	0.3082
V	0.0000	±	0.1933
Cr	0.0000	±	0.0682
Mn	0.0000	±	0.0349
Fe	0.3005	±	0.0110
Co	0.0036	±	0.0222
Ni	0.0028	±	0.0222
Cu	0.0152	±	0.0201
Zn	0.0889	±	0.0083
Ga	0.0000	±	0.0223
As	0.0000	±	0.0268
Se	0.0122	±	0.0147
Br	0.0271	±	0.0046
Rb	0.0003	±	0.0128
Sr	0.0089	±	0.0137
Y	0.0009	±	0.0162
Zr	0.0030	±	0.0187
Mo	0.0000	±	0.0337
Pd	0.0019	±	0.1094
Ag	0.0000	±	0.1201
Cd	0.0313	±	0.1182
In	0.0000	±	0.1456
Sn	0.0000	±	0.1822
Sb	0.0381	±	0.2163
Ba	0.3998	±	0.8108
La	0.4588	±	1.0629
Au	0.0006	±	0.0386
Hg	0.0081	±	0.0320
Tl	0.0054	±	0.0304
Pb	0.0450	±	0.0130
U	0.0116	±	0.0300
Sum	16.1050	±	1.4717

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559021   Site: BG-4   Date: / /   Size: C

Field   Mass   XRF

Exposed Filter Weight (mg): 113.013± 3.360   Flag:

Concentrations (µg/filter)

Al	4.0376	±	1.2032
Si	19.8227	±	6.1983
P	0.1650	±	0.0853
S	1.2706	±	0.4393
Cl	0.1416	±	0.5334
K	1.5678	±	0.3655
Ca	80.1330	±	12.8626
Ti	0.1404	±	0.3115
V	0.0000	±	0.1961
Cr	0.0000	±	0.0692
Mn	0.1116	±	0.0128
Fe	2.2215	±	0.0212
Co	0.0000	±	0.0414
Ni	0.0027	±	0.0225
Cu	0.0135	±	0.0203
Zn	0.0204	±	0.0241
Ga	0.0139	±	0.0233
As	0.0000	±	0.0256
Se	0.0014	±	0.0150
Br	0.0000	±	0.0169
Rb	0.0115	±	0.0128
Sr	0.1839	±	0.0060
Y	0.0071	±	0.0167
Zr	0.0117	±	0.0208
Mo	0.0028	±	0.0345
Pd	0.0000	±	0.1159
Ag	0.0090	±	0.1318
Cd	0.0607	±	0.1283
In	0.0000	±	0.1532
Sn	0.0000	±	0.1949
Sb	0.0113	±	0.2296
Ba	0.2568	±	0.8203
La	0.4878	±	1.0818
Au	0.0180	±	0.0397
Hg	0.0193	±	0.0333
Tl	0.0000	±	0.0313
Pb	0.0223	±	0.0388
U	0.0048	±	0.0308
Sum	110.7707	±	14.4253

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559022 Site: BG-4&5 Date: / / Size: F

Exposed Filter Weight (mg): 115.518± 3.360 Flag: Field Mass XRF

Concentrations (μg/filter)

Al	0.2959	±	0.0569
Si	1.2982	±	0.0502
P	0.0000	±	0.0975
S	6.9722	±	0.0557
Cl	0.0000	±	0.1614
K	0.3271	±	0.0287
Ca	3.2010	±	0.0455
Ti	0.0000	±	0.3193
V	0.0000	±	0.2023
Cr	0.0000	±	0.0707
Mn	0.0000	±	0.0352
Fe	0.3356	±	0.0112
Co	0.0000	±	0.0218
Ni	0.0030	±	0.0220
Cu	0.0052	±	0.0197
Zn	0.0405	±	0.0080
Ga	0.0000	±	0.0237
As	0.0000	±	0.0265
Se	0.0019	±	0.0153
Br	0.0067	±	0.0177
Rb	0.0032	±	0.0130
Sr	0.0095	±	0.0146
Y	0.0000	±	0.0170
Zr	0.0144	±	0.0200
Mo	0.0000	±	0.0358
Pd	0.0473	±	0.1139
Ag	0.0678	±	0.1261
Cd	0.0030	±	0.1239
In	0.0000	±	0.1532
Sn	0.1029	±	0.1931
Sb	0.0118	±	0.2277
Ba	0.0715	±	0.8456
La	0.7234	±	1.1147
Au	0.0057	±	0.0411
Hg	0.0114	±	0.0341
Tl	0.0065	±	0.0323
Pb	0.0136	±	0.0401
U	0.0039	±	0.0317
Sum	13.5832	±	1.5242

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559023　　Site: BG-4　　Date: / /　　Size: C

Exposed Filter Weight (mg): 113.986± 3.360　　Flag:　Field　Mass　XRF

Concentrations (µg/filter)

Al	2.2698	±	0.6837
Si	9.1165	±	2.8527
P	0.0000	±	0.1181
S	0.9120	±	0.3160
Cl	0.0000	±	0.2702
K	0.6333	±	0.1582
Ca	34.6514	±	5.5631
Ti	0.0981	±	0.2924
V	0.0230	±	0.1241
Cr	0.0000	±	0.0394
Mn	0.0672	±	0.0107
Fe	1.0952	±	0.0160
Co	0.0004	±	0.0283
Ni	0.0034	±	0.0223
Cu	0.0086	±	0.0201
Zn	0.0054	±	0.0237
Ga	0.0000	±	0.0232
As	0.0000	±	0.0260
Se	0.0000	±	0.0150
Br	0.0000	±	0.0172
Rb	0.0060	±	0.0129
Sr	0.0852	±	0.0054
Y	0.0050	±	0.0172
Zr	0.0222	±	0.0068
Mo	0.0117	±	0.0358
Pd	0.0000	±	0.1141
Ag	0.0239	±	0.1287
Cd	0.0506	±	0.1268
In	0.0645	±	0.1528
Sn	0.0000	±	0.1888
Sb	0.0510	±	0.2305
Ba	0.0000	±	0.8493
La	0.0041	±	1.1120
Au	0.0000	±	0.0401
Hg	0.0134	±	0.0340
Tl	0.0000	±	0.0316
Pb	0.0026	±	0.0394
U	0.0000	±	0.0313
Sum	49.2245	±	6.4804

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559024 Site: BG-4&5 Date: / / Size: F

Exposed Filter Weight (mg): 117.841± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	0.1565	±	0.0492
Si	0.6650	±	0.0406
P	0.0326	±	0.0863
S	5.5270	±	0.0495
Cl	0.0000	±	0.1352
K	0.2348	±	0.0253
Ca	1.1627	±	0.0339
Ti	0.0000	±	0.3124
V	0.0000	±	0.1979
Cr	0.0000	±	0.0695
Mn	0.0000	±	0.0351
Fe	0.1995	±	0.0102
Co	0.0000	±	0.0215
Ni	0.0101	±	0.0223
Cu	0.0100	±	0.0199
Zn	0.0341	±	0.0080
Ga	0.0043	±	0.0233
As	0.0000	±	0.0263
Se	0.0089	±	0.0151
Br	0.0021	±	0.0171
Rb	0.0005	±	0.0125
Sr	0.0025	±	0.0140
Y	0.0000	±	0.0167
Zr	0.0004	±	0.0193
Mo	0.0000	±	0.0350
Pd	0.0000	±	0.1096
Ag	0.0080	±	0.1277
Cd	0.0000	±	0.1221
In	0.0000	±	0.1501
Sn	0.0000	±	0.1887
Sb	0.0066	±	0.2280
Ba	0.2113	±	0.8251
La	0.6862	±	1.0898
Au	0.0000	±	0.0398
Hg	0.0114	±	0.0333
Tl	0.0000	±	0.0312
Pb	0.0217	±	0.0394
U	0.0000	±	0.0303
Sum	8.9962	±	1.4867

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559027 Site: BG-5 Date: / / Size: C

Exposed Filter Weight (mg): 114.471± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	8.3183	±	2.4523
Si	36.6071	±	11.4434
P	0.4036	±	0.1782
S	2.0122	±	0.6942
Cl	0.6426	±	0.9670
K	2.8694	±	0.6682
Ca	149.8384	±	24.0499
Ti	0.3718	±	0.0975
V	0.0273	±	0.1242
Cr	0.0139	±	0.0396
Mn	0.2394	±	0.0122
Fe	3.9171	±	0.0271
Co	0.0000	±	0.0646
Ni	0.0000	±	0.0222
Cu	0.0162	±	0.0196
Zn	0.0285	±	0.0078
Ga	0.0018	±	0.0230
As	0.0101	±	0.0257
Se	0.0000	±	0.0150
Br	0.0025	±	0.0134
Rb	0.0168	±	0.0046
Sr	0.3529	±	0.0071
Y	0.0137	±	0.0169
Zr	0.0236	±	0.0242
Mo	0.0234	±	0.0349
Pd	0.0000	±	0.1224
Ag	0.0000	±	0.1365
Cd	0.0000	±	0.1363
In	0.0000	±	0.1594
Sn	0.0212	±	0.1982
Sb	0.0144	±	0.2324
Ba	0.0000	±	0.8347
La	0.1116	±	1.0978
Au	0.0169	±	0.0398
Hg	0.0000	±	0.0327
Tl	0.0177	±	0.0315
Pb	0.0015	±	0.0383
U	0.0118	±	0.0313
Sum	205.9457	±	26.8211

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559028 Site: BG-5 Date: / / Size: C

Exposed Filter Weight (mg): 116.053± 3.360 Flag: Field Mass XRF

Concentrations (µg/filter)

Al	3.4407	±	1.0254
Si	14.0225	±	4.3857
P	0.2031	±	0.0957
S	1.7520	±	0.6041
Cl	0.0000	±	0.3912
K	1.0918	±	0.2577
Ca	56.6942	±	9.1008
Ti	0.1355	±	0.2922
V	0.0381	±	0.1241
Cr	0.0000	±	0.0395
Mn	0.0939	±	0.0110
Fe	1.5640	±	0.0183
Co	0.0030	±	0.0333
Ni	0.0136	±	0.0224
Cu	0.0021	±	0.0198
Zn	0.0115	±	0.0236
Ga	0.0032	±	0.0231
As	0.0000	±	0.0259
Se	0.0034	±	0.0152
Br	0.0011	±	0.0171
Rb	0.0061	±	0.0134
Sr	0.1385	±	0.0057
Y	0.0031	±	0.0167
Zr	0.0147	±	0.0203
Mo	0.0032	±	0.0348
Pd	0.0000	±	0.1151
Ag	0.0140	±	0.1271
Cd	0.0121	±	0.1281
In	0.0000	±	0.1539
Sn	0.0000	±	0.1892
Sb	0.0000	±	0.2261
Ba	0.0000	±	0.8301
La	0.1571	±	1.0910
Au	0.0222	±	0.0401
Hg	0.0128	±	0.0333
Tl	0.0046	±	0.0312
Pb	0.0236	±	0.0391
U	0.0104	±	0.0311
Sum	79.4961	±	10.2886

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559029 Site: BG-4&5 Date: / / Size:

Exposed Filter Weight (mg): 113.008± 3.360 Field Flag: B Mass XRF n3

Concentrations (μg/filter)

Al	0.0764	±	0.0934
Si	0.1342	±	0.0165
P	0.0368	±	0.0379
S	0.0000	±	0.0417
Cl	0.0000	±	0.0821
K	0.0000	±	0.0616
Ca	0.0000	±	0.0709
Ti	0.0000	±	0.2949
V	0.0000	±	0.1874
Cr	0.0000	±	0.0664
Mn	0.0000	±	0.0337
Fe	0.0606	±	0.0088
Co	0.0030	±	0.0210
Ni	0.0000	±	0.0216
Cu	0.0044	±	0.0195
Zn	0.0042	±	0.0231
Ga	0.0170	±	0.0218
As	0.0000	±	0.0232
Se	0.0000	±	0.0135
Br	0.0000	±	0.0157
Rb	0.0044	±	0.0116
Sr	0.0001	±	0.0127
Y	0.0000	±	0.0153
Zr	0.0058	±	0.0177
Mo	0.0000	±	0.0319
Pd	0.0000	±	0.1017
Ag	0.0838	±	0.1152
Cd	0.0273	±	0.1131
In	0.0000	±	0.1394
Sn	0.0000	±	0.1776
Sb	0.0000	±	0.2087
Ba	0.2015	±	0.7773
La	0.8102	±	1.0220
Au	0.0063	±	0.0365
Hg	0.0166	±	0.0307
Tl	0.0031	±	0.0292
Pb	0.0000	±	0.0348
U	0.0000	±	0.0278
Sum	1.4957	±	1.3947

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559030 Site: BG-4&5 Date: / / Size:

Exposed Filter Weight (mg): 114.606± 3.360 Field Flag: B Mass XRF

Concentrations (µg/filter)

Al	0.0000	±	0.0962
Si	0.1055	±	0.0179
P	0.0726	±	0.0126
S	0.0000	±	0.0435
Cl	0.0000	±	0.0813
K	0.0000	±	0.0629
Ca	0.0187	±	0.0724
Ti	0.0271	±	0.2782
V	0.0394	±	0.1184
Cr	0.0000	±	0.0383
Mn	0.0000	±	0.0289
Fe	0.0135	±	0.0249
Co	0.0000	±	0.0207
Ni	0.0151	±	0.0219
Cu	0.0028	±	0.0194
Zn	0.0181	±	0.0232
Ga	0.0000	±	0.0212
As	0.0000	±	0.0240
Se	0.0061	±	0.0144
Br	0.0000	±	0.0157
Rb	0.0013	±	0.0118
Sr	0.0076	±	0.0131
Y	0.0000	±	0.0155
Zr	0.0126	±	0.0181
Mo	0.0171	±	0.0327
Pd	0.0000	±	0.1085
Ag	0.0000	±	0.1208
Cd	0.0000	±	0.1229
In	0.0000	±	0.1442
Sn	0.0000	±	0.1827
Sb	0.0000	±	0.2124
Ba	0.0000	±	0.8047
La	0.0000	±	1.0465
Au	0.0350	±	0.0380
Hg	0.0124	±	0.0312
Tl	0.0074	±	0.0293
Pb	0.0127	±	0.0363
U	0.0000	±	0.0286
Sum	0.4250	±	1.4198

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559031 Site: BG-6 Date: / / Size:

Field Mass XRF

Exposed Filter Weight (mg): 116.551± 3.360 Flag: B

Concentrations (µg/filter)

Al	0.0436	±	0.0973
Si	0.0558	±	0.0573
P	0.0481	±	0.0140
S	0.0621	±	0.0139
Cl	0.0000	±	0.0844
K	0.0000	±	0.0627
Ca	0.0000	±	0.0735
Ti	0.0000	±	0.3137
V	0.0000	±	0.1962
Cr	0.0000	±	0.0686
Mn	0.0000	±	0.0339
Fe	0.0000	±	0.0243
Co	0.0063	±	0.0208
Ni	0.0047	±	0.0216
Cu	0.0038	±	0.0193
Zn	0.0000	±	0.0227
Ga	0.0092	±	0.0233
As	0.0000	±	0.0259
Se	0.0000	±	0.0146
Br	0.0007	±	0.0133
Rb	0.0006	±	0.0123
Sr	0.0058	±	0.0140
Y	0.0000	±	0.0166
Zr	0.0000	±	0.0191
Mo	0.0057	±	0.0348
Pd	0.0183	±	0.1100
Ag	0.0120	±	0.1217
Cd	0.0283	±	0.1219
In	0.0000	±	0.1504
Sn	0.0000	±	0.1848
Sb	0.0590	±	0.2218
Ba	0.5460	±	0.8199
La	0.5374	±	1.0768
Au	0.0042	±	0.0394
Hg	0.0037	±	0.0327
Tl	0.0000	±	0.0312
Pb	0.0199	±	0.0389
U	0.0045	±	0.0306
Sum	1.4797	±	1.4711

Comments:

Table 1 (continued)

Analysis Results for Teflon Filters from Deramus Field Station

Filter ID:9559032 Site: BG-6 Date: / / Size:

Exposed Filter Weight (mg): 112.944± 3.360 Field Flag: B Mass XRF

Concentrations (µg/filter)

Al	0.0234	±	0.0984
Si	0.1271	±	0.0174
P	0.0080	±	0.0444
S	0.0132	±	0.0445
Cl	0.0000	±	0.0807
K	0.0000	±	0.0629
Ca	0.0000	±	0.0731
Ti	0.0000	±	0.3075
V	0.0000	±	0.1958
Cr	0.0000	±	0.0693
Mn	0.0029	±	0.0347
Fe	0.0064	±	0.0248
Co	0.0058	±	0.0208
Ni	0.0035	±	0.0217
Cu	0.0119	±	0.0196
Zn	0.0152	±	0.0232
Ga	0.0065	±	0.0227
As	0.0000	±	0.0249
Se	0.0000	±	0.0142
Br	0.0027	±	0.0132
Rb	0.0000	±	0.0121
Sr	0.0000	±	0.0135
Y	0.0000	±	0.0162
Zr	0.0000	±	0.0187
Mo	0.0101	±	0.0341
Pd	0.0000	±	0.1093
Ag	0.0010	±	0.1229
Cd	0.0000	±	0.1210
In	0.0000	±	0.1456
Sn	0.0000	±	0.1858
Sb	0.0485	±	0.2222
Ba	0.0065	±	0.8135
La	0.8515	±	1.0712
Au	0.0111	±	0.0388
Hg	0.0010	±	0.0320
Tl	0.0196	±	0.0310
Pb	0.0037	±	0.0376
U	0.0000	±	0.0297
Sum	1.1796	±	1.4617

Comments:

Table 2

Analysis Results for Quartz Filters from Deramus Field Station

Filter ID	Site	Date	Size	Flags Field	Flags Carbon	Carbon Concentrations (µg/filter) Organic	Elemental	Total	Comments
9557024	RM-37	/ /			b1	20.9 ± 3.3	1.0 ± 0.8	21.9 ± 3.6	
9557025	RM-38	/ /			b1	12.4 ± 3.2	0.0 ± 0.7	12.4 ± 3.5	
9557031	RM-35	12/22/95	TSP		m2,m3	535.1 ± 30.8	1.9 ± 0.9	536.9 ± 19.9	
9557032	RM-34	12/22/95	TSP		m2,m3	417.7 ± 24.1	592.3 ± 158.8	1010.0 ± 37.1	
9557034	RM-33	12/22/95	TSP		i ,m3	203.4 ± 12.1	260.9 ± 70.0	464.3 ± 17.3	
9557035	RM-29	12/22/95	PM-10		m2,m3	267.1 ± 15.6	273.7 ± 73.4	540.8 ± 20.1	
9557036	RM-28	12/22/95	PM-10		m2	563.3 ± 32.4	328.2 ± 88.0	891.5 ± 32.8	
9557038	RM-27	12/22/95	PM-10		m2	626.1 ± 36.0	103.7 ± 27.8	729.8 ± 26.9	
9557039	RM-20	12/21/95	PM-2.5		m2,m3	138.8 ± 8.5	169.9 ± 45.6	308.7 ± 11.8	
9557040	RM-19	12/21/95	PM-2.5		m2,m3	211.7 ± 12.5	326.1 ± 87.4	537.8 ± 20.0	
9557042	RM-18	12/21/95	PM-2.5		m2,m3	212.0 ± 12.5	328.3 ± 88.0	540.2 ± 20.1	
9550004	BG-2	/ /	C		m2	204.1 ± 11.8	41.4 ± 11.1	245.5 ± 9.2	
9550005	BG-2&3	/ /	F			49.9 ± 3.4	9.1 ± 2.5	58.9 ± 2.9	
9550006	BG-2	/ /	C			45.4 ± 3.1	20.9 ± 5.6	66.3 ± 3.1	
9550007	BG-2&3	/ /	F			30.3 ± 2.5	1.3 ± 0.5	31.5 ± 2.3	
9550010	BG-3	/ /	C		m2,m3	223.3 ± 12.9	55.6 ± 14.9	278.9 ± 10.4	
9550011	BG-3	/ /	C	B		19.9 ± 2.1	0.4 ± 0.4	20.3 ± 2.1	
9550012	BG-2&3	/ /		B	b1	23.4 ± 2.2	0.7 ± 0.4	24.1 ± 2.2	
9550013	BG-2&3	/ /		B	b1	23.2 ± 2.2	1.3 ± 0.5	24.5 ± 2.2	
9550014	BG-4	/ /	C			42.2 ± 3.0	5.1 ± 1.4	47.3 ± 2.6	
9550015	BG-4&5	/ /	F			33.8 ± 2.6	3.6 ± 1.0	37.4 ± 2.4	
9550016	BG-4&5	/ /	C	B	b1	27.2 ± 2.3	3.6 ± 1.0	30.8 ± 2.3	TOR: High Blank
9550017	BG-4&5	/ /	F	B	b1	22.3 ± 2.2	1.9 ± 0.7	24.1 ± 2.2	
9550018	BG-5	/ /	C			69.9 ± 4.4	10.3 ± 2.8	80.2 ± 3.5	
9550019	BG-4&5	/ /	C	B		20.1 ± 2.1	1.0 ± 0.5	21.1 ± 2.1	
9550020	BG-6	/ /		B	b1	61.6 ± 3.9	1.9 ± 0.7	63.5 ± 3.1	TOR: High Blank

Table 3

Analysis Results for Resuspended Silt Samples

Sample: BG3&5 Teflon ID: REST365 Quartz ID: RESQ365 Size: PM-10

Flag: Teflon Quartz Mass XRF Carbon

Concentrations (mass percent)

Organic Carbon	5.2288	±	1.2104
Elemental Carbon	1.2054	±	0.3169
Total Carbon	6.2360	±	1.4247
Al	1.9356	±	0.5910
Si	10.0140	±	3.2242
P	0.0151	±	0.0329
S	0.1993	±	0.0159
Cl	0.6134	±	0.1956
K	0.6812	±	0.1660
Ca	35.7800	±	6.3055
Ti	0.0852	±	0.0317
V	0.0000	±	0.0251
Cr	0.0000	±	0.0078
Mn	0.0574	±	0.0047
Fe	0.9346	±	0.0684
Co	0.0000	±	0.0147
Ni	0.0020	±	0.0012
Cu	0.0723	±	0.0054
Zn	0.0227	±	0.0021
Ga	0.0000	±	0.0033
As	0.0000	±	0.0039
Se	0.0006	±	0.0020
Br	0.0004	±	0.0020
Rb	0.0037	±	0.0012
Sr	0.0794	±	0.0059
Y	0.0008	±	0.0024
Zr	0.0041	±	0.0022
Mo	0.0039	±	0.0051
Pd	0.0049	±	0.0176
Ag	0.0018	±	0.0202
Cd	0.0012	±	0.0206
In	0.0000	±	0.0237
Sn	0.0008	±	0.0292
Sb	0.0121	±	0.0335
Ba	0.0000	±	0.1156
La	0.1093	±	0.1526
Au	0.0000	±	0.0055
Hg	0.0000	±	0.0047
Tl	0.0006	±	0.0043
Pb	0.0025	±	0.0059
U	0.0014	±	0.0045
Sum	57.0744	±	7.2238

Comments:

Table 3 (continued)

Analysis Results for Resuspended Silt Samples

Sample: BG3&5 Teflon ID: REST366 Quartz ID: RESQ366 Size: PM-2.5

Teflon Quartz Mass XRF Carbon

Flag:

Concentrations (mass percent)

Organic Carbon	9.3713	±	1.7247
Elemental Carbon	0.9803	±	0.3836
Total Carbon	10.1047	±	1.9101
Al	1.1001	±	0.0877
Si	7.8720	±	0.5794
P	0.0030	±	0.0266
S	0.3268	±	0.0260
Cl	0.6225	±	0.0641
K	0.6639	±	0.0741
Ca	22.5278	±	1.6614
Ti	0.0976	±	0.0520
V	0.0000	±	0.0384
Cr	0.0000	±	0.0118
Mn	0.0473	±	0.0051
Fe	0.9507	±	0.0736
Co	0.0000	±	0.0163
Ni	0.0044	±	0.0015
Cu	0.0577	±	0.0043
Zn	0.0207	±	0.0032
Ga	0.0000	±	0.0059
As	0.0000	±	0.0059
Se	0.0000	±	0.0030
Br	0.0000	±	0.0030
Rb	0.0030	±	0.0015
Sr	0.0606	±	0.0055
Y	0.0015	±	0.0044
Zr	0.0030	±	0.0044
Mo	0.0044	±	0.0074
Pd	0.0030	±	0.0266
Ag	0.0133	±	0.0311
Cd	0.0089	±	0.0311
In	0.0000	±	0.0370
Sn	0.0089	±	0.0458
Sb	0.0089	±	0.0518
Ba	0.0414	±	0.1804
La	0.1538	±	0.2382
Au	0.0030	±	0.0089
Hg	0.0000	±	0.0074
Tl	0.0015	±	0.0074
Pb	0.0074	±	0.0059
U	0.0000	±	0.0074
Sum	44.9684	±	2.5189

Comments:

Table 3 (continued)

Analysis Results for Resuspended Silt Samples

Sample: BG2 Teflon ID: REST363 Quartz ID: RESQ363 Size: PM-10

Flag:	Teflon	Quartz	Mass	XRF	Carbon
					m2

Concentrations (mass percent)

Organic Carbon	6.5346	±	0.9420
Elemental Carbon	1.4644	±	0.1952
Total Carbon	7.8988	±	1.0369
Al	2.0758	±	0.6290
Si	9.3557	±	3.0049
P	0.0031	±	0.0225
S	0.1992	±	0.0148
Cl	0.3467	±	0.1228
K	0.7113	±	0.1675
Ca	33.2780	±	5.8479
Ti	0.1233	±	0.0179
V	0.0032	±	0.0128
Cr	0.0038	±	0.0042
Mn	0.0657	±	0.0049
Fe	1.2813	±	0.0912
Co	0.0002	±	0.0197
Ni	0.0036	±	0.0007
Cu	0.0549	±	0.0040
Zn	0.0227	±	0.0017
Ga	0.0000	±	0.0017
As	0.0005	±	0.0022
Se	0.0004	±	0.0010
Br	0.0000	±	0.0011
Rb	0.0039	±	0.0007
Sr	0.0819	±	0.0059
Y	0.0017	±	0.0008
Zr	0.0049	±	0.0015
Mo	0.0000	±	0.0024
Pd	0.0018	±	0.0093
Ag	0.0077	±	0.0107
Cd	0.0035	±	0.0109
In	0.0000	±	0.0124
Sn	0.0026	±	0.0150
Sb	0.0000	±	0.0170
Ba	0.0263	±	0.0564
La	0.0334	±	0.0735
Au	0.0015	±	0.0028
Hg	0.0015	±	0.0023
Tl	0.0000	±	0.0022
Pb	0.0054	±	0.0020
U	0.0013	±	0.0023
Sum	55.7054	±	6.6791

Comments:

Table 3 (continued)

Analysis Results for Resuspended Silt Samples

Sample: BG2 Teflon ID: REST364 Quartz ID: RESQ364 Size: PM-2.5

Flag: Teflon Quartz Mass XRF Carbon m2

Concentrations (mass percent)

Organic Carbon	4.3710 ±	1.1266
Elemental Carbon	4.6688 ±	0.4899
Total Carbon	8.8483 ±	1.5370
Al	1.2966 ±	0.0984
Si	8.4699 ±	0.6137
P	0.0192 ±	0.0083
S	0.4289 ±	0.0320
Cl	0.4316 ±	0.0519
K	0.7413 ±	0.0757
Ca	21.7121 ±	1.5757
Ti	0.1375 ±	0.0410
V	0.0037 ±	0.0284
Cr	0.0037 ±	0.0092
Mn	0.0568 ±	0.0047
Fe	1.2673 ±	0.0934
Co	0.0000 ±	0.0202
Ni	0.0037 ±	0.0018
Cu	0.0660 ±	0.0050
Zn	0.0275 ±	0.0023
Ga	0.0018 ±	0.0037
As	0.0000 ±	0.0055
Se	0.0009 ±	0.0027
Br	0.0009 ±	0.0027
Rb	0.0037 ±	0.0018
Sr	0.0614 ±	0.0049
Y	0.0018 ±	0.0028
Zr	0.0055 ±	0.0028
Mo	0.0018 ±	0.0055
Pd	0.0018 ±	0.0202
Ag	0.0064 ±	0.0238
Cd	0.0000 ±	0.0238
In	0.0000 ±	0.0284
Sn	0.0000 ±	0.0348
Sb	0.0000 ±	0.0394
Ba	0.0220 ±	0.1365
La	0.0513 ±	0.1778
Au	0.0027 ±	0.0064
Hg	0.0009 ±	0.0055
Tl	0.0018 ±	0.0046
Pb	0.0147 ±	0.0046
U	0.0000 ±	0.0046
Sum	43.8852 ±	2.1107

Comments:

Table 3 (continued)

Analysis Results for Resuspended Silt Samples

Sample: BG4 Teflon ID: REST367 Quartz ID: RESQ367 Size: PM-10

Flag: . Teflon Quartz Mass XRF Carbon

Concentrations (mass percent)

Organic Carbon	5.9411	±	1.0394
Elemental Carbon	2.1097	±	0.2809
Total Carbon	7.9069	±	1.2347
Al	1.6380	±	0.4990
Si	8.3840	±	2.6971
P	0.0464	±	0.0227
S	0.1496	±	0.0118
Cl	0.2457	±	0.1019
K	0.5898	±	0.1488
Ca	34.8046	±	6.1231
Ti	0.0803	±	0.0233
V	0.0000	±	0.0182
Cr	0.0014	±	0.0058
Mn	0.0619	±	0.0047
Fe	0.8964	±	0.0646
Co	0.0003	±	0.0141
Ni	0.0034	±	0.0010
Cu	0.0656	±	0.0048
Zn	0.0152	±	0.0015
Ga	0.0000	±	0.0024
As	0.0000	±	0.0028
Se	0.0000	±	0.0014
Br	0.0000	±	0.0016
Rb	0.0036	±	0.0009
Sr	0.0757	±	0.0055
Y	0.0021	±	0.0011
Zr	0.0031	±	0.0037
Mo	0.0000	±	0.0037
Pd	0.0000	±	0.0131
Ag	0.0118	±	0.0152
Cd	0.0043	±	0.0154
In	0.0101	±	0.0179
Sn	0.0000	±	0.0218
Sb	0.0000	±	0.0246
Ba	0.0000	±	0.0846
La	0.0656	±	0.1103
Au	0.0001	±	0.0040
Hg	0.0009	±	0.0034
Tl	0.0010	±	0.0033
Pb	0.0021	±	0.0043
U	0.0007	±	0.0033
Sum	55.2144	±	6.7996

Comments:

Table 3 (continued)
Analysis Results for Resuspended Silt Samples

Sample: BG4 Teflon ID: REST368 Quartz ID: RESQ368 Size: PM-2.5

	Teflon	Quartz	Mass	XRF	Carbon
Flag:					

Concentrations (mass percent)

Organic Carbon	8.8929	±	1.5635
Elemental Carbon	0.8341	±	0.3343
Total Carbon	9.5123	±	1.7053
Al	1.2036	±	0.0931
Si	8.3737	±	0.6107
P	0.0134	±	0.0248
S	0.3334	±	0.0263
Cl	0.4077	±	0.0550
K	0.6926	±	0.0782
Ca	24.2591	±	1.7700
Ti	0.0991	±	0.0457
V	0.0000	±	0.0320
Cr	0.0021	±	0.0093
Mn	0.0557	±	0.0051
Fe	1.0674	±	0.0799
Co	0.0010	±	0.0175
Ni	0.0041	±	0.0021
Cu	0.0723	±	0.0056
Zn	0.0206	±	0.0023
Ga	0.0021	±	0.0041
As	0.0010	±	0.0052
Se	0.0000	±	0.0031
Br	0.0010	±	0.0021
Rb	0.0041	±	0.0021
Sr	0.0671	±	0.0054
Y	0.0010	±	0.0031
Zr	0.0052	±	0.0031
Mo	0.0000	±	0.0062
Pd	0.0000	±	0.0227
Ag	0.0000	±	0.0268
Cd	0.0145	±	0.0268
In	0.0000	±	0.0310
Sn	0.0041	±	0.0392
Sb	0.0000	±	0.0444
Ba	0.0815	±	0.1539
La	0.0764	±	0.2013
Au	0.0041	±	0.0072
Hg	0.0000	±	0.0062
Tl	0.0010	±	0.0052
Pb	0.0083	±	0.0052
U	0.0010	±	0.0052
Sum	46.6054	±	2.4824

Comments:

Table 4

Ambient and Source Field Sampling Data Validation Flags[a]

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

Table 4 (continued)

Ambient and Source Field Sampling Data Validation Flags[a]

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

Table 4 (continued)

Ambient and Source Field Sampling Data Validation Flags[a]

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

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

Table 5
Chemical Analysis Data Validation Flags[a]

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

Table 5 (continued)
Chemical Analysis Data Validation Flags[a]

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

Table 5 (continued)
Chemical Analysis Data Validation Flags[a]

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

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

desert research institute

University and Community College System of Nevada

Energy and Environmental
Engineering Center

rcid 6/3/96

May 29, 1996

Ms. Mary Ann Grelinger
Midwest Research Institute
425 Volker Boulevard
Kansas City, MO 64110

Dear Ms. Grelinger:

As you requested, I have prepared the resuspension sample analysis results in concentration units of μg/filter. Table 6 shows concentrations for each sample. The last page of the table shows the resuspension blank concentrations. The blank concentrations were subtracted from the sample concentrations before calculating the mass percent composition data reported earlier.

During the resuspension procedure, resuspended dust is introduced into a resuspension chamber where $PM_{2.5}$ and PM_{10} samples are collected simultaneously until the PM_{10} sample has sufficient loading. The PM_{10} filter is replaced with a "dummy" PM_{10} filter and resuspension continues until the $PM_{2.5}$ filter has sufficient loading. Deposit mass is determined on both PM_{10} filters, but only the first PM_{10} sample is chemically analyzed. Table 7 shows the $PM_{2.5}$ / PM_{10} mass ratios for the resuspended samples.

The enclosed disk contains Excel 5.0 file MWCHS02R.XLS which contains the resuspended sample concentration data in μg/filter. Call me at 702-677-3181 if you have any questions.

Sincerely,

Clifton A. Frazier

Clifton A. Frazier
Assistant Research Chemist

enclosures
c: J. Chow
D. Egami
B. Hinsvark
J. Watson

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

Table 6

Filter Deposit Mass for Resuspended Silt Samples

Sample: BG3&5 Teflon ID: REST365 Quartz ID: RESQ365 Size: PM-10

Teflon Quartz Mass XRF Carbon

Flag:

Concentrations (µg/filter)

Mass	1746.0000	±	18.6650
Organic Carbon	103.3000	±	10.0000
Elemental Carbon	18.7000	±	1.2000
Total Carbon	122.0000	±	9.5000
Al	33.9156	±	9.9662
Si	174.4896	±	54.5354
P	0.3586	±	0.5708
S	3.5476	±	0.1001
Cl	10.6427	±	3.3058
K	11.8192	±	2.7505
Ca	622.6916	±	99.9420
Ti	1.4783	±	0.1990
V	0.0000	±	0.3777
Cr	0.0000	±	0.1259
Mn	0.9951	±	0.0286
Fe	16.5751	±	0.0788
Co	0.0000	±	0.2558
Ni	0.0354	±	0.0098
Cu	1.2529	±	0.0180
Zn	0.3927	±	0.0123
Ga	0.0000	±	0.0463
As	0.0000	±	0.0546
Se	0.0106	±	0.0279
Br	0.0074	±	0.0257
Rb	0.0645	±	0.0092
Sr	1.3768	±	0.0180
Y	0.0129	±	0.0333
Zr	0.0702	±	0.0223
Mo	0.0690	±	0.0697
Pd	0.0833	±	0.2528
Ag	0.0322	±	0.2842
Cd	0.0218	±	0.2823
In	0.0000	±	0.3321
Sn	0.0127	±	0.3993
Sb	0.2094	±	0.4620
Ba	0.0000	±	1.5617
La	1.8984	±	2.0400
Au	0.0000	±	0.0751
Hg	0.0000	±	0.0632
Tl	0.0112	±	0.0606
Pb	0.0431	±	0.0814
U	0.0241	±	0.0633
Sum	1004.1420	±	114.847

Comments:

Table 6 (continued)

Filter Deposit Mass for Resuspended Silt Samples

Sample: BG3&5 Teflon ID: REST366 Quartz ID: RESQ366 Size: PM-2.5

Flag: Teflon Quartz Mass XRF Carbon

Concentrations (µg/filter)

Mass	1039.0000	±	18.6650
Organic Carbon	138.8000	±	13.0000
Elemental Carbon	12.2000	±	1.0000
Total Carbon	151.0000	±	11.4000
Al	11.6429	±	0.3163
Si	81.6722	±	0.4147
P	0.1283	±	0.2658
S	3.4546	±	0.0859
Cl	6.3936	±	0.4469
K	6.8259	±	0.5702
Ca	233.5001	±	0.4797
Ti	1.0051	±	0.1740
V	0.0000	±	0.3272
Cr	0.0000	±	0.1084
Mn	0.4896	±	0.0218
Fe	10.1316	±	0.0615
Co	0.0000	±	0.1585
Ni	0.0397	±	0.0078
Cu	0.5856	±	0.0130
Zn	0.2132	±	0.0099
Ga	0.0000	±	0.0386
As	0.0000	±	0.0484
Se	0.0014	±	0.0239
Br	0.0052	±	0.0217
Rb	0.0368	±	0.0073
Sr	0.6226	±	0.0129
Y	0.0148	±	0.0280
Zr	0.0341	±	0.0415
Mo	0.0455	±	0.0585
Pd	0.0271	±	0.2110
Ag	0.1397	±	0.2416
Cd	0.0894	±	0.2365
In	0.0000	±	0.2813
Sn	0.0904	±	0.3491
Sb	0.0848	±	0.4066
Ba	0.4275	±	1.3669
La	1.5776	±	1.7750
Au	0.0330	±	0.0641
Hg	0.0004	±	0.0538
Tl	0.0076	±	0.0511
Pb	0.0794	±	0.0234
U	0.0000	±	0.0517
Sum	510.3997	±	13.2986

Comments:

Table 6 (continued)

Filter Deposit Mass for Resuspended Silt Samples

Sample: BG2 | Teflon ID: REST363 | Quartz ID: RESQ363 | Size: PM-10

	Teflon	Quartz	Mass	XRF	Carbon
Flag:					m2

Concentrations (µg/filter)

Mass	3448.0000	±	18.6650
Organic Carbon	223.0000	±	20.4000
Elemental Carbon	45.0000	±	2.2000
Total Carbon	268.0000	±	19.2000
Al	71.6802	±	21.0156
Si	322.3027	±	100.727
P	0.1995	±	0.7696
S	6.9361	±	0.1331
Cl	11.9156	±	4.1329
K	24.4463	±	5.4897
Ca	1145.6700	±	183.877
Ti	4.2375	±	0.1957
V	0.1074	±	0.3800
Cr	0.1277	±	0.1309
Mn	2.2591	±	0.0416
Fe	44.3950	±	0.1288
Co	0.0051	±	0.6760
Ni	0.1224	±	0.0130
Cu	1.8871	±	0.0209
Zn	0.7788	±	0.0143
Ga	0.0000	±	0.0432
As	0.0153	±	0.0620
Se	0.0149	±	0.0258
Br	0.0005	±	0.0307
Rb	0.1339	±	0.0093
Sr	2.8154	±	0.0236
Y	0.0590	±	0.0104
Zr	0.1693	±	0.0383
Mo	0.0000	±	0.0615
Pd	0.0625	±	0.2702
Ag	0.2644	±	0.3057
Cd	0.1199	±	0.3013
In	0.0000	±	0.3456
Sn	0.0882	±	0.4104
Sb	0.0000	±	0.4656
Ba	0.9040	±	1.4727
La	1.1498	±	1.8886
Au	0.0499	±	0.0755
Hg	0.0512	±	0.0589
Tl	0.0000	±	0.0582
Pb	0.1863	±	0.0257
U	0.0436	±	0.0618
Sum	1911.1986	±	211.836

Comments:

Table 6 (continued)
Filter Deposit Mass for Resuspended Silt Samples

Sample: BG2   Teflon ID: REST364   Quartz ID: RESQ364   Size: PM-2.5

Flag: Teflon Quartz Mass XRF Carbon m2

Concentrations (µg/filter)

Mass	1338.0000	±	18.6650
Organic Carbon	92.4000	±	9.1000
Elemental Carbon	75.0000	±	3.4000
Total Carbon	167.4000	±	12.4000
Al	17.5373	±	0.3818
Si	113.1371	±	0.4868
P	0.3478	±	0.1036
S	5.7766	±	0.1025
Cl	5.7282	±	0.5401
K	9.8434	±	0.7046
Ca	290.0287	±	0.5355
Ti	1.8267	±	0.1659
V	0.0470	±	0.3076
Cr	0.0537	±	0.1021
Mn	0.7539	±	0.0246
Fe	17.1766	±	0.0797
Co	0.0000	±	0.2646
Ni	0.0518	±	0.0076
Cu	0.8763	±	0.0148
Zn	0.3661	±	0.0107
Ga	0.0286	±	0.0359
As	0.0000	±	0.0542
Se	0.0078	±	0.0214
Br	0.0083	±	0.0246
Rb	0.0518	±	0.0067
Sr	0.8202	±	0.0137
Y	0.0231	±	0.0251
Zr	0.0675	±	0.0148
Mo	0.0287	±	0.0508
Pd	0.0229	±	0.2084
Ag	0.0881	±	0.2332
Cd	0.0000	±	0.2315
In	0.0000	±	0.2811
Sn	0.0000	±	0.3418
Sb	0.0000	±	0.3851
Ba	0.2943	±	1.3004
La	0.6863	±	1.6507
Au	0.0342	±	0.0588
Hg	0.0082	±	0.0478
Tl	0.0251	±	0.0479
Pb	0.1906	±	0.0224
U	0.0025	±	0.0464
Sum	633.3394	±	10.0494

Comments:

Table 6 (continued)

Filter Deposit Mass for Resuspended Silt Samples

Sample: BG4 Teflon ID: REST367 Quartz ID: RESQ367 Size: PM-10

Teflon Quartz Mass XRF Carbon

Flag:

Concentrations (µg/filter)

Mass	2402.0000	±	18.6650
Organic Carbon	149.2000	±	13.9000
Elemental Carbon	45.1000	±	2.2000
Total Carbon	194.3000	±	14.2000
Al	39.4973	±	11.5997
Si	201.2096	±	62.8857
P	1.2024	±	0.5370
S	3.6669	±	0.1066
Cl	5.8753	±	2.3979
K	14.1027	±	3.4110
Ca	834.0867	±	133.870
Ti	1.9225	±	0.2013
V	0.0000	±	0.3782
Cr	0.0346	±	0.1267
Mn	1.4773	±	0.0328
Fe	21.7913	±	0.0905
Co	0.0055	±	0.3348
Ni	0.0814	±	0.0106
Cu	1.5659	±	0.0196
Zn	0.3633	±	0.0121
Ga	0.0000	±	0.0465
As	0.0000	±	0.0551
Se	0.0009	±	0.0276
Br	0.0004	±	0.0330
Rb	0.0836	±	0.0090
Sr	1.8074	±	0.0200
Y	0.0511	±	0.0114
Zr	0.0745	±	0.0809
Mo	0.0000	±	0.0699
Pd	0.0000	±	0.2610
Ag	0.2838	±	0.2984
Cd	0.1025	±	0.2942
In	0.2406	±	0.3512
Sn	0.0000	±	0.4126
Sb	0.0000	±	0.4714
Ba	0.0000	±	1.5839
La	1.5687	±	2.0286
Au	0.0024	±	0.0752
Hg	0.0199	±	0.0648
Tl	0.0248	±	0.0614
Pb	0.0508	±	0.0817
U	0.0164	±	0.0642
Sum	1325.5105	±	149.110

Comments:

Table 6 (continued)
Filter Deposit Mass for Resuspended Silt Samples

Sample: BG4 Teflon ID: REST368 Quartz ID: RESQ368 Size: PM-2.5

Flag: Teflon Quartz Mass XRF Carbon

Concentrations (μg/filter)

Mass	1189.0000	±	18.6650
Organic Carbon	149.0000	±	13.9000
Elemental Carbon	11.9000	±	1.0000
Total Carbon	160.9000	±	12.0000
Al	14.5079	±	0.3518
Si	99.3891	±	0.4595
P	0.2536	±	0.2950
S	4.0195	±	0.0928
Cl	4.8084	±	0.5321
K	8.1551	±	0.6975
Ca	287.6775	±	0.5322
Ti	1.1659	±	0.1683
V	0.0000	±	0.3090
Cr	0.0233	±	0.1020
Mn	0.6586	±	0.0233
Fe	12.9362	±	0.0693
Co	0.0078	±	0.2009
Ni	0.0508	±	0.0076
Cu	0.8459	±	0.0147
Zn	0.2429	±	0.0097
Ga	0.0195	±	0.0362
As	0.0072	±	0.0459
Se	0.0023	±	0.0217
Br	0.0075	±	0.0197
Rb	0.0537	±	0.0069
Sr	0.7896	±	0.0136
Y	0.0136	±	0.0254
Zr	0.0615	±	0.0146
Mo	0.0000	±	0.0528
Pd	0.0000	±	0.2093
Ag	0.0000	±	0.2319
Cd	0.1657	±	0.2355
In	0.0000	±	0.2762
Sn	0.0432	±	0.3317
Sb	0.0000	±	0.3849
Ba	0.9601	±	1.2992
La	0.9002	±	1.6705
Au	0.0495	±	0.0594
Hg	0.0000	±	0.0484
Tl	0.0080	±	0.0473
Pb	0.0930	±	0.0214
U	0.0092	±	0.0479
Sum	598.8263	±	14.1725

Comments:

Table 6 (continued)

Filter Deposit Mass for Resuspended Silt Samples

Sample:Res. Blank Teflon ID: Quartz ID: Size:

Flag: Teflon Quartz Mass XRF Carbon

Concentrations (µg/filter)

Mass	11.0000	±	6.0450
Organic Carbon	22.1875	±	14.7933
Elemental Carbon	0.0000	±	4.5758
Total Carbon	25.2625	±	18.7152
Al	0.3341	±	0.1576
Si	0.7475	±	0.4686
P	0.0953	±	0.0401
S	0.0890	±	0.0638
Cl	0.0000	±	0.1167
K	0.0000	±	0.0925
Ca	1.9081	±	1.8907
Ti	0.0000	±	0.5010
V	0.0000	±	0.2187
Cr	0.0000	±	0.0542
Mn	0.0000	±	0.0307
Fe	0.3590	±	0.2253
Co	0.0000	±	0.0199
Ni	0.0000	±	0.0192
Cu	0.0000	±	0.0203
Zn	0.0000	±	0.0194
Ga	0.0000	±	0.0367
As	0.0000	±	0.0412
Se	0.0000	±	0.0219
Br	0.0000	±	0.0201
Rb	0.0000	±	0.0194
Sr	0.0000	±	0.0216
Y	0.0000	±	0.0259
Zr	0.0000	±	0.0310
Mo	0.0000	±	0.0541
Pd	0.0000	±	0.1709
Ag	0.0000	±	0.2060
Cd	0.0000	±	0.2188
In	0.0000	±	0.2445
Sn	0.0000	±	0.3142
Sb	0.0000	±	0.3544
Ba	0.0000	±	1.2590
La	0.0000	±	1.6793
Au	0.0000	±	0.0600
Hg	0.0000	±	0.0493
Tl	0.0000	±	0.0464
Pb	0.0000	±	0.0605
U	0.0000	±	0.0462
Sum	0.0000	±	0.0000

Comments:

Table 7

$PM_{2.5}$ / PM_{10} Mass Ratios for Resuspended Dust Samples

Sample	$PM_{2.5}$ Filter Mass (μg)	PM_{10} Filter Mass (μg)	PM_{10} Dummy Filter Mass (μg)	$PM_{2.5}$ / PM_{10} Mass Ratio
BG3&5	1039	1746	14,112	0.0655
BG2	1338	3448	10,603	0.0952
BG4	1189	2402	12,793	0.0782