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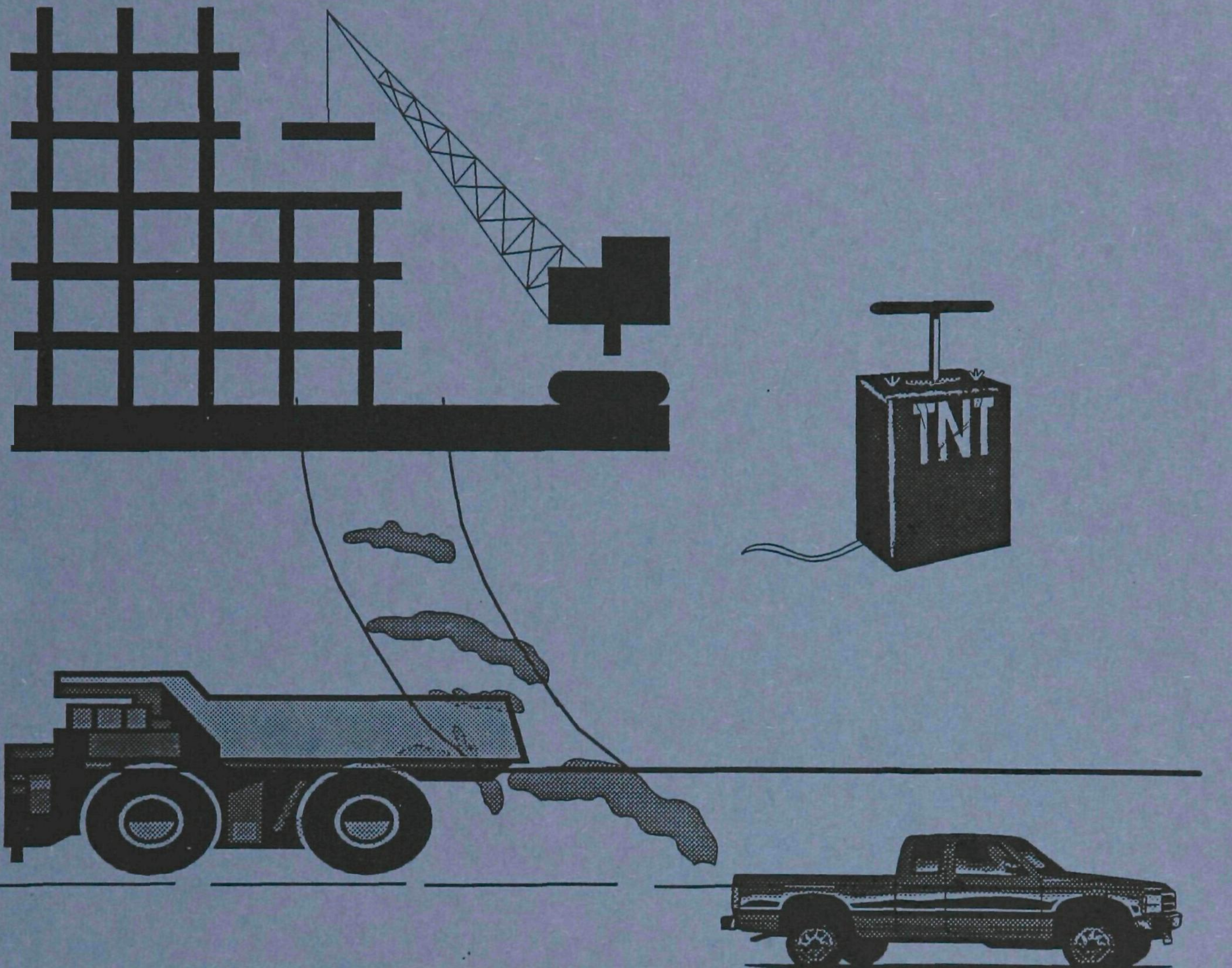
EPA

Characterization of Mud/Dirt Carryout onto Paved Roads from Construction and Demolition Activities



J E I O G

Joint Emissions Inventory Oversight Group

FOREWORD

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E. Timothy Oppelt, Director
National Risk Management Research Laboratory

EPA REVIEW NOTICE

EPA-600/R-95-171
December 1995

CHARACTERIZATION OF MUD/DIRT CARRYOUT ONTO PAVED ROADS FROM CONSTRUCTION AND DEMOLITION ACTIVITIES

FINAL REPORT

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ABSTRACT

Several urban areas of the country in violation of the National Ambient Air Quality Standard for particulate matter have identified fugitive dust generated by vehicular traffic on paved streets and highways resulting from mud/dirt carryout from unpaved areas as a primary source of PM-10. Since little data are currently available on the amount of mud/dirt carryout deposited on paved roads, this work characterizes the process and evaluates selected control methods. Three control technologies were evaluated for effectiveness in controlling mud/dirt carryout from an unpaved construction access area onto an adjacent paved road. The first control used a street sweeper to mechanically sweep the dirt and debris from the paved road surface. The second applied a 6- to 12-in layer of woodchip/mulch material onto the access area of the construction site to a distance of 100 ft from the paved road. The third control applied a 6-in layer of gravel over the access area. Street sweeping was found to be only marginally effective (approximately 20%) in reducing average silt loading on the paved road lanes. Treatment of the access area with a buffer of woodchip/mulch was moderately effective, reducing average silt loading by 38 to 46%. The gravel buffer showed the greatest effectiveness, reducing the average silt loading by 57 to 68%. These silt loading reductions result in the following calculated PM-10 reductions: street sweeping, 14%; woodchips, 27 to 33%; and gravel, 42 to 52%.

ACKNOWLEDGEMENTS

This report was prepared by Midwest Research Institute's (MRI's) Michael M. Raile with assistance from Chatten Cowherd and Greg Muleski. This project was initially directed by John Kinsey and subsequently completed by Michael Raile. Kathryn Weant of EPA's Office of Air Quality Planning and Standards is the contract Project Officer. Other MRI personnel participating in the project were Gary Garman, David Griffin, and Frank Pendleton.

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METRIC CONVERSIONS

Certain nonmetric units are used in this report for the reader's convenience. Readers who are more familiar with the metric system may use the following to convert to that system.

Nonmetric	Multiplied by	Yields Metric
ft	0.3048	m
in.	2.54	cm
mi	1.609	km
ton	907.2	kg

SECTION 1

INTRODUCTION

Several areas of the country that are in violation of the National Ambient Air Quality Standard (NAAQS) for PM-10 (particles ≤ 10 µm in aerodynamic diameter) have conducted studies to identify the sources of these emissions. A primary source of PM-10 in many urban areas is the fugitive dust generated by vehicular traffic on paved streets and highways (USEPA, 1992).

Road dust emissions occur whenever a vehicle travels over a paved surface, such as public and industrial roads and parking lots. Particulate emissions originate primarily from the road surface material loading (measured as mass of material per unit area). The surface loading is in turn replenished by other sources (e.g., pavement wear, deposition of material from vehicles, deposition from other nearby sources, carryout from surrounding unpaved areas, and litter). Because of the effects of the surface loading, available control techniques attempt either (a) to prevent material from being deposited on the surface or (b) to remove (from the travel lanes) any material that has been deposited.

According to the Environmental Protection Agency (EPA) publication, *Compilation of Air Pollutant Emission Factors* (AP-42), the quantity of dust emissions from vehicle traffic on a paved public road (per vehicle kilometer traveled or VKT) may be estimated using the following empirical expression:

$$E = 4.6\ (sL/2)^{0.65}\ (W/3)^{1.5}$$

where:

E	=	PM-10 emission factor (g/VKT)
s	=	surface silt content (fraction of particle < 75 µm in physical diameter)
L	=	total road surface dust loading (g/m^2)
W	=	average weight (tons) of the vehicle traveling on the road

The total loading (excluding litter) shown in the above equation is measured by sweeping and vacuuming lateral strips of known area from each active travel lane. Using a modified version of ASTM C 136 (as described in USEPA, 1995), the silt fraction is determined by measuring the proportion of loose dry road dust that passes a 200-mesh screen.

Activities such as construction and demolition projects can create a temporary, but substantial, increase in the amount of fine particles on the surfaces of adjacent paved roads. This increase in fine particle loading is the result of mud/dirt carryout from vehicles leaving the construction/demolition site.

Furthermore, tracking of material onto a paved road is characterized by substantial spatial variation in loading about the point of access to the site. This variation complicates the estimation of emissions caused by carryout as well as the emission reductions achievable by control of carryout. The spatial variations and the associated difficulties in estimating emissions become less important as the number of access points in an area increases.

A prior field study specifically addressed mud/dirt carryout onto urban paved roads. It was conducted in 1982 as part of a national demonstration study of construction-related dust emissions (Kinsey and Englehart, 1984).

This report describes a field study undertaken to better understand the mechanisms of mud/dirt carryout as well as the effectiveness of measures used to control carryout. The study collected and analyzed surface material samples taken from a paved road adjacent to a construction site in the Brush Creek flood control project in the metropolitan area of Kansas City, Missouri. The effects of mud/dirt carryout control were evaluated by monitoring the changes in paved road surface dust loading. Both *preventive and mitigative* measures for controlling carryout were considered. Preventive measures attempted to keep material from being deposited on roadways, while mitigative measures attempted to remove the material after being deposited. The mitigative control measure of interest in this study was combined water flushing and broom sweeping. The two preventive measures that were studied both involved covering the access area with a coarse material (gravel and woodchips/mulch).

The rest of this report is structured as follows. Section 2 describes the test site and the sampling methods. Section 3 discusses the methods used to analyze the samples collected. Section 4 presents the test results. Section 5 contains the conclusions that were derived from this study. Section 6 lists the references.

SECTION 2

FIELD SAMPLING PROGRAM

This section describes the site selection process and the sampling plan for characterizing the effects of mud/dirt carryout from construction activities.

2.1 SITE SELECTION AND CHARACTERISTICS

The first objective was to locate a paved roadway used by heavy trucks to enter and exit from a construction or demolition site. An additional condition was that the paved roadway should have an average daily traffic count (ADT) of at least 10,000. Such a road, classified as an arterial, would provide for rapid resuspension of mud/dirt carryout from the site by relatively heavy traffic not associated with the site activity.

The paved roadway segment that was selected for this study was Elmwood Avenue between Blue Parkway and Brush Creek Boulevard in east central Kansas City, Missouri. This road was highly impacted by mud/dirt carryout from an adjacent construction activity.

Figure 2-1 shows the location of the sampling site with respect to the Kansas City metropolitan area, and Figure 2-2 is an enlarged view of the boxed portion of Figure 2-1. The roadway segment is approximately 1200 ft in length and is 40 ft wide. It carries an annual average daily traffic volume of ~ 10,000 vehicles and is classified as a minor arterial roadway. At the time of this study, a pocket of construction activity associated with the Brush Creek Flood Control Project was located on the east side of Elmwood Avenue.

Construction activities involving several contractors extended west along Brush Creek for approximately 2 miles. In addition, several other construction projects were

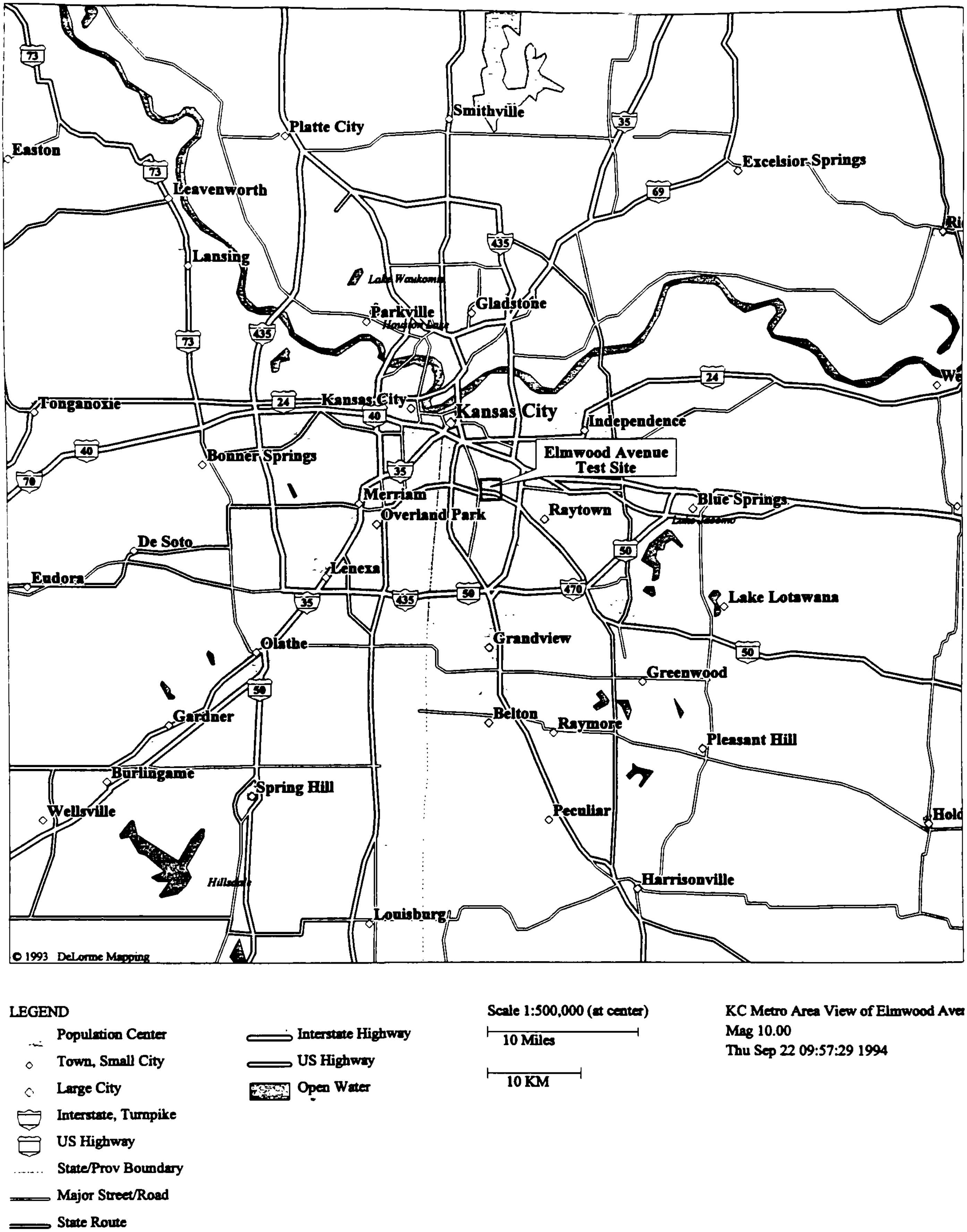

Figure 2-1. Kansas City metropolitan area view of Elmwood Avenue test site. (Reproduced with permission.)

LEGEND

Population Center

Park

Street, Road

Major Street/Road

US Highway

Railroad

River

Scale 1:15,625 (at center)

1000 Feet

500 Meters

Elmwood Avenue Test Site
Mag 15.00
Thu Sep 22 09:48:07 1994

Figure 2-2. Enlarged view of the Elmwood Avenue test site. (Reproduced with permission.)

active in the Brush Creek corridor, including major roadway and institutional construction. All adjacent paved roads in the area were subject to mud/dirt carryout.

Elmwood Avenue was chosen as the field sampling location partially because its lower traffic volume made sampling easier than on the other streets associated with the flood control project. It also happened to be the location where the Army Corps of Engineers was building a dam for containment purposes. With the construction of the dam and other earthmoving activities, the Elmwood site was expected to provide enough truck traffic to support a field sampling program throughout the summer of 1994. Ten-wheel dump trucks carried earth from the site, south on Elmwood, and then on to their final destination. On days that it rained, the trucks could not enter the site due to an incline near the site entrance that became too muddy to support vehicles safely. On those days the trucks were redirected to other sites where they could work.

The contractor responsible for earthmoving activities at the site had already implemented a street sweeping program near the test site. For the control technology portion of the field sampling, the same street sweeping company (Delta Sweeping of Kansas City, Missouri) was hired to sweep Elmwood Avenue in the same manner as the other various mud/dirt carryout locations in the area. This allowed for evaluation of a control technology that was already being used in the area.

2.2 FIELD SAMPLING PROCEDURES

The information collected at the field sampling site falls into two broad categories:

- Roadway surface samples
- Source activity levels

Each category is described in detail below.

2.2.1 Road Surface Sampling

This field sampling program was designed to efficiently collect paved road surface material samples at various distances from the construction site entrance on

Elmwood Avenue over an extended time period. This enabled a reasonably large number of samples to be collected and analyzed. Samples representative of several control technologies, weather conditions, and traffic volumes were collected.

From previous studies of silt loading on paved roads, it was known that the loadings could vary from one lane to the next. For this reason, the sampling scheme shown in Figures 2-3 and 2-4 was adopted to allow for segregation of the two southbound lanes. If necessary, at the end of the data reduction process, the data from the two southbound lanes could be integrated with each other to represent just the southbound portion of the roadway. Sample area 1 was designated for the collection of background silt loading samples which ideally would not be impacted by carryout from the construction site.

Samples of the material on the road surface were collected by dry vacuuming and then analyzed for silt content. The procedures used for sampling and analysis are described in detail in Section 3. Sample collection forms are also presented in Section 3 along with applicable calculation procedures.

2.2.2 Source Activity Monitoring

Source extent and activity data were collected in the sampling program. Vehicle-related parameters were acquired using a combination of manual and automatic recording techniques. Pneumatic tube axle counters were used to obtain traffic volume data. However, because these counters recorded only the number of passing axles, it was necessary to obtain 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. Detailed procedures and forms used for obtaining source activity data also are provided in Section 3.2.

Daily weather data were obtained from a local newspaper, and rainfall measurements were made on site with a rain gauge. A daily log was also maintained, noting any activities that were observed at the site or any communications that were pertinent to the outcome of the project. This log is presented in Appendix A.

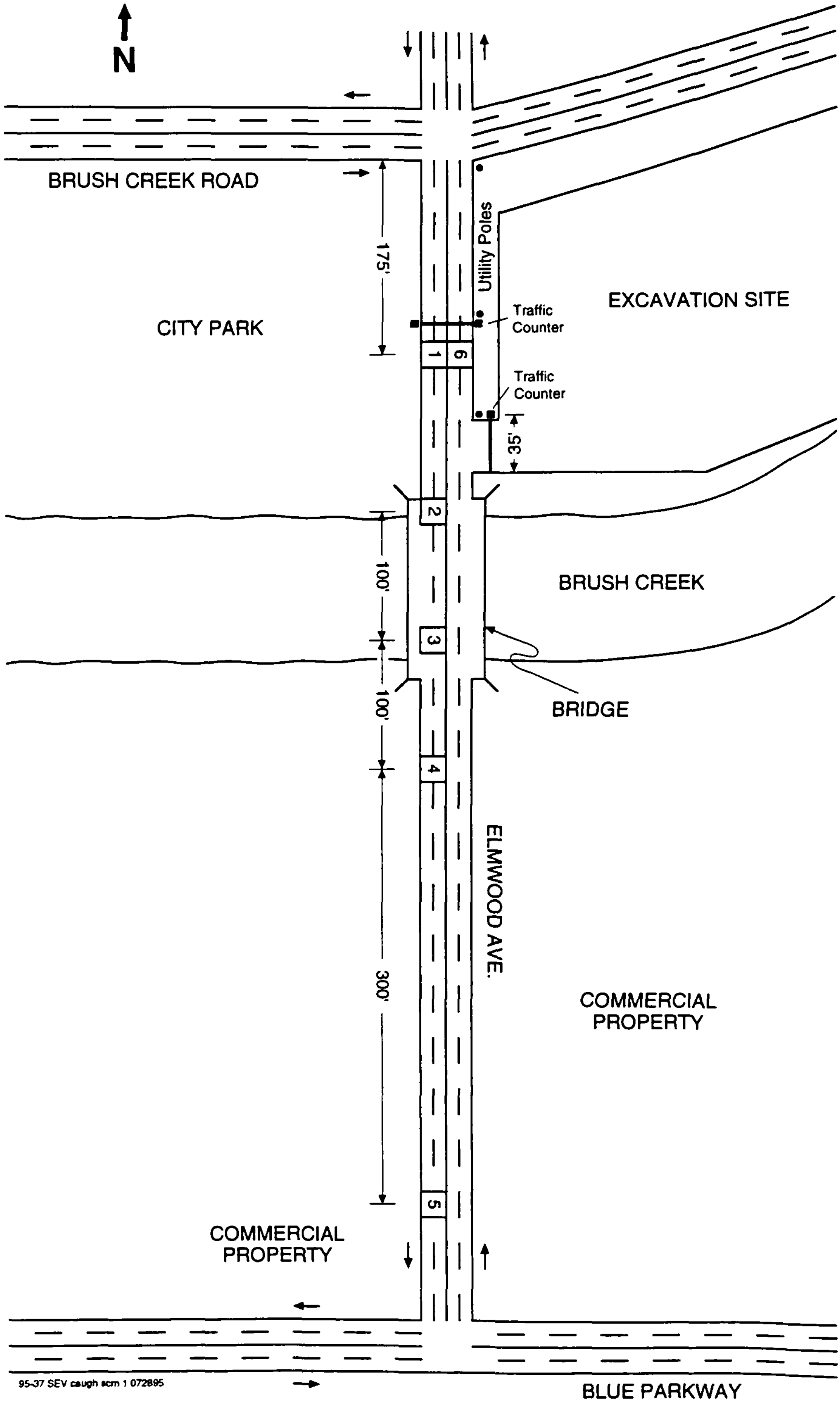

Figure 2-3. Site sampling diagram.

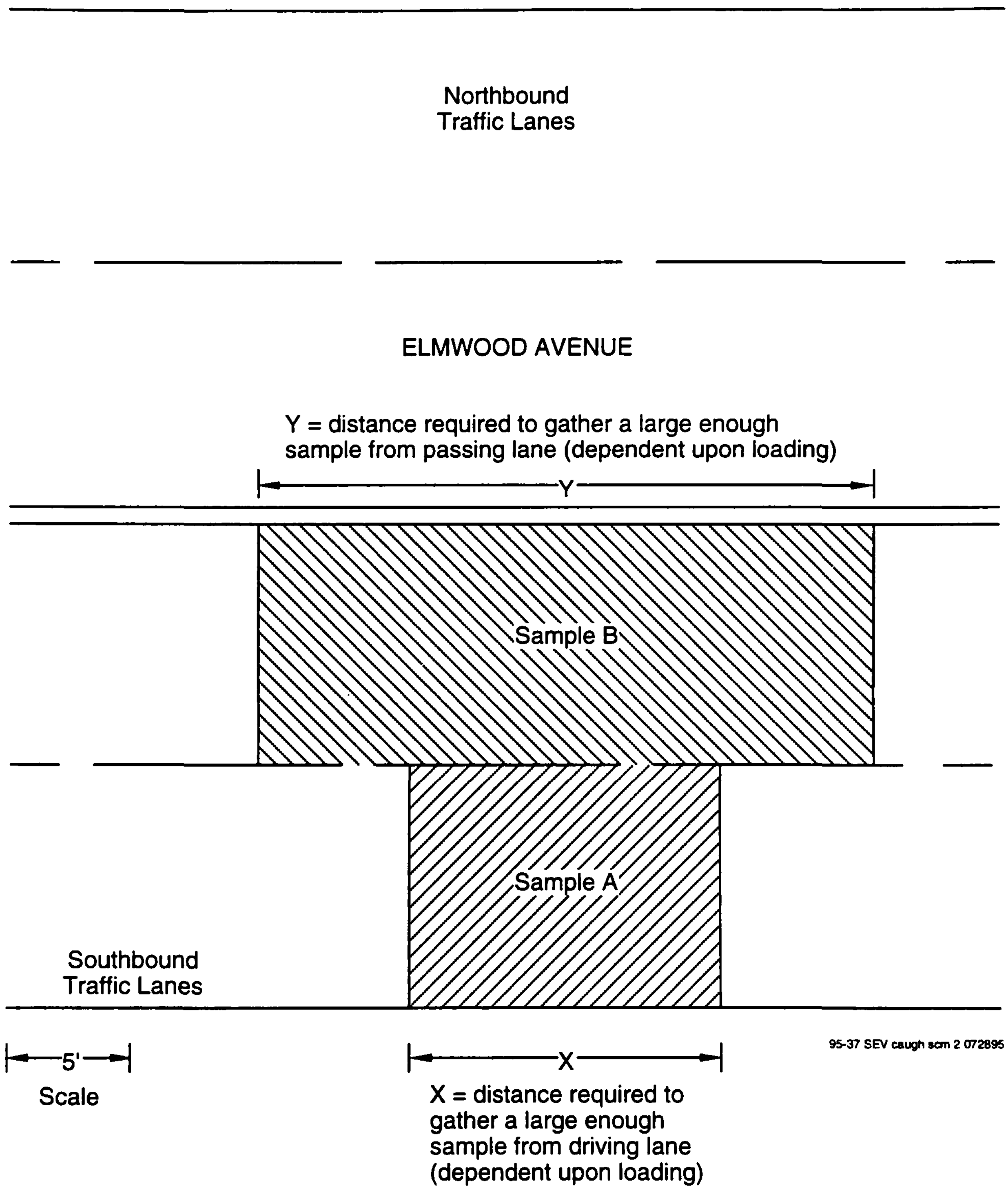

Figure 2-4. Sample designation for southbound lanes.

2.3 STUDY CONDITIONS

In addition to the uncontrolled study condition, three different mud/dirt carryout controls were evaluated in the program: street sweeping; installation of a woodchip/ mulch apron (buffer) at the site access point; and installation of a gravel buffer at the same point. These controls were evaluated sequentially as described below.

As the first step, the paved road adjacent to the site (Elmwood Avenue) was cleaned to the extent practical using a combination of broom sweeping and flushing. This cleaning represented a "baseline" silt loading value for future reference. (In this context, "baseline" refers to as clean a road surface condition as possible.)

Once the baseline levels were reached, the surface loading was allowed to increase to its "steady state" condition, with sampling conducted before and after precipitation throughout the "conditioning" period. Post-precipitation sampling was performed once the road surface became dry enough to collect surface samples. The data from these samples established both the magnitude and extent of the uncontrolled mud/dirt carryout from the site, and provided a time history of the overall carryout process starting from an essentially clean surface.

When the uncontrolled tests were completed, the paved road was thoroughly cleaned again (sweeping and flushing) to baseline condition prior to evaluation of street sweeping as the first control method. Thereafter, the road was swept on a periodic basis using the fleet of street sweepers that were already being used to control carryout in the immediate vicinity. Sweeping occurred every other workday, except on days that it rained. Surface sampling was conducted at approximately the same time periods before and after precipitation, as was done for the uncontrolled sampling, to determine the overall reduction in silt loading.

Prior to evaluation of the second control method, the paved road was again aggressively cleaned (sweeping and flushing) to reestablish the baseline condition. Coordinated with the cleaning, the woodchip/mulch material was applied in a 6- to 12-in layer to the site access point and adjacent areas to provide a 100-ft buffer between the paved and unpaved surfaces. The buffer allowed the mud/dirt carried on the truck tires and underbodies to deposit in the buffer area, rather than on the paved road. Reductions in silt loading were then quantified by appropriate surface sampling at comparable time periods before and after precipitation.

Finally, after the paved road was cleaned again (sweeping and flushing) to the baseline condition, the previously installed woodchip/mulch buffer area was replaced with a gravel buffer (100-ft length and 6-in depth). Comparable surface sampling was performed before and after precipitation in a manner similar to that described above.

Note that the original test plans had called for the evaluation of street sweeping, the gravel buffer, and an asphalt buffer. However, the construction site supervisor responded to the city request for controlling on-site fugitive dust by using a woodchip/mulch buffer. Because the woodchip/mulch buffer was an actual control measure chosen by the contractor, it was decided to evaluate this buffer's effectiveness.

By the time that the gravel buffer was to be evaluated, traffic into and out of the site had been reduced and was not expected to pick up until concrete pouring began in earnest at the dam site. Because of schedule constraints, it was jointly decided by the EPA work assignment manager and MRI to generate "captive" traffic to complete the evaluation of the gravel buffer. The "captive" traffic that was used was a ten-wheeled truck that was identical to the type of trucks that were originally hauling material from the site. The captive truck was half loaded to represent the average of a loaded and an unloaded condition.

SECTION 3

DATA ANALYSIS

3.1 SAMPLE COLLECTION AND ANALYSIS PROCEDURES

Samples of the material on the road surface were collected by dry vacuuming, followed by analysis for silt content (percent less than 200 mesh or 75 μm physical diameter). The procedures used for sampling and analysis are described below.

3.1.1 Road Surface Sampling

Paved road samples were collected by cleaning the surface of the road with a vacuum cleaner with preweighed filter bags. An "industrial-type" vacuum cleaner was used due to the heavy loadings that were anticipated in the study.

The following steps describe the collection method for individual samples:

1. Ensure that proper measures have been taken to redirect traffic around the area to be swept. The use of orange traffic cones, an "arrow board," and reflective vests for the field crew were used at all times.

2. By using string, surveying paint, or other suitable markers, mark the sampling width across the road. The widths may vary between 10 ft for visibly dirty roads and 100 ft for clean roads when using an "industrial-type" vacuum.

3. If large, loose material was present on the surface, it was collected with a whisk broom and dustpan. On roads with painted side markings, collect material "from white line to white line" (but avoid any centerline mounds). Temporarily store the swept material in a clean, labeled container until it can be recombined with the vacuum sample that was taken from the same sample area.

4. Vacuum sweep the sample area using a portable vacuum cleaner fitted with an empty preweighed filter bag. On roads with painted side markings, collect material "from white line to white line" (but avoid centerline mounds).

5. Carefully remove the bag from the vacuum sweeper and check for tears or leaks. If necessary, transfer any broom-swept material from its original container into the vacuum bag. Fold the unused portion of the filter bag, wrap a rubber band around the folded bag, and store the bag for transport.

6. Record the required information on the sample collection sheet (Figure 3-1).

If part of the sample was collected through broom sweeping, then the combined sample (i.e., the broom-swept plus vacuumed material) should weigh at least 400 g (~ 1 lb). If the sample was collected solely through vacuuming, then the sample should weigh at least 200 g (~ 0.5 lb). Addition increments should be taken until these samples mass goals have been achieved. (Sample weights can be estimated in the field using either an inexpensive scale or the experience of the sampling personnel.)

3.1.2 Procedures for Sample Compositing and Splitting

All samples obtained in the field were first weighed to determine the net mass of material collected according to SOP No. EET-611 (Appendix B). Wherever possible, broom-swept material was transferred to the vacuum bag in the field (see Section 3.1.1) to obtain one sample with a single mass (M_T).

Once composed, a sample may require splitting to a size more amenable for analysis. Two methods are recommend for sample splitting—riffling, and coning and quartering. Since a riffle was used in the study, only this procedure will be described.

Figure 3-2 shows two riffles for sample division. Riffle slot widths should be at least three times the size of the largest aggregate in the material being divided. The following quote from ASTM Standard Method D2013-72 describes the use of the riffle (ASTM, 1977).

SAMPLING DATA FOR PAVED ROADS

Date Collected ______________________ Recorded by ______________________

Project No. 4601-04-03 ______________________ Vacuum Cleaner ID No ______________________

Sampling location* Elmwood Ave. between Blue Pkwy and Brush Creek Blvd

Surface type (e.g., asphalt, concrete, etc.) asphalt No. of lanes 4

Surface condition (e.g., good, rutted, etc.) ______________________

* Use code given on plant or road map for segment identification. Indicate sampling location on sketch below.

SAMPLING DATA COLLECTED

Sample Area	Sample ID #	Surface area sampled (Dimensions)	Time	Broom Swept Sample	
				Collected (Y/N)	Added to Vac Bag (Y/N)

Sketch of Sampling Event:

Figure 3-1. Sample data form.

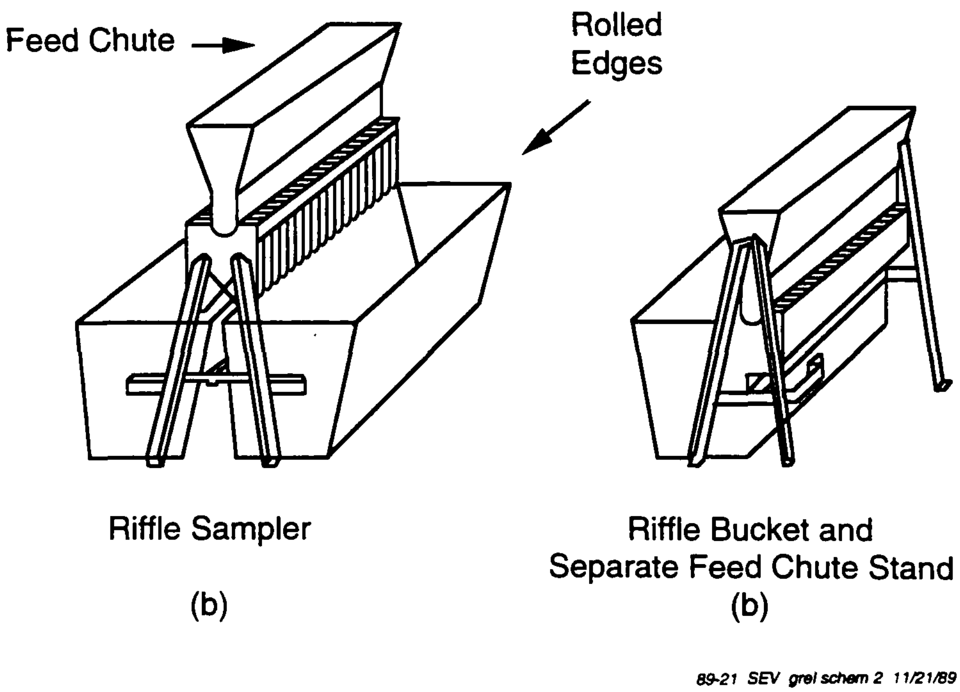

Figure 3-2. Sample dividers (riffles).

"Divide the gross sample by using a riffle. Riffles properly used will reduce sample variability but cannot eliminate it. Riffles are shown in Figure 3-2. Pass the material through the riffle from a feed scoop, feed bucket, or riffle pan having a lip or opening the full length of the riffle. When using any of the above containers to feed the riffle, spread the material evenly in the container, raise the container, and hold it with its front edge resting on the top of the feed chute, then slowly tilt it so that the material flows in a uniform stream through the hopper straight down over the center of the riffle into all the slots, thence into the riffle pans, one-half of the sample being collected in a pan. Under no circumstances shovel the sample into the riffle, or dribble into the riffle from a small-mouth container. Do not allow the material to build up in or above the riffle slots. If it does not flow freely through the slots, shake or vibrate the riffle to facilitate even flow." (ASTM, 1977)

3.1.3 Silt Analysis Procedures

Paved road samples collected vacuuming are not normally oven-dried because filter bags are used to collect the samples. After the sample was recovered by dissection of the bag, and split if necessary, it was ready for silt analysis.

As discussed in Section 3.1.2 above, paved road samples where the broom-swept particles and vacuum swept dust are combined to calculate total surface loading on the traveled lanes. The composite sample is usually small and should not require splitting in preparation for sieving. If splitting is required, the protocol outlined in Section 3.1.2 is used.

The following procedure is used to analyze surface samples for silt content:

1. Select the appropriate 20-cm (8-in) diameter, 5-cm (2-in) deep sieve sizes. Recommended U.S. Standard Series sizes are: $^3/_8$ in, No. 4, No. 20, No. 40, No. 100, No. 140, No. 200, and a pan. Comparable Tyler Series sizes can be utilized. The No. 20 and No. 200 are mandatory. The others can be varied if the recommended sieves are not available or if buildup on one particular sieve during sieving indicated that an intermediate sieve should be inserted.

2. Obtain a mechanical sieving device such as a vibratory shaker or a Roto-Tap without the tapping function.

3. Clean the sieves with compressed air and/or a soft brush. Material lodged in the sieve openings or adhering to the sides of the sieve should be removed (if possible) without handling the screen roughly.

4. Obtain a balance (capacity of at least 1,600 g or 3.5 lb) and record the make, capacity, smallest division, and date of last calibration. Perform a calibration check of the balance according to SOP EET-611 (Appendix B) and record the results in a logbook.

5. Weigh the sieves and pan to determine tare weights. Check the zero before every weighing. Record the weights.

6. After nesting the sieves in decreasing order with the pan at the bottom, transfer the laboratory sample into the top sieve. The sample should weigh between ~ 200 and 1,000 g (0.5 and 2.5 lb). This amount will vary for finely textured materials; 100 to 300 g may be sufficient when 90% of the sample passes a No. 8 (2.36-mm) sieve. Brush fine material adhering to the sides of the container into the top sieve and cover the top sieve with a special lid normally purchased with the pan.

7. Place nested sieves into the mechanical sieving device and sieve for 10 min. Remove the pan containing the material that was small enough to pass through the No. 200 sieve and weigh. Repeat the sieving in 10-min intervals until the difference between two successive pan sample weighings (where the tare weight of the pan has been subtracted) is less than 3.0%. Do not sieve longer than 40 min.

8. If the difference between the last two successive pan sample weighings is still larger than 3.0% after the 40-min interval, the material may need to be brushed through the smaller opening sieves (sieve Nos. 100 through 200). The operator should take a brush and lightly brush the material on the sieve in a back and forth motion until it looks as though no clogging of the sieve appears apparent

and all the smaller particles seem to have passed through the sieve. Repeat this procedure on the remaining sieves (No. 140 and No. 200).

9. Weigh each sieve and its contents and record the weight. Check the zero reading on the balance before every weighing.

10. Collect the laboratory sample and place the sample in a separate container if further analysis is expected.

11. Calculate the percent of mass less than the 200 mesh screen (75-μm physical diameter). This is the silt content. See Figure 3-3.

3.2 SOURCE ACTIVITY MONITORING

Source extent and activity data were collected with a variety of tools. For example, in addition to visual observation and note taking, pneumatic traffic counters were used to determine source activity.

Pneumatic tube axle counters were used to record traffic volume data. Counters were placed across the site entrance, across lane A and across A and B south of the site, and across both southbound lanes north of the site entrance. This arrangement provided information on passes into and out of the test site as well as total traffic on Elmwood Avenue. Figure 3-4 shows an example pneumatic traffic log.

Because these counters record only the number of passing axles, it was necessary to obtain traffic mix information (e.g., number of axles per vehicle) to convert axle counts to the number of vehicle passes. Vehicle mixes were recorded on a form similar to Figure 3-5 during a 10- to 60-min visual observation period. Comparison of the observed vehicle mix to the pneumatic count totals recorded during the observation period also allowed the accuracy of the axle counter to be assessed.

MIDWEST RESEARCH INSTITUTE
Silt Analysis*

Date ______________ MRI Project # ______________ Recorded by ______________

Sample ID No.: ______________ Material: ______________

Total Sample Weight: ______________
Excl. Container)

Number of Splits: ______________

Sampling Dimensions: ______________

Split Sample Weight
Bag + Sample: ______________
Bag: ______________
Net Sample: ______________

Analytical Balance:
Make ______________
Capacity ______________
Smallest Division ______________
Date of Last Mfg. Calibration ______________
Calibration Logbook No. ______________

Non Recoverable Material
Empty bag weight: ______________
Bag tare weight: ______________
Nonrecoverable mass: ______________

Sieving

Time: Start:	Weight (Pan Only)
Initial (Tare):	
10 min:	
20 min:	
30 min:	
40 min:	

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh				
40 mesh				
100 mesh				
140 mesh				
200 mesh				
Pan				

$$\% \text{ Silt} = \frac{\text{Net Pan Weight}}{\text{Total Net Weight}} \times 100 = \_\_\_\_\_\_\_\_ \%$$

*All unit weights are in grams unless otherwise specified

94-18 SEV kin frm 040594

Figure 3-3. Example silt analysis form.

PNEUMATIC TRAFFIC COUNT LOG

Site: Elmwood Ave. Project #: 4601-04-03 Recorded by: ______

Counter ID No.	Site location	Start Count	Start Date	Start Time	Stop Count	Stop Date	Stop Time

Figure 3-4. Example pneumatic traffic count log.

VEHICLE LOG

Date ____________________ Project #: 4601-04-03 Recorded by ____________

Road Location: Elmwood Avenue between Blue Pkwy and Van Brunt Blvd

Road Type: Paved 4-lane street with no divided median

Sampling Start Time: ________________ Stop Time: ______________________

Traffic counter ID #: ________

Counter Start Count: ________________ Counter Stop Count: ______________

Vehicle Type	Axles/Wheels	1	2	3	4	5	6	7	8	9	10	Total
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											

Figure 3-5. Example manual traffic count log.

In order to determine the number of vehicle passes from axle count data a simple calculation was necessary. If A represents the total number of axle counts, and N_j the number of passes by vehicles with j axles, then:

$$A = \sum_j j N_j$$

If N is the total number of vehicle passes (regardless of the number of axles), then:

$$N = \frac{A}{\sum_j j f_j}$$

where: $f_j = \frac{N_j}{N}$ = fraction of vehicles with j axles

3.3 CALCULATION PROCEDURES

The silt loading (sL) on the road surface was calculated from the data obtained from the silt analysis of the sample collected according the relationship:

$$sL = \frac{s \times (M_T - M_N) + M_N}{a}$$

where:

- sL = silt loading (mass/area)
- s = silt content of the recovered sample, expressed as a fraction
- M_T = total mass of the sample (i.e., before any splits) in grams
- M_N = nonrecoverable mass which is assumed to be less than 200 mesh (see Figure 3-3) in grams
- a = total surface area sampled (length^2) = $l \times w$
- l = length of road surface sampled (length)
- w = width of travel lane (length)

To determine the effectiveness of the different control strategies, the silt loading data collected during each sampling event were plotted as shown in Figure 3-6. The "A" and "B" samples (Figure 2-4) were analyzed separately for each point along the "impacted" portion of the road, and those points along with the background data point were plotted against distance from the site access point. Next, the effect of carryout

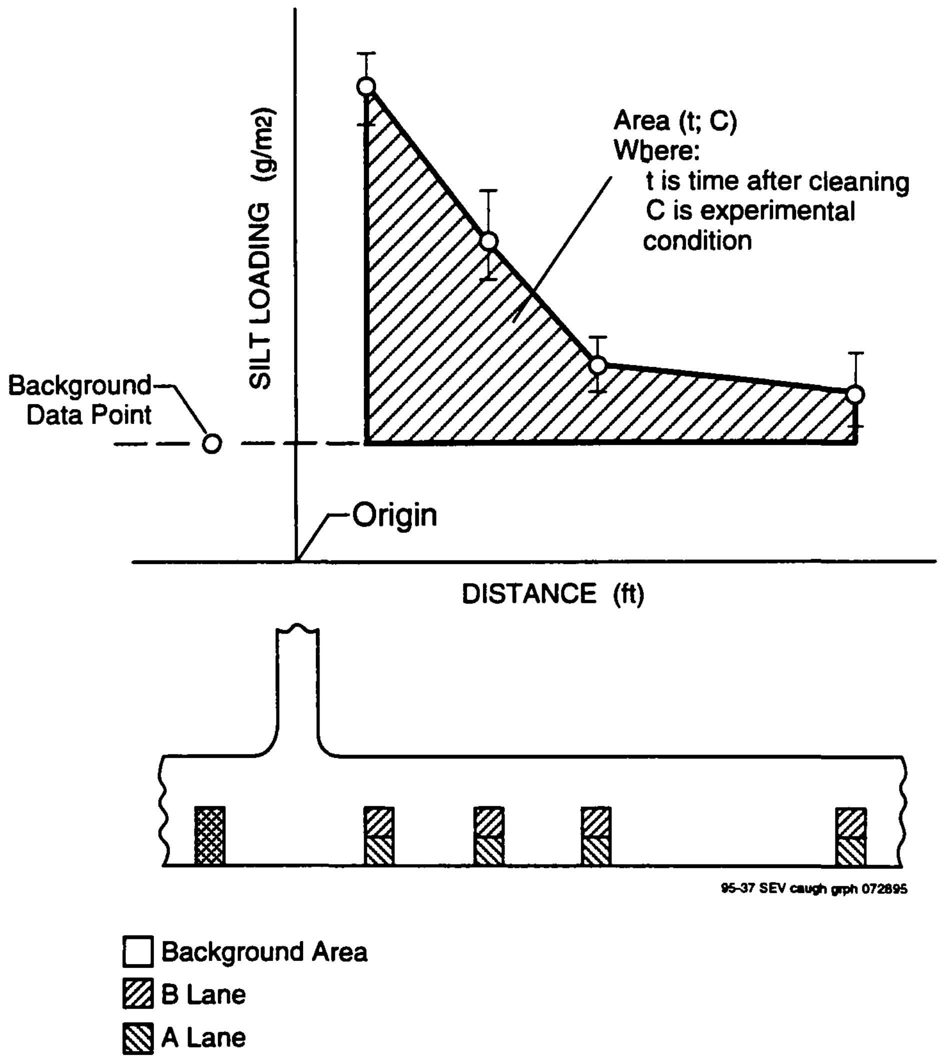

Figure 3-6. Data analysis scheme (hypothetical silt-loading distribution).

was evaluated by integrating the shaded area using the trapezoidal rule over the distance of 50 to 550 ft from the site entrance. Fifty feet was chosen as the starting point because all of the wheels on the trucks were usually onto the southbound lanes at this distance from the site entrance. The integrated area was then divided by the distance that was used for integration (500 ft) and viewed as representing an average silt loading ($\overline{sL}$) (above background) on the impacted portion of the road. In turn the average silt loading was expected to vary as a function of time after cleaning (t) and the experimental condition C (e.g., uncontrolled, woodchips/mulch).

Once all experimental conditions were evaluated, the $\overline{sL}$ values were used to determine overall mean control efficiency values by ratioing the geometric mean value of $\overline{sL}$ for each control technique to the geometric mean value of $\overline{sL}$ for the uncontrolled testing. This allowed for evaluation of a representative control efficiency value for each of the control technologies studied in this program.

SECTION 4

RESULTS

The results of the study are summarized in this section. After presenting a brief time history of the field study, the data are grouped into individual control technologies for comparison purposes, and then the quality assurance results are discussed.

4.1 TIME HISTORY OF THE PROJECT

Table 4-1 lists the milestones of the field sampling portion of the project. The field sampling portion of the program spanned from the end of May until mid-September 1994. The reason for the long time span was the numerous delays caused by the weather.

There were consecutive days when no sampling activity occurred. During those days, there was either no hauling activity at the site or it had rained the evening before. This prevented any trucks from entering the site and also prevented surface samples from being taken. These data are illustrated in Figures 4-1 and 4-2, which show the cumulative rainfall at the site and the amount of truck traffic entering and leaving the site, respectively. Figure 4-3 shows the cumulative amount of traffic on the southbound lanes of Elmwood Avenue during the field sampling.

The sampling program was also affected by the fact that the trucks originally left the site going south and later began exiting to the north. This change in direction caused problems in maintaining a constant flow of traffic from the test site over the southbound lanes of Elmwood. Also, because of interference from a power pole, trucks exiting north from the construction site were forced to swing into the southbound lane, thereby impacting the silt loading background area. These aberrations in the desired traffic pattern are documented in Appendix B.

As mentioned earlier, traffic in and out of the site slowed after the earthmoving activities were largely completed and concrete pouring for the dam had not yet begun.

TABLE 4-1. CHRONOLOGY OF EVENTS

Date	Julian date	Event
5/31/94	151	Baseline cleaning of Elmwood Avenue
6/14/94	165	1st uncontrolled sampling event
6/21/94	172	2nd uncontrolled sampling event
6/24/94	175	3rd uncontrolled sampling event
6/28/94	179	4th uncontrolled sampling event
6/30/94	181	5th uncontrolled sampling event
7/1/94	182	Baseline cleaning of Elmwood Avenue
7/6/94	187	1st street sweeper controlled sampling event
7/11/94	192	Sweeper Cleaning Test
7/12/94	193	2nd street sweeper controlled sampling event
7/13/94	194	Sweeper Cleaning Test
7/14/94	195	3rd street sweeper controlled sampling event
7/15/94	196	Department of Parks and Recreation puts down woodchip/mulch material as a control method
7/15/94	196	Baseline cleaning of Elmwood Avenue (Sweeper Cleaning Test)
7/27/94	208	1st woodchip/mulch controlled sampling event
7/29/94	210	2nd woodchip/mulch controlled sampling event
8/13/94	225	Removed woodchip/mulch material from entrance to site and did a baseline cleaning of Elmwood Avenue
8/15/94	227	Placed 3/4" gravel on access point to site
8/17/94	229	Hired Construction Materials Trucking to generate traffic at test site
8/18/94	230	1st gravel controlled sampling event
8/23/94	235	2nd gravel controlled sampling event
9/7/94	250	3rd gravel controlled sampling event
9/9/94	252	4th gravel controlled sampling event
9/9/94	252	Baseline cleaning of Elmwood Avenue (Sweeper Cleaning Test)

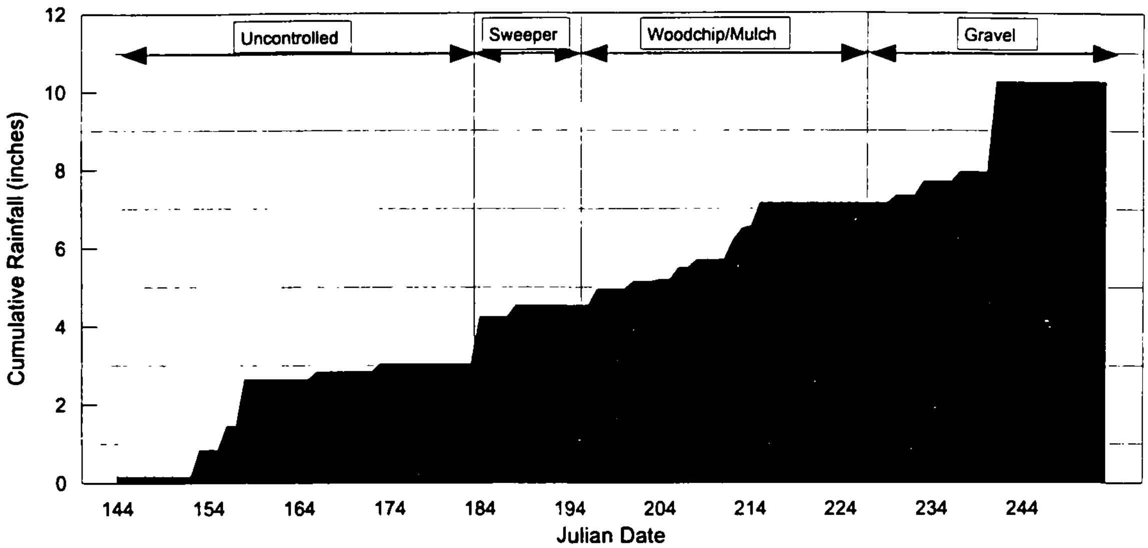

Figure 4-1. Cumulative rainfall at test site.

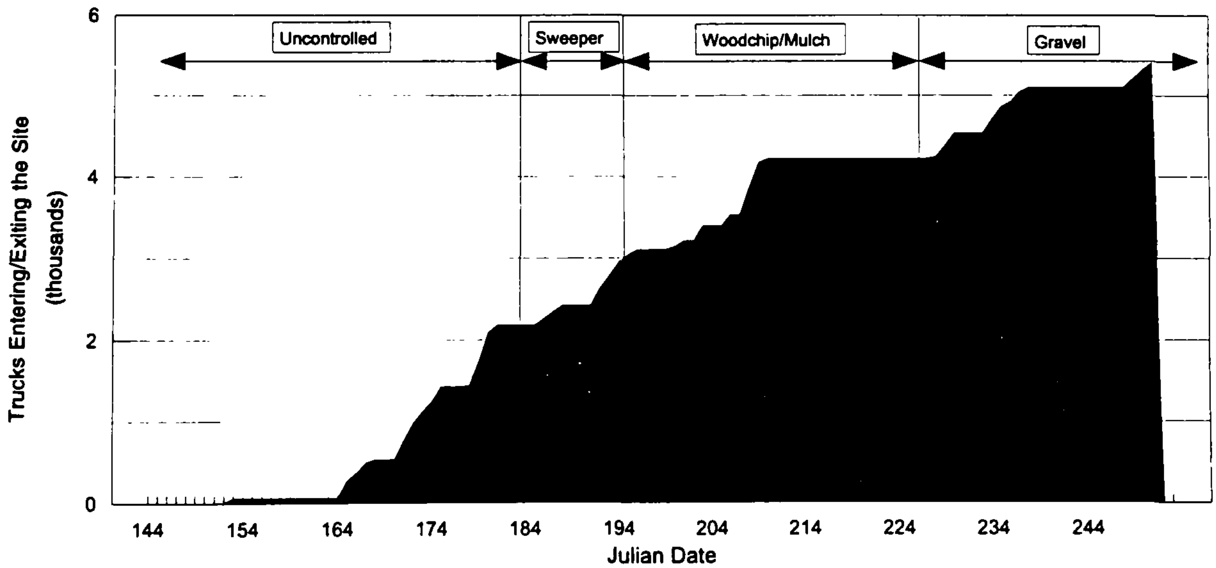

Figure 4-2. Cumulative truck traffic entering or exiting the construction site.

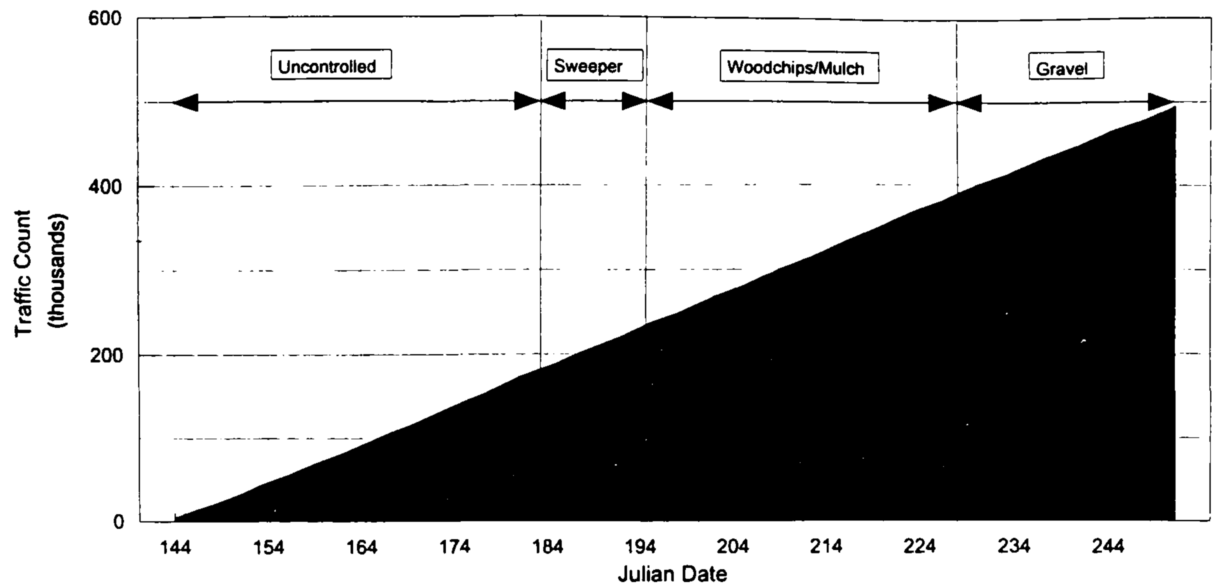

Figure 4-3. Cumulative traffic on the southbound lanes of Elmwood Avenue.

Therefore, supplemental "captive" traffic was generated by hiring a truck and driver to drive in and out of the test site for the remaining portion of the field sampling program, i.e., the evaluation of the gravel buffer.

Additional details on the sampling program are provided in Appendix A.

4.2 DATA ANALYSIS

Appendix C contains a printout of the spreadsheet used to calculate the silt loadings for all of the samples collected. The silt loading data were plotted as a function of distance from the site access point. Because earlier studies found a rapid decrease in silt loading with distance, the data were plotted on a semi-logarithmic graph. The data were grouped by control technology (i.e., uncontrolled, woodchip/ mulch, etc.) to construct a single plot for each control. The data were then regressed for each lane and for each control method.

The results are shown in Figures 4-4 through 4-11. Figures 4-4 and 4-5 graphically illustrate silt loading distributions based on the samples taken from

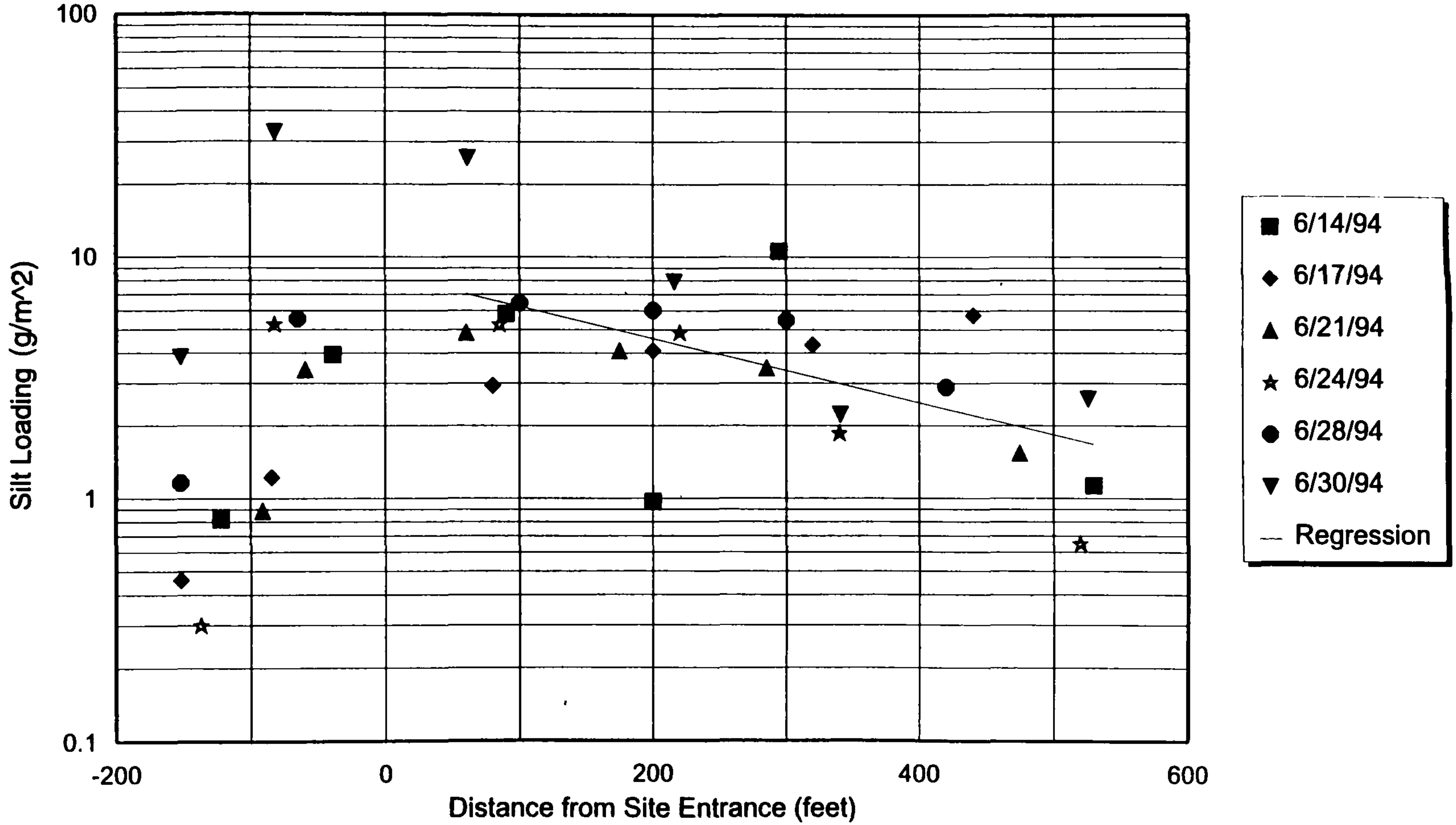

Figure 4-4. Uncontrolled samples taken from the "A" lane.

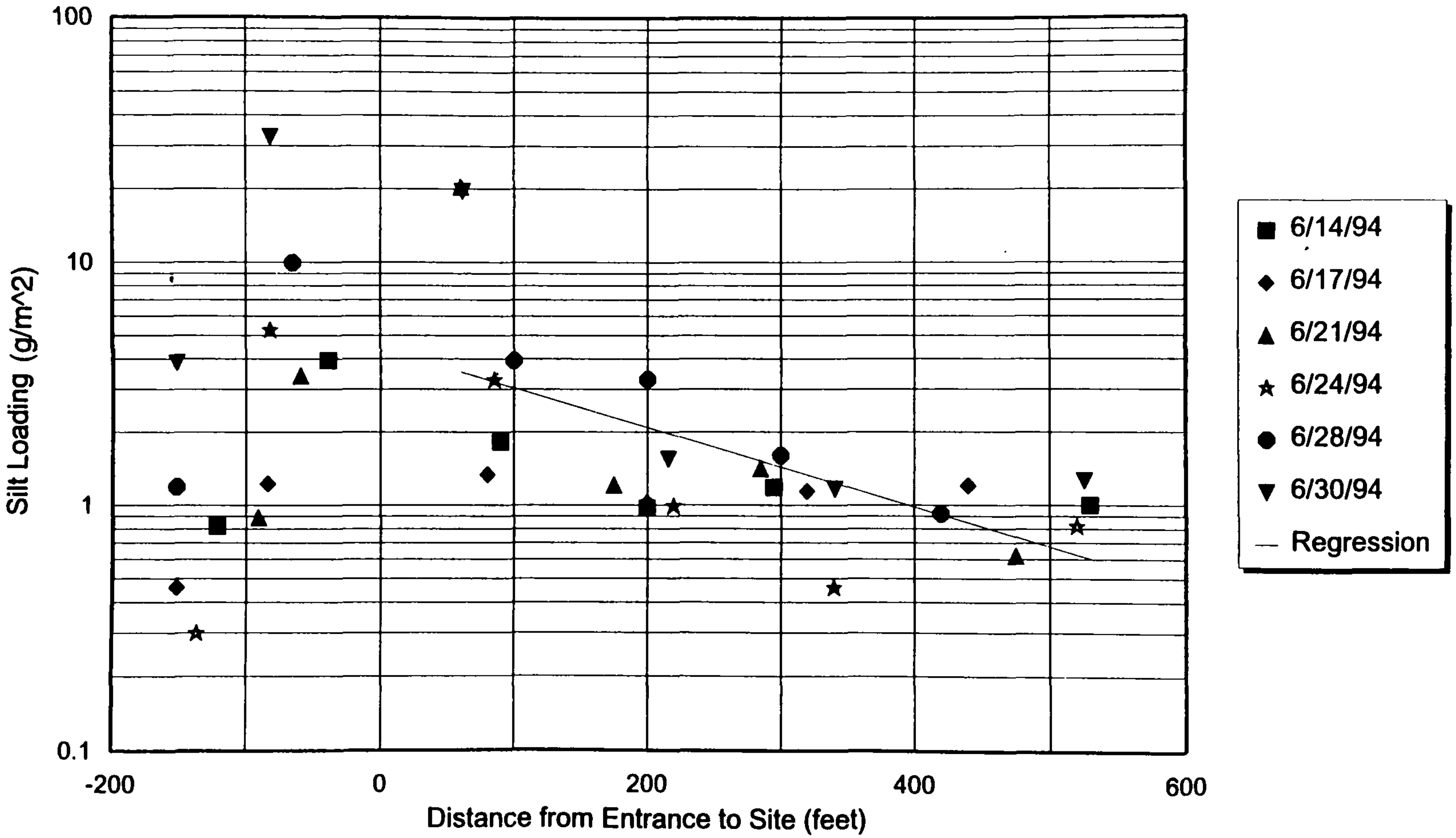

Figure 4-5. Uncontrolled samples taken from the "B" lane.

the uncontrolled "A" and "B" lanes, respectively, of southbound Elmwood Avenue. Figures 4-6 and 4-7 present the distributions from the samples taken from the sweeper controlled "A" and "B" lanes, respectively. Figures 4-8 and 4-9 show the distributions from the samples taken from the woodchip/mulch controlled "A" and "B" lanes, respectively. Figures 4-10 and 4-11 display the distributions from the samples taken from the gravel controlled "A" and "B" lanes, respectively.

On each plot, a log-linear line of best fit is also shown. The consistency of the slope indicates that the relative spatial distribution of silt loading is similar regardless of the absolute levels.

Note that the uncontrolled silt loadings did not exhibit any discernible trend to increase with time. This is probably due to the fact that, because of the steep slope of the access road, no truck haulage occurred for one or two days after rainfall. Thus, at the study site, precipitation did not enhance carryout onto Elmwood, but rather rainfall at least partially cleaned the road surface. The trucks were diverted to haul from other sites in the area during these periods.

The area under the silt loading distribution curve was determined using the trapezoidal rule (as discussed in Section 3.3) for each of the sampling events. When the resulting area was divided by 500 ft, the average silt loading ($\overline{sL}$) was found. These averages are presented in Table 4-2.

Several points should be noted about Table 4-2. First, the average silt loadings measured for the uncontrolled condition ranged from 2.6 to 8.9 g/m^2 for the "A" lane and from 1.0 to 5.8 g/m^2 for the "B" lane. These ranges correspond approximately to the upper 20th-percentile of the silt loading data base presented in AP-42. Thus, carryout clearly resulted in heavy silt loadings on Elmwood Avenue. In addition, the curb or "A" lane was roughly twice as heavily loaded as the other southbound lane ("B"). This was expected because the loaded trucks tended to travel almost exclusively in the "A" lane in preparing to turn west onto Blue Parkway.

Because of problems encountered in defining an appropriate "background value" of silt loading (as a result of the impacts of construction vehicles occasionally exiting to the north on Elmwood), the control efficiency of reduction in sL is presented in Table 4-2 in terms of a range between a lower bound and an upper bound. The lower bound was obtained by assuming a background value of zero for silt loading.

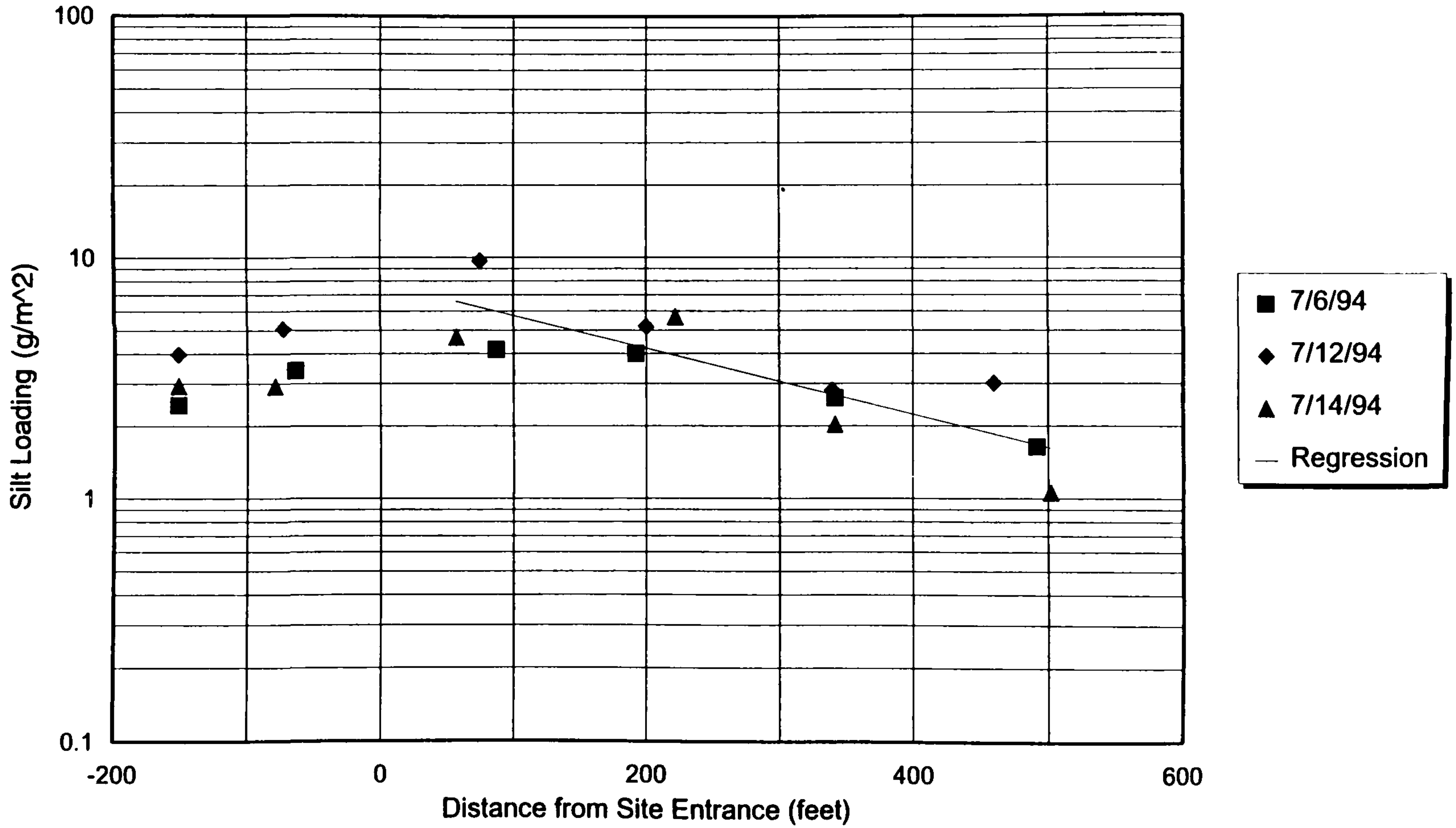

Figure 4-6. Street sweeper controlled samples taken from the "A" lane.

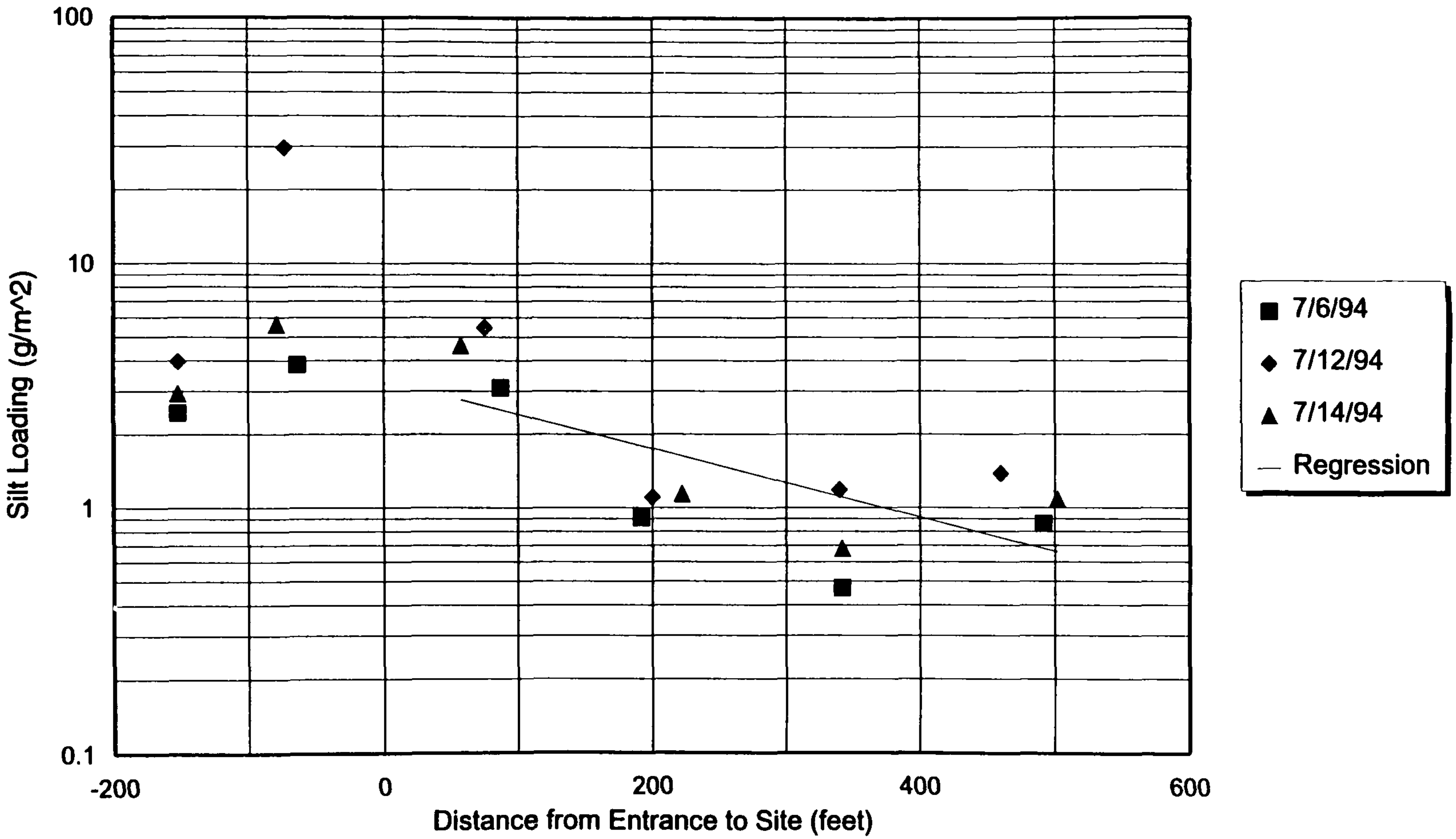

Figure 4-7. Street sweeper controlled samples taken from the "B" lane.

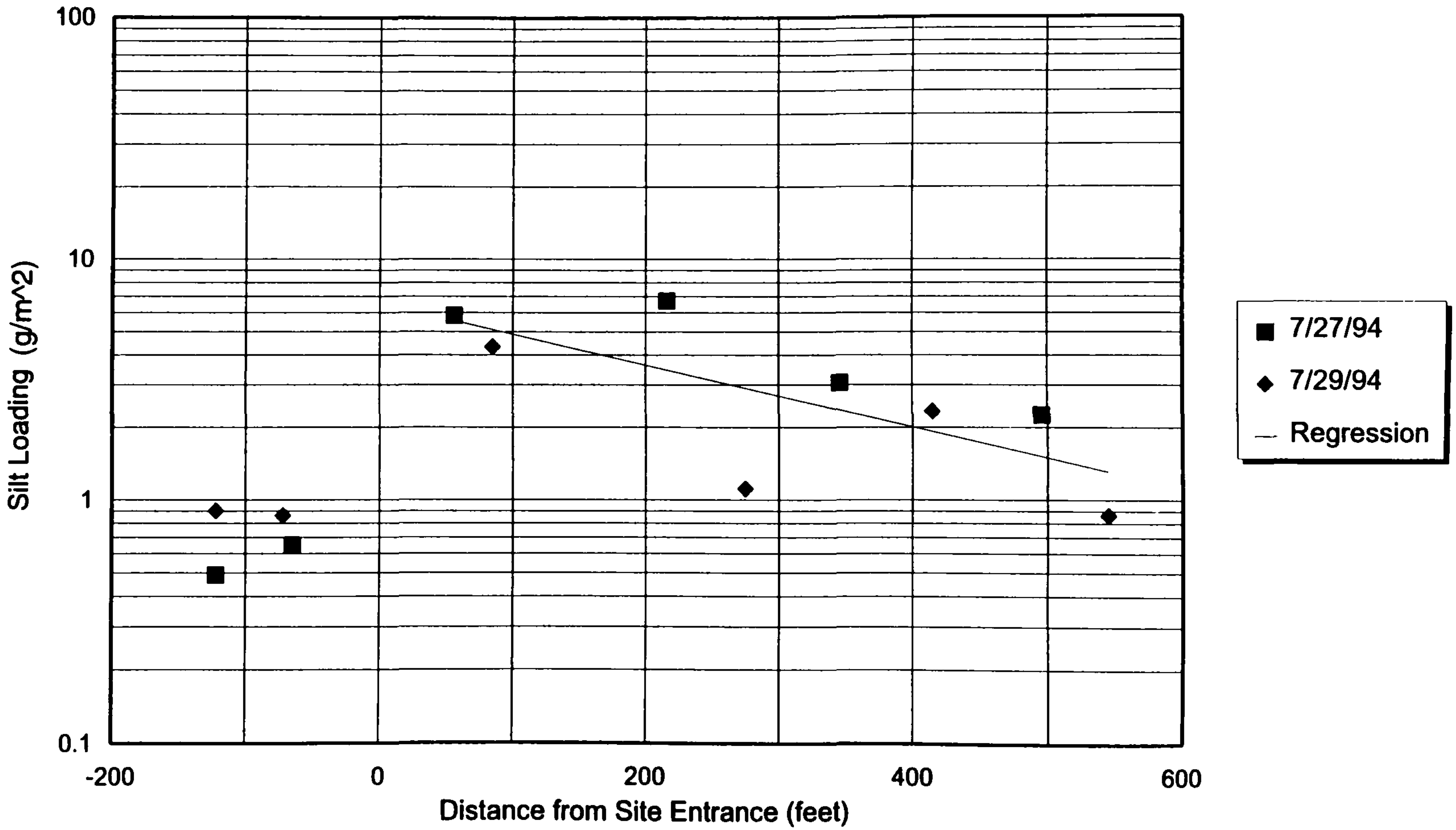

Figure 4-8. Woodchip/mulch controlled samples taken from the "A" lane.

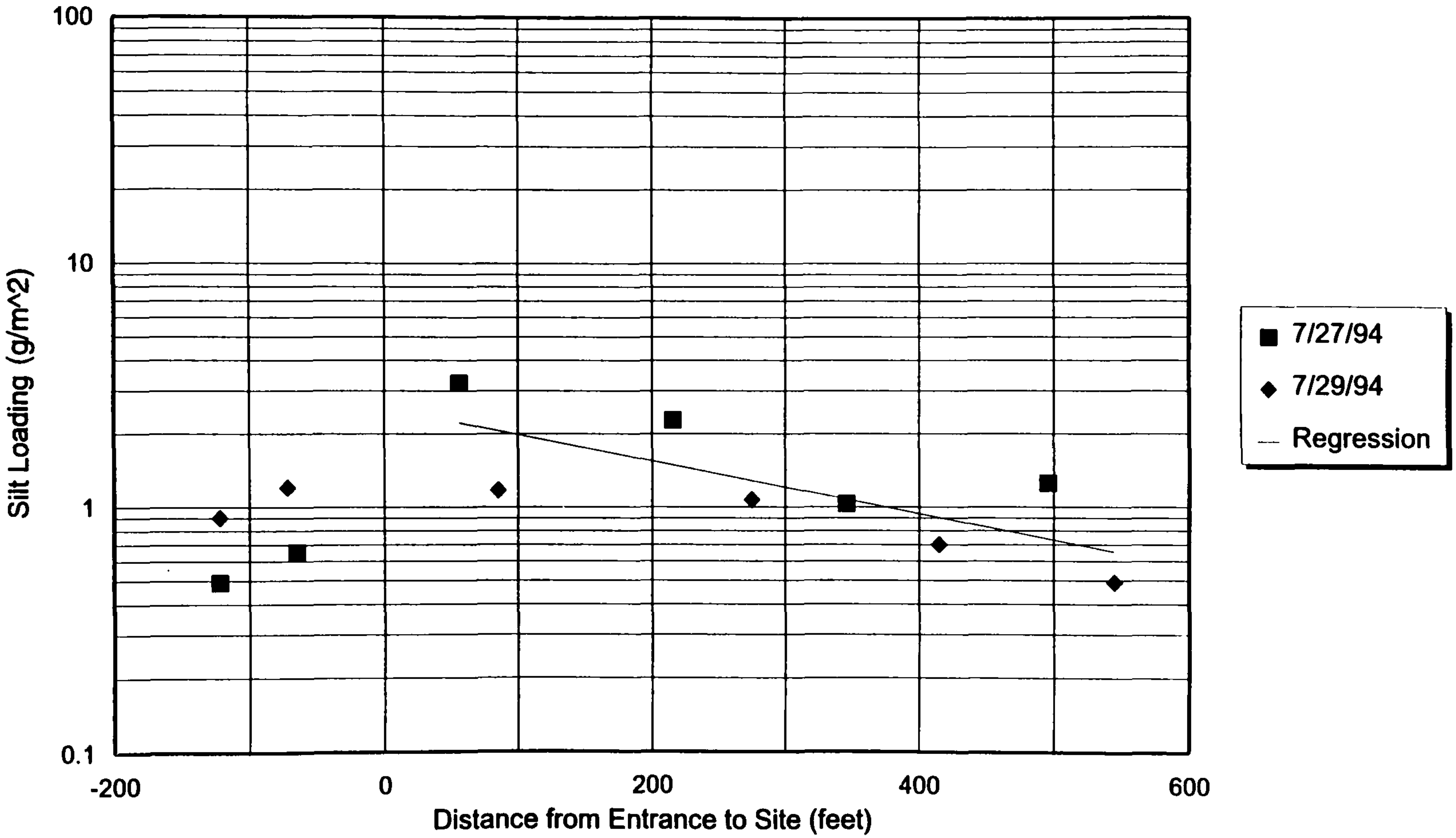

Figure 4-9. Woodchip/mulch controlled samples taken from the "B" lane.

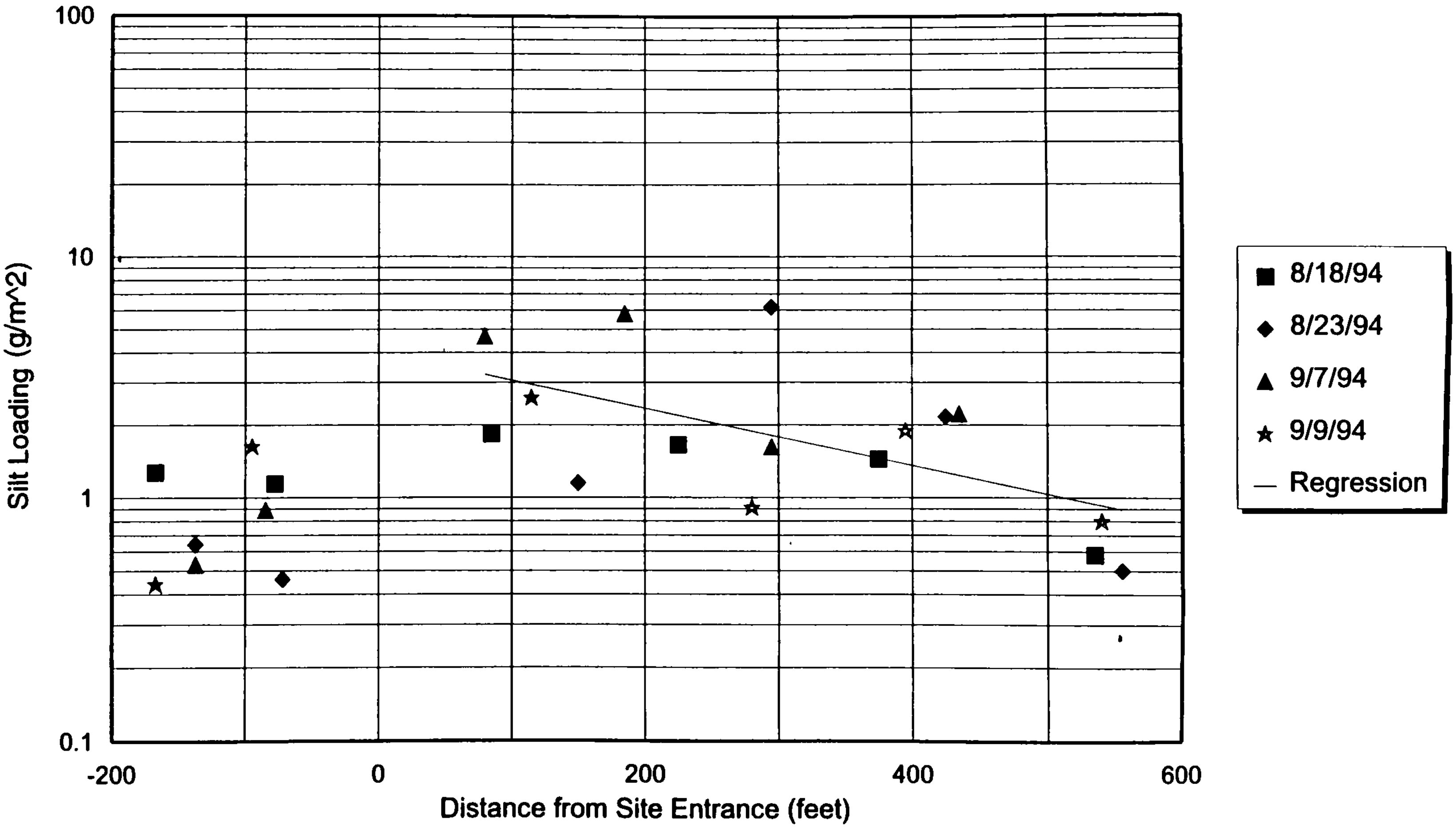

Figure 4-10. Gravel controlled samples taken from the "A" lane.

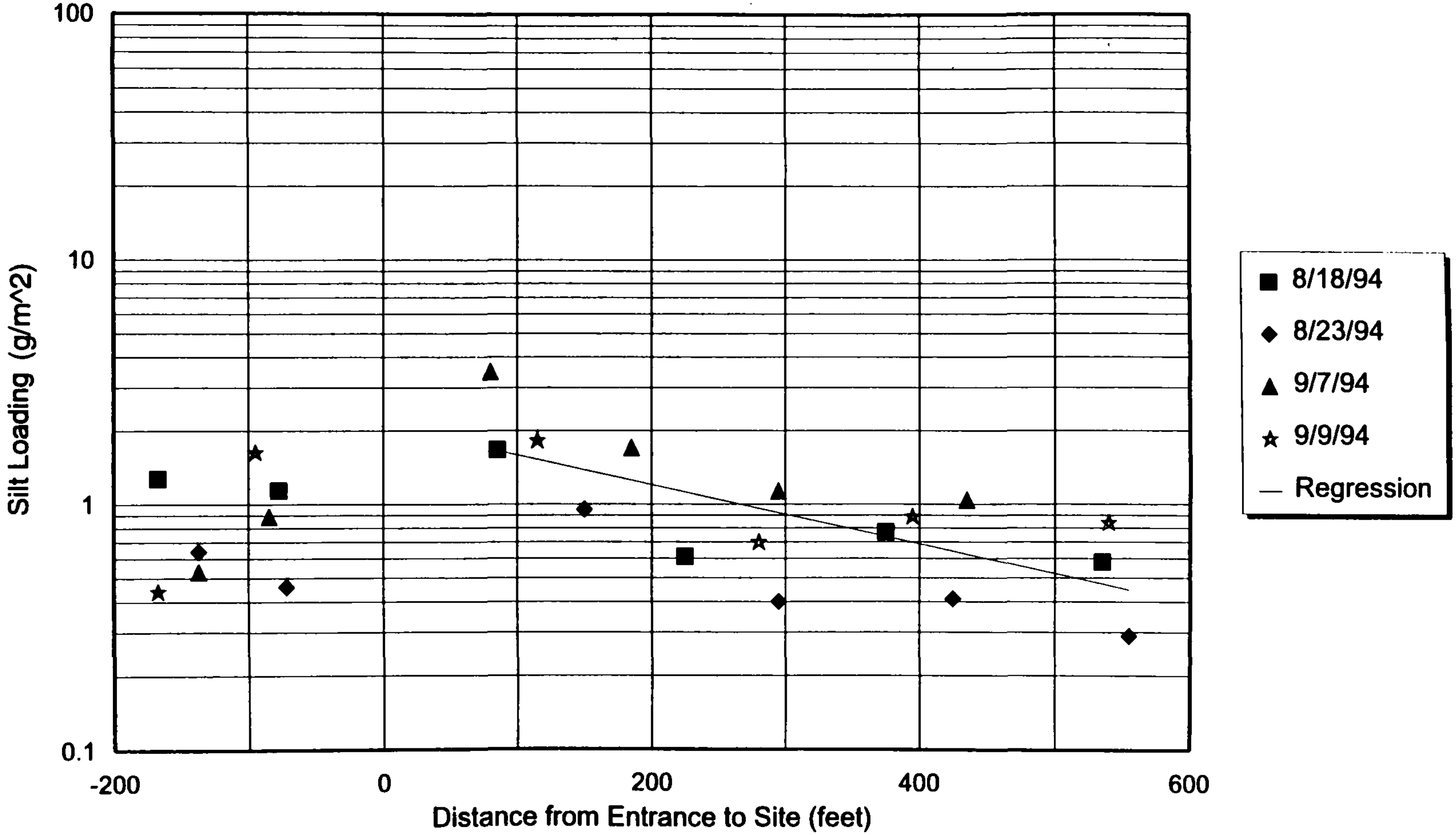

Figure 4-11. Gravel controlled samples taken from the "B" lane.

TABLE 4-2. AVERAGE VALUES FOR ALL THE SAMPLING EVENTS

		$\overline{sL}$ (g/m²)		
Control technology	Sampling date	"A" Lane	"B" Lane	Both lanes
Uncontrolled	6/14/94	3.74	1.09	
	6/17/94	3.65	1.00	
	6/21/94	2.80	5.80	
	6/24/94	2.59	1.32	
	6/28/94	4.03	1.99	
	6/30/94	8.86	5.76	
	Geometric Mean	3.90	2.14	
Sweeper Controlled	7/6/94	2.52	1.29	
	7/12/94	4.59	2.16	
	7/14/94	2.69	1.75	
	Geometric Mean	3.14	1.70	
Control Efficiency (lower limit/upper limit)		19%/22%	21%/27%	20%/24%
Woodchip/Mulch Controlled	7/27/94	3.62	1.68	
	7/29/94	1.91	0.71	
	Geometric Mean	2.63	1.09	
Control Efficiency (lower limit/upper limit)		33%/37%	49%/64%	38%/46%
Gravel Controlled	8/18/94	1.11	0.81	
	8/23/94	1.95	0.51	
	9/7/94	2.97	1.64	
	9/9/94	1.36	0.97	
	Geometric Mean	1.72	0.90	
Control Efficiency (lower limit/upper limit)		56%/64%	58%/76%	57%/68%

The upper bound was obtained by subtracting the relatively high background value of 0.5 g/m^2. This high background value was determined from an average daily traffic value of 10,000 using the relationship between silt loading and traffic volume as presented by Cowherd and Englehart (1984).

The overall control efficiency for street sweeping was found to be 19% and 27% for the "A" and "B" lanes, respectively, based on the reduction in $\overline{sL}$. As discussed in Section 4.3, street sweeping was found to be much more effective in reducing total surface loadings. Part of the poor performance for removal of silt loading can be attributed to the abrasion of coarse material left on the roadway after sweeping. That is to say, the sweeper generated additional material in the silt fraction by breaking large particles into smaller ones. In addition, the same sweeper already was being used to control carryout from construction sites in the immediate vicinity.

The woodchip/mulch buffer proved to be more effective than the street sweeper in reducing average silt loading. Over the two sampling events, an average control efficiency of 33% to 37% for the "A" lane and 49% to 64% for the "B" lane was found for the woodchip/mulch buffer. This control measure is of considerable interest because it represents a "real world" solution to the problems of carryout in that the contractor constructed a buffer from waste material collected on-site. This resulted in a far more cost-effective (i.e., reduction in silt loading per unit cost) control than the street sweeping.

An important potential drawback was observed during the use of woodchip/mulch. Because woodchip/mulch is a soft material that is easily compressed by vehicles, the weight of a passing vehicle will displace the air contained in the buffer. This effect was the cause of substantial fugitive dust clouds that could be seen when a vehicle traveled over the buffer. Although the buffer was effective in controlling the carryout of materials from the site, on-site reentrained fugitive dust vehicular emissions may have increased due to the woodchip/mulch buffer.

The gravel buffer was found to be the most effective control studied in this report, reducing average silt loadings by 56% to 64% in the "A" lane and 58% to 76% in the "B" lane. In addition, unlike the woodchip/mulch material, the gravel buffer probably reduced on-site reentrained fugitive dust vehicle emissions by covering the travel surfaces with a coarser material.

It is important to note that the range of silt loadings measured during each controlled phase overlapped part the range found in the uncontrolled phase.

4.3 STREET SWEEPER EVALUATION

Although several different sweepers were used, all were Wayne Model No. 945. This particular sweeper was manufactured in the early 1970s by FMC. It has a 32-in rotating curb brush on each side of the sweeper to remove heavy loading from the curb. Under normal operation the brushes rotate at approximately 450 rpm. It also has a 57-in rotating brush in the rear of the sweeper that rotates in the opposite direction of travel of the sweeper at approximately 150 to 175 rpm. This rear brush removes the debris from the road. It sweeps the material onto a 58-in conveyor belt that carries debris into a hopper for storage. This sweeper was being used on streets in the area as a control measure by the earthmoving contractor.

An "embedded" collocated sampling approach, as shown in Appendix D, was used to measure the effectiveness of the street sweeper. The road was marked in 2-ft increments for approximately 50 to 60 ft. Before the sweeper passed over the street, surface samples from every other sample area were collected using a portable vacuum cleaner with an unused, preweighed vacuum bag. As soon as the street sweeper had swept the road, the samples were collected from the remaining (alternate) sample sections using the same vacuum cleaner with another unused, preweighed vacuum bag.

The effectiveness was based on the "before" and "after" samples collected. Figures 4-12 and 4-13 show the total loading and the silt loading before and after the street sweeper had cleaned the road. In three out of the four sweeper tests the total loading was reduced by at least 30% and as much as 50%. The silt loading on the other hand usually increased after sweeping.

Two reasons are believed to have caused the silt loading to be elevated. First, the brushing of the material from the road caused a significant amount of abrasion of the coarse surface material, and the rear brush was unable to remove the finer particles from the road. The second reason related to the curb loadings. In all of the sweeper tests, a significant amount of curb loading was present. The actual "before" sweeping sample did not include any material from the curb (samples were taken only from "white line to white line" avoiding any centerline mounds). Once the street

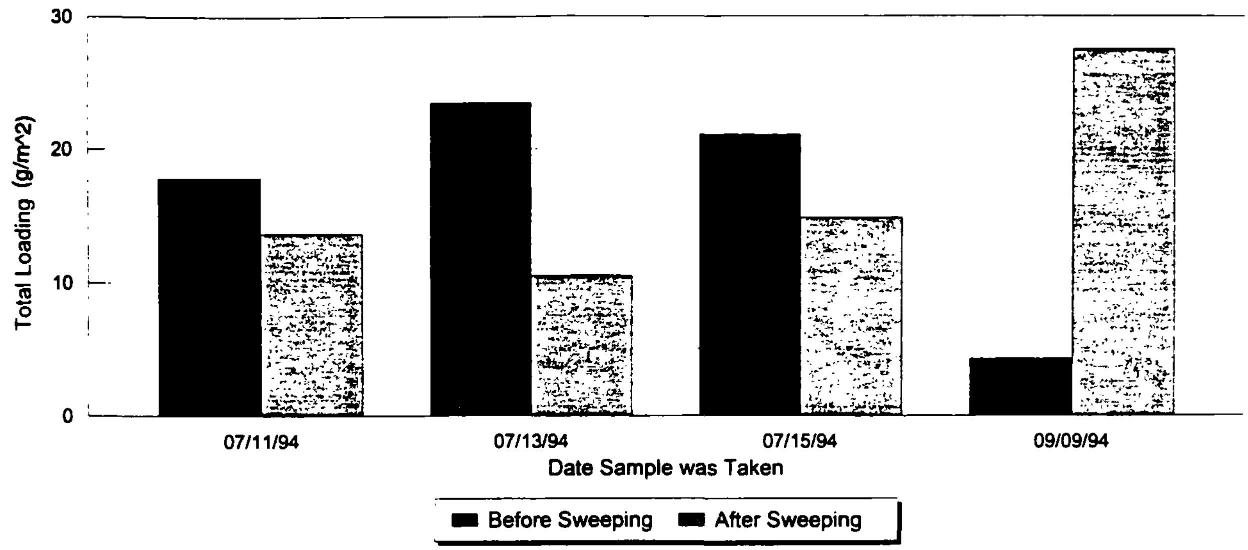

Figure 4-12. Total loadings before and after street sweeping.

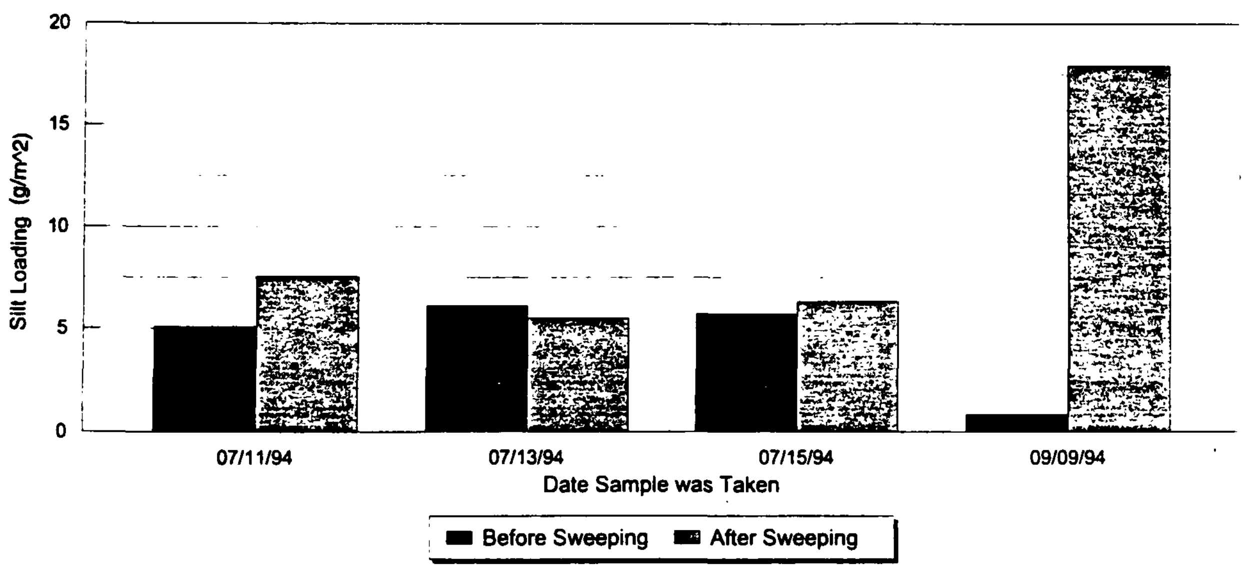

Figure 4-13. Silt loadings before and after street sweeping.

sweeper began cleaning the road, its first pass removed all of the curb loading by using the curb brush to force the material into the roadway so that the rear brush could then pick it up. The "after" sample thus contained material that had been in the curb area. The brushing action used to remove the debris left behind a very silty material. The laboratory analysis showed that the "before" samples ranged from 17% to 26% silt by weight. The "after" sweeping samples ranged from 41% to 65% silt by weight.

A final point to be made involves the last sweeper test. In Figures 4-12 and 4-13, it can be seen that the data from the sweeper test on September 9, 1994, are not consistent with the three other tests. However, during the first three tests, the operator spent between 60 and 75 min cleaning the roadway. This consisted of repetitive passes over the sections to be sampled. During the last test, the operator spent approximately 25 min cleaning the roadway. The operator was rushed and only had time to make a single pass on the roadway.

4.4 QUALITY ASSURANCE RESULTS

As described in Appendix D, the field sampling and laboratory analysis were subject to certain quality assurance (QA) procedures. A total of 8 sets of co-located surface samples were collected (using the "embedded" sampling approach described in Appendix D) and analyzed. Table 4-3 presents the results from the paired samples. The regular and the QA sample yielded comparable results for total loading, silt loading, and overall silt content (as determined by dividing the total loading by the silt loading.) The silt loading range percent values fell well within the ±50% guideline set forth in the test plan, with a overall mean of 17% in absolute value of range percent.

In order to evaluate laboratory analysis procedures, a total of 24 QA samples were obtained by riffle splitting of field samples of road surface loading. Each subsample was taken through sieve analysis. Table 4-4 shows the results from these QA subsamples. The QA statistic (relative value, RV) for 17 of the 24 pairs (71%) fell within the ±0.05 guideline established in the test plan, with an absolute maximum of 0.154 for Sample 2-B-R-593 (i.e., having a "regular" silt content of 10.5% contrasted with a QA value of 9.3%). In general, larger absolute values of the QA statistic are associated with lower silt fractions (Figure 4-14).

TABLE 4-3. CO-LOCATED SAMPLE RESULTS

Date	Lane	Distance (ft) from site	Total loading (g/m^2) Regular sample	Total loading (g/m^2) QA sample	Silt loading (g/m^2) Regular sample	Silt loading (g/m^2) QA sample
6/14/94	A	90	24.6	21.5	5.81	5.53
6/17/94	A	200	33.1	43.9	4.08	5.34
6/24/94	A	220	21.9	27.3	4.87	4.92
6/30/94	A	61	122	132	25.7	27.8
7/14/94	A	57	20.9	36.4	4.66	7.50
7/27/94	A	56	48.0	53.9	5.81	6.27
8/23/94	A	150	4.96	8.69	1.14	1.61
9/07/94	A	80	49.9	44.1	4.66	4.45

TABLE 4-4. QA CHECK OF LABORATORY SPLITS

Date sample was collected	Sample ID No.	Fractional amount of silt in split #1	Fractional amount of silt in split #2	RV $1-(Silt_{\#1}/Silt_{\#2})$
06/14/94	4-A-R-121	0.259	0.266	0.026
06/17/94	4-A-R-132	0.119	0.138	0.138
06/21/94	2-A-R-507	0.223	0.22	-0.014
06/21/94	2-B-R-508	0.18	0.186	0.032
06/24/94	7-A-R-527	0.199	0.202	0.015
06/28/94	6-A-R-537	0.239	0.234	-0.021
06/28/94	6-B-R-538	0.116	0.133	0.128
06/30/94	1-A/B-R-539	0.298	0.304	0.02
06/30/94	2-A-R-540	0.191	0.209	0.086
06/30/94	2-A-QA-541	0.205	0.197	-0.041
06/30/94	2-B-R-542	0.273	0.27	-0.011
07/06/94	5-B-R-558	0.102	0.102	0
07/12/94	1-A/B-R-562	0.297	0.282	-0.053
07/12/94	5-A-R-567	0.257	0.261	0.015
07/12/94	5-B-R-568	0.153	0.173	0.116
07/12/94	6-B-R-569	0.242	0.236	-0.025
07/13/94	2-A-R-572	0.251	0.232	-0.082
07/14/94	5-B-R-585	0.142	0.149	0.047
07/15/94	2-A-R-588	0.243	0.251	0.032
07/27/94	2-A-QA-592	0.096	0.093	-0.032
07/27/94	2-B-R-593	0.105	0.091	-0.154
07/27/94	3-A-R-594	0.074	0.072	-0.028
08/23/94	4-A-R-630	0.178	0.182	0.022
09/09/94	2-A-S-664	0.652	0.644	-0.012

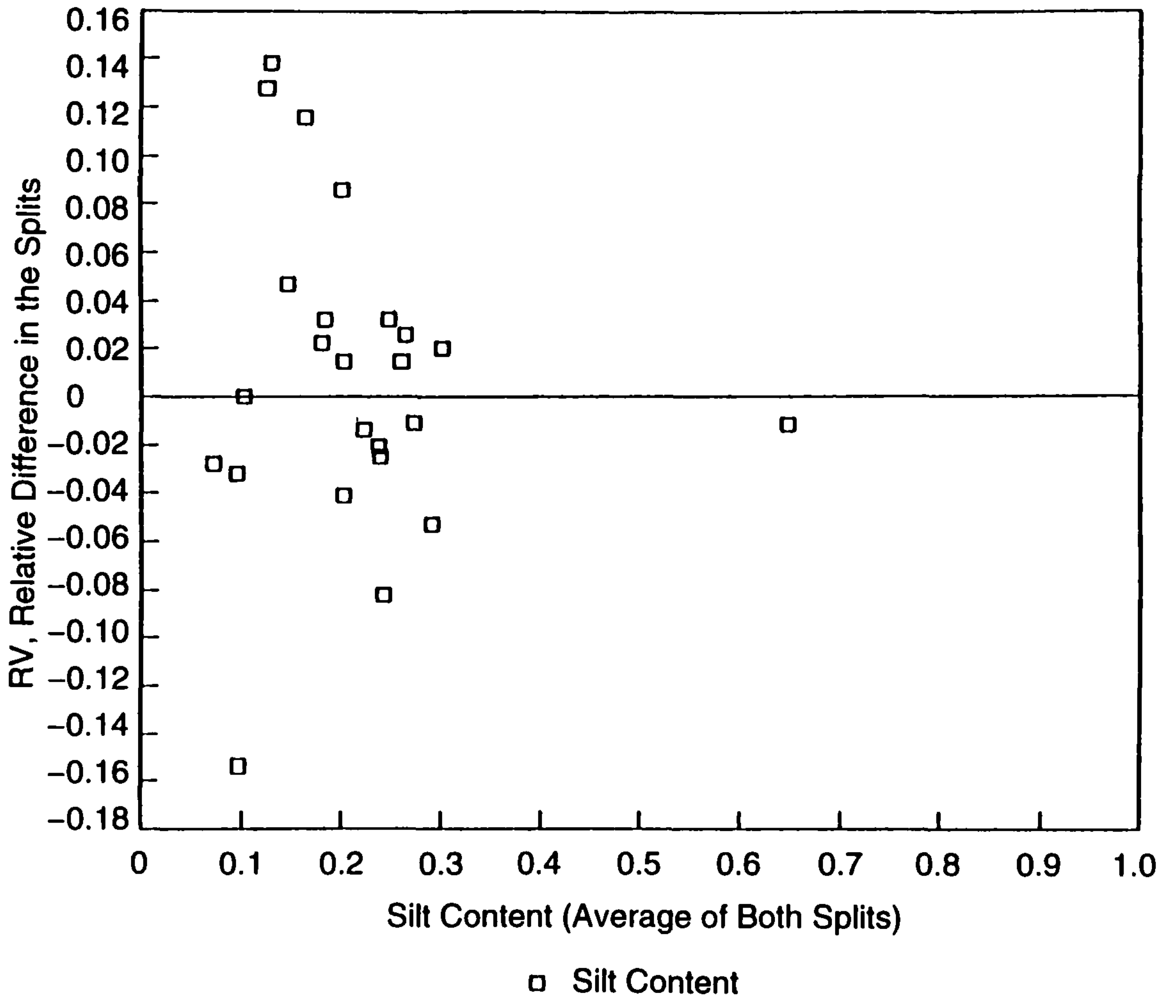

Figure 4-14. Relative value (RV) in relation to silt content.

As required by the Quality Assurance Plan, the QA coordinator reviewed the sample collection and analysis data sheets and data reduction procedures in comparison to the procedures described in the test and quality assurance plans. The coordinator checked the spreadsheet program against a set of hand calculations "from start to finish" and found no discrepancies. The coordinator also oversaw the reporting of the specific QA samples—the so-called "embedded collocates" and the laboratory splits—described above. Finally, the coordinator provided a summary of the review to the MRI QA manager for approval.

The QA review noted only one deviation from the test and quality assurance plan. The "A" and "B" loadings were considered individually in the integrations rather than averaged as described in the plan. Because this represents additional information and the average can be readily obtained from the two different integrations, this deviation is considered inconsequential.

SECTION 5

CONCLUSIONS

From the testing and evaluation program that was conducted, the following conclusions have been drawn.

- There was a broad range of paved road silt loadings measured near the construction site access point under the uncontrolled condition and each controlled condition, but no condition exhibited clearly discernible time trends. In other words, silt loadings did not tend to increase with time. This may be the result of rainfall partially cleaning the surface between different sampling events and largely reducing access road traffic until the steep slope had dried. Once access point traffic was restored to its normal level, reentrainment and displacement to nontraveled parts of the road, i.e., curb, offset the additional loading from carryout so that a new "equilibrium" was established.

- Street sweeping was found to be only marginally effective (approximately 20%) in lowering average paved road silt loading values in carryout areas. In general, total loadings were reduced far more effectively, but the street sweeper appears to have abraded the remaining material, thus "creating" additional material in the silt fraction.

- The 6- to 12-in layer of woodchip/mulch was moderately effective in controlling carryout, with average paved road silt loadings being reduced 38% to 46%. This control measure was implemented by the construction contractor at the request of Kansas City officials. Furthermore, the control made use of material that was available on-site at no cost. Although the woodchip/mulch buffer was moderately effective in controlling off-site emissions, it was noted that this buffer may have increased on-site PM-10 emissions. The buffer was fairly "soft" and was readily compressed by vehicles traveling over it. This compression displaced the trapped air, and puffs of fugitive dust were observed.

- The 6-in layer of gravel was found to reduce average paved road silt loadings by 57% to 68%. This was the highest efficiency found in the present study. Unlike the other buffer material, gravel formed a far stronger surface that did not yield under vehicular traffic, and no on-site increase in fugitive dust emissions was noted.

- Based on these measured reductions in silt loading, and using the PM-10 emission factor equation on page 1-1, the following calculated PM-10 emission reductions would result. Street sweeping would reduce PM-10 by only approximately 14%. Treatment of the access area with woodchips/mulch would reduce PM-10 by a moderate amount between 27 and 33%. The gravel buffer would result in the largest reduction of PM-10 by 42 to 52%. The PM-10 control efficiencies are somewhat lower than the silt loading reductions, because of the 0.65 power on silt loading in the PM-10 emission factor equation.

SECTION 6

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APPENDIX A

Project No. 4601-04
Daily Activity Log

10/26/93	Did site surveys with John Kinsey during A.M. Found a good location out on Old Highway 9 near Parkville (near Red-X). Phone number for contact is 741-2646
10/27/93	Did site surveys with John Kinsey during P.M. Found another possible location on Manchester Trafficway just south of ARMCO. Vacant lot with entrance and exit gates coming onto Manchester. Phone number for contact is 921-7303. (998 Manchester)
10/28/93	Contacted person at Seal-O-Matic about test site at Red-X. Spoke with Mike Jayler and he said that Gary Walz was person in charge of site. Gary would be in the office on 11/1/93. Also tried to reach person about the site on Manchester; phone number was disconnected. If site falls through, Mike Jayler said we should contact Winston Peeler with Peeler Oil Company to locate another site.
11/1/93	Tried finding out owner of Manchester site; no luck.
11/2/93	Spoke with Gary Walz about Seal-O-Matic. He said that the truck traffic to and from the site would remain constant for the next year. He felt that there would be no problem with us using this location as a test site but he wanted to okay it with the owner of the land. He will return a call as soon as he finds out something. If site falls through, need to go to Tax Records Office at City Hall to find out who owns property on Manchester.
11/3/93	Spoke to Gary Walz about Seal-O-Matic. He was unable to contact the property owner; he said he would try again today and get back in touch with me as soon as possible. Also went to Field Station to get equipment and supplies.
11/4/93	Set up traffic counters at site. Did not have enough hose for 4th counter so we put down counters across the highway and across the east entrance.

Daily Activity Log (Continued)

11/5/93	Strung 4th counter across west entrance and then tried to calibrate all the counters. Found many problems with counters; ended up going back to MRI to fix 3 counters. After lunch successfully installed all counters and did ~ 1-hour traffic counts at the site for all 4 counters.
11/6/93	Checked counters at site. Counter on eastbound traffic side of highway had hose pulled up. Put hose back down and checked it.
11/7/93	Checked counters and took readings around 1400 hours. Everything seemed okay.
11/8/93	Checked traffic counters at about 0745 hours and everything was working correctly. Tried to contact Gary Walz at Seal-O-Matic and he was out. He will return call. Checked traffic counters at about 1840 and the westbound traffic on the highway was pulled up. I put the hose back down and took readings on all counters.
11/9/93	Checked counters at 0734 hours and took readings. All counter hoses were okay. Also checked traffic counters and hoses at about 1840 hours and took readings.
11/10/93	Checked counters at about 0730 hours and took readings. All hoses were still in place and okay. Took manual traffic counts in the A.M. to verify counter readings. In the P.M. went out and got dimensions on site and described a sampling strategy.
11/11/93	Checked counters at about 0740 hours and took readings. All hoses were still in place.
11/12/93	Checked counters at about 0730 hours and took readings. All hoses were still in place.

Daily Activity Log (Continued)

11/16/93 Called around for price quotes on sweeping services.

Delta Sweep (221-8851) $80/hr w/2 hr minimum or rental @ $195/day w/$75 pickup and delivery charge

Clean Sweep (478-4477) $65/hr (Chris Peters) (no rentals)

Benwell Company (822-1000) (David Carver) $55-$75/hr; no brush (vacuum)

American Sweeping (966-1161) (Steve) $65/hr, 2 days notice

Rentals:

Delta Sweeping; $195/day w/$75 delivery charge (riding)

Glad Rents (436-0900) $288/day; skid loader type $50 delivery charge

Glen Rental (436-6193) $200/day; $800/wk; $50-$75 delivery charge (riding)

11/17/93 Checked hoses and took readings on all counters. Counter at west entrance of landfill was full of water and not working. All others were okay during A.M. After lunch returned to site and moved west entrance counter back approximately 50 feet. Also installed another counter: hose for the eastbound traffic on highway was torn up, so we reinstalled it and took a reading. Everything else was muddy but all seemed to be working.

11/18/93 Returned to site in A.M. and took manual traffic counts to calibrate all counters, including the one that was installed on 11/17/93. Upon return to MRI were told to halt all activities until the meeting on 11/24/93 to determine the implementation schedule that the City of Riverside is going to enforce on Seal-O-Matic at the site. Plan to attend meeting at Riverside Courthouse at 10:00 A.M. on 11/24/93.

11/19/93 Checked traffic counters; everything was okay.

11/22/93 Checked traffic counters; everything was okay.

11/23/93 Checked traffic counters; all hoses were still in place. Everything was okay.

Daily Activity Log (Continued)

11/24/93	Had meeting with Highway Department, Mayor, and various other people dealing with our Riverside project. Basically we were told the site could not be used for the project. Larry Reese with the City of Riverside; E.H. Young, owner of Red-X, Vernon Koch, Highway Department. Also went and looked at track-out from Peeler Oil Company and a site on Blue Parkway at Cleveland.
11/29/93	Picked up counters and hoses at Red-X site.
5/1/94	Met with Parks and Recreation people (Jud Huff). They said they will haul on Cleveland for another month, then they would switch over to the site on Elmwood. Elmwood is a suitable location and they will have to remove dirt for the dam and then backfill it back in again. We will need a lane closure permit from Street and Traffic for sampling.
5/14/94	Brian Rosson and I went to Elmwood site and took dimensions on the site and roadway.
5/17/94	Talked with Mike Members (Street and Traffic) about lane closure permit. I sent him a fax of the work plan and said I would be in touch with him this afternoon.
5/18/94	Brian Rosson and I went to site, took traffic counts and made sure that the counters were still in place and everything was working properly.
5/19/94	Brian Rosson and I went to site, took traffic counts and made sure that everything was okay. Talked with Mike at Street and Traffic and he said that he would issue a temporary 30-day lane closure for preliminary purposes, then he would issue a 60-day if we were doing everything accordingly.
5/20/94	Brian Rosson and I went out and did traffic counts, and made sure that the hoses were still down and that the counters were working okay. Revised new data forms and waiting to start sampling.

Daily Activity Log (Continued)

5/23/94	Brian Rosson and I took counts during A.M. Hoses and counters are still in place and working properly. Went to get lane closure permit and found out it would cost $25.00. So returned to MRI. Went to Field Station to get safety equipment.
5/24/94	Took traffic counts, got permit from Public Works and entered data into spreadsheet for traffic counts and calibrations.
5/25/94	Took counter readings and entered data into spreadsheet. Talked to City people and tried to contact Judd and left him messages.
5/26/94	Talked with Judd. He said that hauling could start 5/31/94 at the earliest. Went out to check counters and southbound traffic hose had a hole in it. Talked to a foreman and he said that Bill Schneider was in charge (861-0149) and he could tell me when things would be happening.
5/27/94	Reinstalled traffic counter and hose on southbound traffic lanes. Contacted Judd Huff at Parks and Recreation. He said that hauling out of site would begin 5/31/94 and go for at least 4 weeks. I then arranged for equipment rental and planned to sweep street on 5/31/94.
5/31/94	Picked up sweeper and skid loader at 8:00 A.M. Tried sweeping the street at 12:00 when truck traffic had stopped. Very successful until we washed the road down and the trucks started leaving the site. The mud started caking to the road surface. Have excellent cleaning if conducted on a weekend when there was no truck traffic and low volume of traffic.
6/1/94	Read counters and made sure they were operating correctly. Installed 2 counters on haul site to get volume of traffic in and out of site. Tried contacting Bill Schneider to find out how long they would be hauling for the west side, but I was not able to get in touch with him. Need to install one more counter further south on the southbound traffic lanes to characterize traffic out of west side of Elmwood.

Daily Activity Log (Continued)

6/2/94	Gary and I put down 1 more traffic counter on the southbound lanes to get a count including the trucks leaving the site. We also did counts for the east and west haul site and the southbound traffic lanes. A water truck went into the Parks and Recreation site and began to spray to control the dust.
6/3/94	Rained approximately 0.75 in. of H_2O last night. Sampling has been delayed until road dries out and trucks begin to haul out of site again. All sampling equipment is ready to go and we will just wait.
6/6/94	Rained approximately 0.60 in. over the weekend. Site was very muddy and there was no activity once again. We will wait for it to dry out and they start hauling again.
6/7/94	Hauling on west side of road started in A.M. Road was very muddy but eventually it looked as though it would dry out. Brian and I took traffic counts on counters for southbound traffic. Chance of rain today, so I will go back out and check to see if road is dry by Noon. If not we may have to wait another day. After lunch road was dry, but mud carryout was very wet still. Also rain started to fall again around 2:00 P.M. Sampling will be delayed again.
6/8/94	Rain started around 11:00 last night and rained off and on all through the night and into the morning. Hoses were still in place and site was extremely muddy. No activity was present. Rain continued throughout the day.
6/9/94	Rained last night and a slight chance today. Hoses were still in place but both sites were extremely muddy. No sign of any activity today.
6/10/94	No precipitation in last 24 hours. Both sites were still very muddy and no activity was present. No activity after lunch either.
6/13/94	Light rain throughout the weekend. Sites were a little muddy but not very bad. No activity on either side of the street. Chance of rain today again. Hole in counter hose on southbound traffic counter. Replaced hose and counter and replaced the west side counter to get a better reading of traffic coming out of the site.

Daily Activity Log (Continued)

6/14/94 Dry and hot today. Griffin, Rosson, Raile and Kinsey were the sampling team. Spent most of day collecting samples. Traffic from both the east and west sites were present. Bridge had small grooves in it, so I expect larger loadings to be present in those sampling areas.

6/15/94 Counter to south road, east site was not working properly. Replaced it and still having problems. No activity on the west site. Seems as though Parks and Recreation trucks quit hauling around 1430 every day. The reason for this is unknown. Flat tire on truck, probably from bottle. Plan to sweep tomorrow provided we don't get any rain.

6/16/94 Rained approximately 0.20 in. this morning at site. Both sites were very muddy. No activity on west site but the Parks and Recreation people were hauling on the east site. Carryout was very heavy and sampling should take place tomorrow. Replaced counter on east site, south road again. Hopefully that problem will be solved.

6/17/94 Sampled today. There was no hauling operations taking place on the west side of the road. Everything went extremely well. Team consisted of Raile, Rosson and Griffin.

6/20/94 Hauling from east site was going strong, but no activity was taking place on west side of Elmwood. Gary and I took traffic counts and I re-verified the dimensions of the previous 2 sampling events. Planned sampling for tomorrow.

6/21/94 Sampled today. Crew consisted of Griffin, Garman and Raile. No hauling was taking place on the west side of the road. All trucks that previously were used on west side are now being used on the east side along with all the Parks & Recreation trucks. Sampling went very well.

Daily Activity Log (Continued)

6/22/94	All trucks hauling from east side of street now. All are 3/10 trucks and no 2/6 trucks. Large amounts of traffic from site are present. Slight rain while I was at site, made carryout heavy onto road. Good sampling for tomorrow. Majority of loading present is due to overloading of trucks, not from carryout, except right at entrance. Some of the trucks leave the site by going north instead of south; this could be a problem.
6/23/94	Slight rain this morning, so site was muddy. Try sampling this afternoon. Trucks were still going both north and south out of site.
6/24/94	Sampled today. Crew consisted of Garman, Griffin, and Raile. Trucks still entering and leaving the site from both the north and south. Possibility that the street sweeper went by on the southbound "A" lane, but we are not sure. The QA sample taken at site 3A will have more loading due to mud clod being located in it. Sampling went well again today.
6/27/94	Checked counters this morning. Tried to get in touch with Judd, but we kept missing each other. Put equipment together so we could sample tomorrow. Trucks still leaving the site and heading both north and south.
6/28/94	Sampled today. Crew consisted of Griffin, Garman, and Raile. Saw a street sweeper, sweeping on Van Brunt/Brush Creek heading west, so no samples were taken on that street. Carryout loading was very high, mud was caked to the road. Traffic counter for north road was moved by construction people, so I put it back down.
6/29/94	Garman and I went out and took video tape and pictures of site for Masser. I also talked to Judd and got a few things cleared up. He said he would try to get the trucks to leave only going to the south. Went to Field-Station for supplies and cleaned out the 241C Laboratory with the trip to the Field Station. Chance of rain tomorrow.

Daily Activity Log (Continued)

6/30/94 Sampled today in the P.M. Crew consisted of Garman, Griffin and Raile. Trucks still going both north and south out of the site (about 30% south and 70% north). Loading was very heavy on road going both directions from the site. Plan to clean road tomorrow evening.

7/1/94 They watered down the site this morning. Very little dust was being generated at the site, but carryout was extremely heavy. Called around to set up street sweeper cleaning of the street. Going to wash and clean the street after the P.M. rush hour is over. Tried to sweep the street but the mud was caked too heavy, so we just used the power washer and all we ended up doing was making a thin layer of mud out of it. Going to have Delta try and sweep instead of us doing it.

7/5/94 7/1/94 late evening it rained approximately 2.6 in. at the house, so hopefully it washed the street down. They made another road at the site now, so there are 3 roads. The north road is now the middle road and all traffic entering is crossing that counter hose. I will put another counter down on the new north road, which handles almost all of the northbound exiting traffic. Delta sweeper came by and swept the two traveled lanes on each side. He did a very good job, but left a very silty material behind which tended to become airborne once it was traveled on.

7/6/94 Sampled today. Crew consisted of Garman, Griffin and Raile. Loading was definitely less throughout the area. Had a few problems, mainly with generators, but overall everything went well. Very little traffic going to the south from the site, all seemed to be going to the north, although hauling from the site seemed to let up quite a bit.

7/7/94 Slight amount of rain this afternoon. I went out to calibrate counters in P.M. and found that traffic at the site had picked up and the majority of the traffic (21 out of 28 trucks) were leaving the site going toward the south. Due to the rain, carryout was heavy. Delta will probably sweep tomorrow if it doesn't rain throughout the day.

Daily Activity Log (Continued)

7/8/94 Rained approximately 0.35 in. last night and the site was very muddy. No activity was present so sweeping will be delayed by one day.

7/11/94 No rain this past weekend. Had Delta come by and sweep the street on Elmwood. We took a collocated sample before and after the sweeper went by to evaluate how well the street sweeper cleaned the road. As predicted the sample taken after the sweeper went by was very silty. Possibly making the dirt more of an airborne problem, but at least it isn't on the road anymore. Sweeper ripped up both of the counter hoses and we had to replace them.

7/12/94 Sampled today. Team consisted of Raile, Garman and Griffin. Sampling went well. Trucks still leaving going north and south, but most of the trucks were entering the site from the north. Loading on road was heavy near entrance to site, as usual. All counters and hoses still working.

7/13/94 Had street sweeper come by today. We took another collocated sample before and after the sweeper swept the street to see how much good it was doing. Trucks still leaving the site going both north and south (about a 50/50 split) and entering the site from both directions (50/50 split). Should sample tomorrow if weather cooperates.

7/14/94 Sampled today. Team consisted of Raile, Griffin and Pendleton. Trucks still leaving going both north and south from site. Around 11:00 A.M., one-half of the trucks started hauling material back into the site, so our days could be numbered. They were also hauling some material out while they were hauling material in. If it doesn't rain tonight, the sweeper will come by tomorrow.

Daily Activity Log (Continued)

7/15/94	Wood chips had been spread at the entrance and most of the traveled paths, almost as far as we intended to gravel. They made a new entrance to the site which is just south of the stoplight. All traffic leaving this entrance goes north, so it may be a better idea than having all the trucks leaving the site from one entrance. Looks as though a sweeper came by sometime yesterday afternoon. We are going to go ahead and do a sweeper test and prepare for the next control technology (i.e., the wood chips instead of the gravel). Sweeper came by and we took a before and after sample to test how well the sweeper was doing. Light rain and sprinkles fell while sweeper was cleaning the road, but it dried out right away and everything was okay. The wood chips seemed to reduce the carryout quite a bit, but they also increased the amount of airborne PM.
7/18/94	Rained throughout the weekend off and on (about 0.40 in. at site) so site was still muddy and there was no hauling going on at site. Northbound traffic counter hose was pulled up so Gary reinstalled it while I checked the other counters.
7/19/94	No hauling at site this morning. The river area where they were working looked to be very muddy. This could be influencing the hauling operations. I will go back and check to see if there is any activity after lunch. After lunch, 4 trucks were working. Three were going to the north and one to the south, so no sampling tomorrow.
7/20/94	Northbound traffic counter hose was pulled up. Heavy truck traffic today, but it looks as though it will rain. Started raining about 2:00 p.m. and then rained on and off the remainder of the afternoon. After rain started, trucks quit hauling.
7/21/94	No truck hauling today. Maintenance of track hoes was taking place but that was it.

Daily Activity Log (Continued)

7/22/94	In morning 5 trucks were going to the north from the site. No southbound activity. After lunch 5 more trucks were hauling material into site. All trucks leaving to the south were using the south road when leaving and the middle road when entering. Very heavy loading was present at both access points.
7/25/94	8-10 trucks were hauling material from the site going to the north. No trucks were going south. The northbound traffic counter hose was pulled up and replaced. At 10:00 a.m. trucks had switched and were now hauling to the south only. We took traffic counts then. After lunch trucks were running in both directions, but the majority were still going to the south. We had holes in the middle road hose and the northbound traffic hose was pulled up again, so we fixed those hoses. Then took traffic counts again.
7/26/94	Rained last night ~ 0.30 in. of H_2O. No activity during the a.m. Also no activity during p.m. Called City Public Works to see if they had swept or would be sweeping Elmwood. They said it was scheduled for May 27 but the sweeper was broken down then, and now it was scheduled for September 12, 1994.
7/27/94	Swept today; team consisted of Raile, Garman and Griffin. Road was heavily loaded due to the site being a little muddy from the previous day's rain. Approximately 7-8 trucks were hauling material into the site.
7/28/94	Heavy truck traffic during the a.m. hauling material into the site. No material was leaving the site yet. Called Delta and told them that their drivers needed to start lifting their brushes completely up or they would continue to catch our traffic counter hoses when they drive by.
7/29/94	Sampled today. Crew consisted of Raile, Griffin and Pendleton. It seemed to take longer today, but everything went well.
8/1/94	Rained this a.m., approximately 0.50" H_2O in rain gauge @ 11:00 a.m. Then it started raining again around 11:30 a.m. Looks as though there will not be any activity at the site for at least 2 days.

Daily Activity Log (Continued)

8/2/94	Approximately 0.30" H_2O fell yesterday and last night. Site was very muddy and no activity was present. If sun comes out and it doesn't rain, possibly we will be able to sample tomorrow.
8/3/94	Rained a trace last night, but it looks like rain again today. No activity at site.
8/4/94	Rained ~ 0.60" last night, site was very muddy. No activity. Also rained on and off throughout the day.
8/5/94	Today trucks were entering and leaving from the west site, all going to the north. On the east site, they were constructing a rebar dam in the entrance area. It will be quite awhile before the entrance is cleaned enough for any trucks to enter the site from the south and middle roads. Looks as though they will begin pouring cement for the dam next week, or as soon as it dries out.
8/8/94	Trucks were still entering and leaving the west site going to and from the north. Also two trucks were working on the east side. They were also hauling to the north and entering from the north. All of their activity will be mainly across the middle road. Still a lot of activity in the entrance areas where they are storing the rebar and building some dam structures. In the afternoon, trucks quit hauling from the east site. All hauling was being done from the west site.
8/9/94	Trucks still hauling from west site and going north. Only construction type activities were taking place on the east site. Talked with Judd Huff and he said the remaining hauling activities would be only going to the north, nothing going to the south. He said he might have an alternative site on Van Brunt Boulevard. We looked at it (Gary and I) but we didn't know if it was going to work since it doesn't have any traffic except for the truck traffic. I will look at it tomorrow with Greg and see what he has to say about it.
8/10/94	No hauling activities on either the east or west side of Elmwood. Greg and I decided to see if the trucks bringing in the concrete would generate enough traffic in and out of the site.

Daily Activity Log (Continued)

8/11/94	No activity. Tried to contact Judd to find out about concrete hauling.
8/12/94	Called Judd. He said there would be some concrete hauled in and out and if we wanted to supplement additional traffic that would be fine. Tried to find a truck driver that would do the additional traffic, but I had no luck. Arranged for equipment rental and plan to sweep and pull up mulch on 8/13/94. Contacted Ernie at Beyer Crushed Gravel to set up a delivery.
8/13/94	Gary and I removed the mulch from the entrance using a skid loader. It was very time consuming but we successfully removed most of it. In the afternoon we then swept and washed down the road. I then returned the rental equipment before Glad Rents closed.
8/15/94	Had Beyer Crushed Rock Company lay down about 100 ft × 27 ft of $^1/_4$ in. gravel at the entrance of the site. Intended to contract out a truck to generate traffic at the site as soon as it is okayed by Chuck Masser. May have to put the traffic counter further down the hill now that is on top of the gravel.
8/16/94	Got the OK from Chuck Masser to generate our own traffic at the site. Schedule the truck to arrive at the site tomorrow @ 8:00 a.m. so we can get an idea of how many passes he can make through the site in one day. Moved south road counter further down the hill and that corrected the problem.
8/17/94	Had CMT start generating traffic today. He averaged ~ 10 passes per hour, so I think only one truck will be necessary to generate traffic at site. Took traffic counts before and after lunch and monitored the trucks path. Plan to sample tomorrow.
8/18/94	Sampled today. Team consisted of Garman, Griffin and Raile. Very light loading was present. Also noted that sometimes Delta was sweeping the northbound lane of Elmwood when they come by. Sweeping went well except for the fact that large sample areas were taken to get enough sample.

Daily Activity Log (Continued)

8/19/94 Rained approximately 0.20" H_2O last night. Site was pretty muddy and the only vehicle that made it through the site was a 4-wheel drive vehicle. No activity today.

8/22/94 Rained ~ 0.35" H_2O over the weekend (mainly Friday night). CMT was generating traffic again today. Plan to sample tomorrow.

8/23/94 Sampled today. Team consisted of Griffin and Raile. CMT was still generating traffic. Everything went well today.

8/24/94 Driver was still generating traffic at site. He said he was having to take a different route now and it was taking him longer to make a round trip. I timed him and he was only taking about 7 minutes to complete a round trip, which is still okay. Plan to sweep tomorrow.

8/25/94 Griffin and I sampled today. Larry Wallace with EPA came out and watched us for awhile. We were plagued with sweeper problems so we stopped at sample area #4. Decided to quit and disregard all samples due to the fact that the sweeper wasn't working properly. Used this day as our contingent day.

8/26/94 Driver was making traffic at the site, hoses were still in place. Rained ~ 0.25" H_2O but it was just enough to keep the dust down.

8/29/94 Started raining about 10:00 p.m. of 8/28/94, and rained throughout the night and all day today. No activity at the site.

8/30/94 Rained all day yesterday and during the a.m. today. Rain gauge had 2.3" of rain in it. Extremely muddy at site. We will be lucky if the truck driver can make traffic at the site tomorrow.

8/31/94 Site was extremely muddy, with just a trace of rain in the rain gauge. Some dirt working activity was going on but no truck traffic was taking place.

9/1/94 Still too muddy for truck to drive through the site, so no traffic will be generated today. I called Earl at CMT and told him to have truck start driving either 9/5 or 9/6 to avoid the weekend.

Daily Activity Log (Continued)

9/2/94	Site had dried out, but I decided to wait until Monday or Tuesday to have the driver generate any traffic out of the site.
9/6/94	Driver began to generate traffic at site today. Site was dry and hopefully there will not be any rain the rest of the week.
9/7/94	Sampled today. Team consisted of Garman and Raile. Truck was tracking out mud and loading was very heavy. Sampling went extremely well. Truck should generate traffic at site the rest of today and all day tomorrow.
9/8/94	Truck was making traffic at site today. If it doesn't rain, we will sample tomorrow.
9/9/94	Sampled today. Team consisted of Garman and Raile. Truck was at site today, so I told him he was done yesterday. He then left. Also had sweeper come by when we were done sampling. We did a collocate sweeper test when sweeper came by . Sampling is now done.

APPENDIX B

STANDARD OPERATING PROCEDURE TECHNICAL	SOP No. EET-611 Revision: 1 Date: 4/11/94 Page: 1 of 3

Title: Balance Operation for Weighing Bulk Aggregate Samples

Author: David Griffin

Approved: ______________________________

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Quality Assurance Unit

I. SCOPE

The following procedure describes proper methods and techniques for operation of an analytical balance for the gravimetric analysis of bulk aggregate samples, primarily for moisture and dry sieving.

II. MATERIALS

1. Balance—The primary balance used for the analysis of bulk aggregate is a Sartorius electro-balance having a capacity of 4,100 g and an accuracy of 0.1 g.

2. Calibration weights—Class "S" calibration weights of 200 and 500 g are used.

III. CHECK-OUT PROCEDURES

1. Activation—Make sure balance has been plugged in and turned on for 1 hr prior to weighing. The balance needs proper warm-up to achieve consistent and reproducible weights.

2. Zeroing—Prior to weighing, clean the platform of the balance of dust or debris. Generally, a soft brush will be adequate. Press the "tare" button. This will zero the balance. The zero should be checked before every weighing.

3. Calibration Check—To ensure the proper working order of the balance, it should be calibrated with Class "S" weights. These weights should be kept as clean as possible (i.e., free of fine dust, dirt, and oil from handling with bare hands). Choose Class "S" weights that bracket the weight range of pans, samples, etc., used in the analysis. Typically 200- and 500-g weights, together and separate, should be used. The calibration results are documented in the balance logbook. If the weights meet the acceptance criteria specified in Section IV of this SOP, the balance is ready for use in weighing bulk aggregate samples.

4. Postcalibration—Check the calibration at the end of analysis or work session. The calibration check is documented in the balance logbook.

IV. ACCEPTANCE CRITERIA

Acceptance requirements must be ±0.1% of the actual weight of all calibration weights greater than 100 mg. Acceptance for this procedure is:

- 200 g ± 0.2 g
- 500 g ± 0.5 g
- 700 g ± 0.7 g

V. CORRECTIVE ACTION

If the balance does not meet acceptable requirements as described in Section IV, one or more of the following must result:

1. Check the zero and recalibrate.

2. Check the Class "S" weights against another balance.

3. Have the balance serviced.

4. Use another balance of equal capacity and precision, which meets the calibration criteria.

VI. MAINTENANCE AND CALIBRATION

The balance will be maintained and calibrated annually by a manufacturers representative. A record of this activity will be made in the balance logbook and the certificate of calibration kept on permanent file.

APPENDIX C

SILT LOADING WORKSHEET

Elmwood wk4
Mud/Dirt Carryout Project
Project # 4601 04
Done by: Mike Raile

Date	Time	Sample #	Distance From Inter (feet)	Distance from Entran (feet)	Sampling Conditions	Vacuum Bag I D #	Sample Area (ft^2)	Total Loading (grams/m^2)	Silt Loading (grams/m^2)	# of Splits	Bag Tare Weight (grams)	Bag Loaded Weight (grams)	Bag Empty Weight (grams)	Weight on 3/8 In (grams)	Weight on 4 Mesh (grams)	Weight on 10 Mesh (grams)	Weight on 20 Mesh (grams)	Weight on 40 Mesh (grams)	Weight on 100 Mesh (grams)	Weight on 140 Mesh (grams)	Weight on 200 Mesh (grams)	Weight on Pan (grams)	Total Sample Recovered (grams)	% Silt
06/14/94	09:10	1-A/B-R-044	115	-122	Uncontrolled	44	570	3.977	0.82	0	62.4	273	72.7	0	6.5	24.6	53.9	36.3	34.7	5.6	3.3	32.7	197.6	16.5
06/14/94	09:44	2-A-R-045	327	90	Uncontrolled	45	90	24.566	5.81	0	62.7	268.1	71.1	0	22.5	28.6	61.1	21.4	15.2	3.3	2.2	39.5	193.8	20.4
06/14/94	10:00	2-A-QA-R-126	327	90	Uncontrolled	126	90	21.457	5.53	0	61.7	241.1	70.4	0	7.8	21.4	67.6	19.3	11	2.4	1.6	37	168.1	22.0
06/14/94	10:10	2-B-R 125	327	90	Uncontrolled	125	250	9.210	1.81	0	59.9	273.8	68.4	1.2	15.5	33.4	48	33.4	31.1	4.5	3	33.2	203.3	16.3
06/14/94	10:30	3-A R 124	437	200	Uncontrolled	124	380	3.507	0.97	0	60.1	183.9	67.5	6	16.5	22.1	20.6	12.7	8.1	1.3	1	28.3	114.6	22.9
06/14/94	11:00	3-B R 123	437	200	Uncontrolled	123	400	2.850	0.97	0	59.7	165.6	67.3	0	16.3	20.1	13.5	7.4	5.4	1.6	1.5	27.8	95.8	29.0
06/14/94	11:47	4 A R 121 S1	532	295	Uncontrolled	121	180			1	61.7	701.9	73.4				115.4	48.7	45.6	6.5	7.6	79	305	25.9
06/14/94	11:47	4 A R 121 S2	532	295	Uncontrolled	121	180			1	61.7	701.9	73.4				121.9	52.5	45.1	6.7	6.5	85.1	319.8	26.6
06/14/94	11:47	4-A-R 121	532	295	Uncontrolled	121	180	38.285	10.57	0	61.7	701.9	73.4				237.3	101.2	90.9	17.2	14.1	164.1	624.8	26.3
06/14/94	11:20	4-B-R 122	532	295	Uncontrolled	122	500	4.607	1.16	0	61.5	275.5	70				97.4	31.7	20.4	3.7	4.6	45.7	203.5	22.5
06/14/94	12:04	5-A R 120	767	530	Uncontrolled	120	360	5.394	1.13	0	62.2	242.6	70				94.3	24.4	17.6	3.2	2	29.7	171.2	17.3
06/14/94	12:25	5-B-R 127	767	530	Uncontrolled	127	400	13.969	1.00	0	61.5	580.6	69				281.4	119.6	64.3	6.4	6.8	29.5	510	5.8
06/14/94	12:47	6-A/B-R 131	198	-39	Uncontrolled	131	380	14.781	3.93	0	61.4	583.2	72.7				220.3	88.5	52.3	8.9	11.5	127.1	508.6	25.0
06/17/94	08:54	1 A/B R 128	85	152	Uncontrolled	128	570	3.139	0.48	0	61.6	228	68.9				92.6	22.6	19.1	3.5	2.1	17.2	157.1	10.9
06/17/94	09:30	2-A-R 129	317	80	Uncontrolled	129	180	14.657	2.93	0	61	306.1	71.4				128.4	32.7	25.6	3.6	4.1	38.2	232.6	16.4
06/17/94	09:45	3-A-R-141	437	200	Uncontrolled	141	90	33.082	4.06	0	61.7	338.3	71.2				177.7	36.9	20.7	3.1	2.1	24.4	264.9	9.2
06/17/94	09:52	3-A-QA-133	437	200	Uncontrolled	133	90	43.894	5.34	0	61	428	69.3				226.1	52.4	32.7	3.9	4.4	36	355.5	10.1
06/17/94	10:06	4-A-R-132-S1	557	320	Uncontrolled	132	160			1	60.4	553.3	71.6				168.6	38.8	30.9	4.8	4.3	33.4	280.8	11.9
06/17/94	10:06	4-A-R-132 S2	557	320	Uncontrolled	132	180			1	60.4	553.3	71.6				115.9	26	21.6	3.5	2.1	27.3	198.4	13.8
06/17/94	10:06	4-A-R-132	557	320	Uncontrolled	132	180	29.476	4.32	0	60.4	553.3	71.6				284.5	66.8	52.5	8.3	6.4	60.7	479.2	12.7
06/17/94	10:21	5-A-R 500	677	440	Uncontrolled	500	180	31.904	5.72	0	58.4	691.9	70.5				274.4	74.6	65.2	9.8	11.6	63.2	518.8	16.0
06/17/94	10:35	2 B R-501	317	80	Uncontrolled	501	200	8.213	1.33	0	58.6	211.2	68				88.2	19.6	12.9	2.1	2	15	139.8	10.7
06/17/94	10:55	3-B-R 502	437	200	Uncontrolled	502	500	3.765	1.02	0	59.8	234.7	70.3				56.7	35.2	25.9	4	4.7	36.4	162.9	22.3
06/17/94	11:05	4-B R-503	557	320	Uncontrolled	503	500	3.722	1.14	0	60	232.9	70.3				51.1	30.1	25.3	5.6	5.9	41.6	160	26.1
06/17/94	11:40	5-B-R-504	677	440	Uncontrolled	504	500	5.759	1.20	0	59.6	327.1	70				97.1	57.4	42	7.5	5.1	44.9	254	17.7
06/17/94	11:55	6-A/B-R-505	153	-84	Uncontrolled	505	380	11.767	1.22	0	59.9	475.3	69.4				183.7	102.7	69.7	8.2	6.4	33.4	404.1	8.3
06/21/94	08:35	1-A/B R-506	146	-91	Uncontrolled	506	570	3.377	0.89	0	61.6	240.4	71.4				49.7	36.3	31.1	7.1	5.3	37	166.5	22.2
06/21/94	09:00	2-A-R-507-S1	297	60	Uncontrolled	507	90			2	60.8	231.5	64.4				173.5	63.7	55.1	8.4	10.2	89.4	400.3	22.3
06/21/94	09:00	2-A-R-507-S2	297	60	Uncontrolled	507	90			2	60.8	231.5	64.4				168.6	62.3	53.3	8.2	10.4	85.6	388.6	22.0
06/21/94	09:00	2-A-R-507	297	60	Uncontrolled	507	90	20.416	4.86	0	60.8	231.5	64.4				342.3	126	108.4	16.6	20.6	175	788.9	22.2
06/21/94	09:20	2-B-R-508-S1	297	60	Uncontrolled	508	100			1	60.6	1030.8	74.7				195.2	66.5	68.3	11.8	10.9	76.8	427.5	18.0
06/21/94	09:20	2 B-R-508-S2	297	60	Uncontrolled	508	100			1	60.8	1030.8	74.7				230.1	85.1	85	12.5	14.3	97.6	524.6	18.6
06/21/94	09:20	2-B-R-508	297	60	Uncontrolled	508	100	104.435	20.37	0	60.8	1030.8	74.7				425.3	151.6	151.3	24.3	25.2	174.4	952.1	18.3
06/21/94	09:30	3-A-R-509	412	175	Uncontrolled	509	180	14.263	4.08	0	58.6	297.1	70.2				97.9	32	27.5	5.6	4.8	55.9	223.7	25.0
06/21/94	09:35	3-B-R-510	412	175	Uncontrolled	510	400	5.008	1.21	0	58.8	244.9	68.9				79.3	30.1	22	3.4	3.6	34.3	172.7	19.9
06/21/94	09:57	4-A-R 511	522	285	Uncontrolled	511	360	11.012	3.47	0	58.5	426.8	70.6				131.7	54.3	46.7	7.6	10.1	103	353.4	29.1
06/21/94	10:15	4-B-R 512	522	285	Uncontrolled	512	600	8.339	1.41	0	60.2	525	73.5				228.5	89.8	50	7.5	7.3	64.9	448	14.5
06/21/94	10:29	5-A-R 513	712	475	Uncontrolled	513	720	5.348	1.54	0	60.6	418.2	72.4				132.2	58.2	45.8	8.5	6.9	90	341.6	26.3
06/21/94	10:55	5-B-R-514	712	475	Uncontrolled	514	600	3.825	0.62	0	60.6	273.8	69.7				93.6	46.3	29.8	3.7	3.8	25.1	202.5	12.4
06/21/94	11:23	6-A/B-R-515	177.5	59.5	Uncontrolled	515	285	21.680	3.41	0	60.6	634.6	72.6				227.4	129.9	98.8	13.4	12.1	77.8	559.4	13.9
06/24/94	08:47	1-A/B-R-516	100	-137	Uncontrolled	516	1140	1.301	0.30	0	60.7	198.5	68.5				44.4	28.4	24.3	4.3	2.9	23.9	128.2	18.6
06/24/94	09:17	2-A-R-517	322	85	Uncontrolled	517	90	19.998	5.26	0	61.3	228.5	71.8				74.4	23.7	17.4	2.5	2.9	32.8	153.7	21.3
06/24/94	09:25	2-B-R-518	322	85	Uncontrolled	518	100	14.446	3.28	0	61.6	195.8	70.9				61	20.2	15.6	2.3	2.4	20.7	122.2	16.9
06/24/94	09:35	3-A-R 519	457	220	Uncontrolled	519	90	21.923	4.87	0	61.1	244.4	69.9				80.5	35.6	19.9	3.3	2.4	31.7	173.4	18.3
06/24/94	09:45	3-A-QA-520	457	220	Uncontrolled	520	90	27.341	4.92	0	61.1	289.7	70.5				123	34.4	21.3	3.1	3.6	31.4	217	14.5
06/24/94	09:55	3-B-R 521	457	220	Uncontrolled	521	200	5.091	0.99	0	61.2	155.8	67.6				43.3	18.3	10.2	1.5	1.5	11.6	86.6	13.6
06/24/94	10:07	4-A-R-522	577	340	Uncontrolled	522	180	6.494	1.66	0	60.9	169.5	68.6				37.3	19.8	14.5	2.6	1.6	22.8	98.6	23.1
06/24/94	10:20	4-B-R 523	577	340	Uncontrolled	523	800	2.135	0.46	0	61.6	220.5	70.7				61.2	32.5	23	3.1	3.3	24.8	147.9	16.8
06/24/94	10:51	5-A R-524	757	520	Uncontrolled	524	360	2.885	0.65	0	61.1	157.6	67.2				39.8	18.3	11.6	1.6	1.9	15.4	88.8	17.3
06/24/94	11:01	5-B-R-525	757	520	Uncontrolled	525	400	5.928	0.82	0	60.1	280.4	67.7				96.1	55.6	30.1	4.1	2.6	22.6	211.1	10.7
06/24/94	11:35	6-A/B-R-526	155	-82	Uncontrolled	526	190	39.499	5.26	0	63.7	760.9	71.3				363.7	123.2	90.6	13.9	11.5	85.1	688	12.4
06/24/94	11:47	7-A-R-527 S1	237	0	Uncontrolled	527	5.833			3	63.2	3438.3	74.1				179.3	53.6	71	10.5	10.9	81	406.3	19.9
06/24/94	11:47	7-A-R-527-S2	237	0	Uncontrolled	527	5.833			3	63.2	3438.3	74.1				187	54.3	65.8	12.6	8.5	83.2	411.4	20.2
06/24/94	11:47	7-A-R-527	237	0	Uncontrolled	527	5.833	6228.435	1266.79	0	63.2	3438.3	74.1				366.3	107.9	136.8	23.1	19.4	164.2	817.7	20.1
06/28/94	08:43	1-A/B-R-528	85	-152	Uncontrolled	528	570	5.660	1.19	0	63.7	383.4	70.5				73.3	50.1	78.6	16.6	15.8	56	290.6	19.3
06/28/94	09:10	2-A-R-529	337	100	Uncontrolled	529	180	25.499	6.44	0	60.6	487.2	69.8				173.6	71.8	52.7	7.8	10.3	98	414.2	23.7
06/28/94	09:25	2 B-R-530	337	100	Uncontrolled	530	200	16.426	3.92	0	61.3	366.5	68.3				144.1	42.5	31.9	5.4	5.7	65.1	294.7	22.1
06/28/94	09:45	3-A R-531	437	200	Uncontrolled	531	180	23.598	6.01	0	61.1	455.7	68.3				180	52.7	40.9	8.4	8.5	91.6	380.1	24.1
06/28/94	09:53	3-B R 532	437	200	Uncontrolled	532	200	16.534	3.28	0	61.6	368.6	67.6				154	48.1	31.9	4.8	5.7	54.6	298.9	18.3
06/28/94	10:03	4-A-R 533	537	300	Uncontrolled	533	180	28.992	5.48	0	61.7	546.5	67.6				270.5	64.1	43.9	6.5	6.9	85.1	477	17.8
06/28/94	10:15	4-B-R 534	537	300	Uncontrolled	534	400	7.928	1.59	0	62	356.6	67.2				125.5	62.4	37.7	5.3	3.5	53.5	287.9	18.6
06/28/94	10:33	5-A-R-535	657	420	Uncontrolled	535	360	14.185	2.88	0	61.9	536.3	67.3				230.3	74.4	55.9	7.4	8.8	90.8	467.6	19.4
06/28/94	10:51	5-B-R-536	657	420	Uncontrolled	536	600	6.755	0.92	0	61	437.5	66.5				186.7	73	51.5	7.3	6.3	45.5	370.3	12.3
06/28/94	11:30	6-A R 537 S1	172	-65	Uncontrolled	537	270			1	60.9	629.5	67.1				79.7	45.5	58.4	12.6	8.9	64.4	269.5	23.9
06/28/94	11:30	6-A-R-537 S2	172	-65	Uncontrolled	537	270			1	60.9	629.5	67.1				78.8	47.9	67.7	11.7	12.7	66.7	285.5	23.4
06/28/94	11:30	6-A-R-537	172	-65	Uncontrolled	537	270	22.669	5.54	0	60.9	629.5	67.1				158.5	93.4	126.1	24.3	21.6	131.1	555	23.6
06/28/94	11:41	6-B-R-538-S1	172	65	Uncontrolled	538	100			1	61.5	727.5	72				156.1	62.4	47	6.7	5.8	36.8	314.8	11.6
06/28/94	11:41	6-B R-538-S2	172	65	Uncontrolled	538	100			1	61.5	727.5	72				157.6	69	48.6	7.5	4.8	44	331.5	13.3
06/28/94	11:41	6-B-R-538	172	65	Uncontrolled	538	100	71.690	9.93	0	61.5	727.5	72				313.7	131.4	95.6	14.2	10.6	80.8	646.1	12.5
06/28/94	11:34	7-A/B-R-62894	237	0	Uncontrolled	N/A	2.007	13124.141	2794.09	3	0	2447	0				132	33.7	48.1	10.1	6.8	62.4	293.1	21.3
06/30/94	12:03	1-A/B-R-539-S1	85	-152	Uncontrolled	539	570			1							54.4	39.9	86	20.5	20.6	93.9	315.3	29.8
06/30/94	12:03	1-A/B-R-539-S2	85	-152	Uncontrolled	539	570			1							49.2	41.4	90.2	18.7	21.4	96.5	317.4	30.4
06/30/94	12:03	1-A/B-R-539	85	-152	Uncontrolled	539	570	12.199	3.85	0	61.2	707.2	74.8				103.6	81.3	176.2	39.2	42	190.4	632.7	30.1
06/30/94	12:23	2-A-R-540-S1	298	61	Uncontrolled	540	90			2							122.3	34.3	33.1	6.1	6.3	47.6	249.9	19.1
06/30/94	12:23	2-A-R-540-S2	298	61	Uncontrolled	540	90			2							117.5	35.2	31.8	6.1	4.7	51.7	247	20.9
06/30/94	12:23	2-A-R-540	298	61	Uncontrolled	540	90	121.839	25.69	0	61.2	1079.9	74.7				239.8	69.5	64.9	12.2	11	99.5	496.9	20.0
06/30/94	12:30	2-A-QA-541-S1	298	61	Uncontrolled	541	90			2							118.6	35.8	37.1	6.6	7.2	53	258.5	20.5
06/30/94	12:30	2-A-QA-541-S2	298	61	Uncontrolled	541	90			2							122.9	41.4	39.4	6.7	8.1	53.5	272	19.7
06/30/94	12:30	2-A-QA-541	298	61	Uncontrolled	541	90	131.755	27.77	0	61.6	1163.4	75.6				241.5	77.2	76.5	13.5	15.3	106.5	530.5	20.1
06/30/94	12:40	2-B-R-542-S1	298	61	Uncontrolled	542	100			1							116.7	52.9	42.4	6.7	5.1	83.9	307.7	27.3
06/30/94	12:40	2-B-R-542-S2	298	61	Uncontrolled	542	100			1							109.2	52.3	45.6	5.6	6.9	81.3	300.9	27.0
06/30/94	12:40	2-B-R-542	298	61	Uncontrolled	542	100	67.438	19.54	0	61.9	688.4	77.7				225.9	105.2	88	12.3	12	165.2	608.6	27.1
06/30/94	12:54	3-A R-543	453	216	Uncontrolled	543	90	37.220	7.87	0	62.1	373.3	72				142.1	54.5	36.8	5.4	5.4	55.6	299.8	18.5
06/30/94	13:07	3-B-R 544	453	216	Uncontrolled	544	200	6.787	1.54	0	61.5	187.6	67.7				59.3	23.2	11.6	1.6	1	22.2	118.9	18.7
06/30/94	13:15	4-A-R 545	578	341	Uncontrolled	545	360	10.660	2.22	0	61	417.5	71.1				197.4	45.1	29.1	4.3	5.2	64	345.1	18.5
06/30/94	13:45	4-B R 546	578	341	Uncontrolled	546	600	5.274	1.16	0	61.4	355.4	72.1				140.7	47.2	31.2	4.2	5.1	53.6	282.2	19.1

Elmwood wk4
Mud/Dirt Carryout Project
Project # 4801-04
Done by: Mike Raile

Date	Time	Sample #	Distance From Inter (feet)	Distance from Entran (feet)	Sampling Conditions	Vacuum Bag I D #	Sample Area (ft^2)	Total Loading (grams/m^2)	Silt Loading (grams/m^2)	# of Splits	Bag Tare Weight (grams)	Bag Loaded Weight (grams)	Bag Empty Weight (grams)	Weight on 3/8 in (grams)	Weight on 4 Mesh (grams)	Weight on 10 Mesh (grams)	Weight on 20 Mesh (grams)	Weight on 40 Mesh (grams)	Weight on 100 Mesh (grams)	Weight on 140 Mesh (grams)	Weight on 200 Mesh (grams)	Weight on Pan (grams)	Total Sample Recovered (grams)	% Silt
06/30/94	14.15	5-A-R-547	763	526	Uncontrolled	547	360	10.675	2.58	0	62	419	73				148.4	61.9	47.9	7.9	5.5	74.8	344.4	21.7
06/30/94	14.25	5-B-R-548	763	526	Uncontrolled	548	400	7.212	1.26	0	62	330	70.2				115	51	41.9	6.1	5.6	38.5	258.3	14.9
06/30/94	15.00	6-A/B-R-549	155.5	-81.5	Uncontrolled	549	95	116.458	32.60	2	62.5	1090.3	78.6				66	50.1	62.1	10	11.5	73.3	273	26.8
07/06/94	08.33	1-A/B-R-550	85	-152	Sweeper Control	550	570	10.362	2.44	0	62.4	611.1	77				150	94.2	125.6	27.4	18.9	113.7	529.8	21.5
07/06/94	09.05	2-A-R-551	324	87	Sweeper Control	551	240	13.016	4.14	0	62.5	352.7	78.5				128	24	29.2	6.3	7.2	75.1	269.8	27.8
07/06/94	09.15	2-B-R-552	324	87	Sweeper Control	552	300	14.216	3.09	0	62.5	458.7	78.1				220.9	38.9	34.6	5.9	6.6	71.9	379	19.0
07/06/94	09.40	3-A-R-553	429	192	Sweeper Control	553	240	10.567	3.99	0	62.4	298	74.2				80.9	21.7	29.1	7	5.7	78	220.4	34.5
07/06/94	09.55	3-B-R554	429	192	Sweeper Control	554	900	3.221	0.91	0	61.7	331	74.3				118.1	38.9	26.6	4.3	4.3	63	253.2	24.9
07/06/94	10.25	4-A-R-555	579	342	Sweeper Control	555	360	8.145	2.60	0	61.4	333.6	73.5				108.6	29.6	32.6	7.1	5.6	74	257.7	28.7
07/06/94	11.22	4-B-R-556	579	342	Sweeper Control	556	1000	2.825	0.47	0	62	324.4	71.1				107.6	58.7	40.4	4.9	4.9	34.6	251.1	13.8
07/06/94	12.09	5-A-R-557	729	492	Sweeper Control	557	540	6.437	1.64	0	61.8	384.7	74.9				110.6	53.6	56.5	9.5	8.6	68.9	307.7	22.4
07/06/94	12.25	5-B-R-558-S1	729	492	Sweeper Control	558	1000			1							161	68.3	57.2	7.1	6.7	34.1	334.4	10.2
07/06/94	12.25	5-B-R-558-S2	729	492	Sweeper Control	558	1000			1							169.2	68.7	51.2	8.2	5.3	34.2	336.8	10.2
07/06/94	12.25	5-B-R-558	729	492	Sweeper Control	558	1000	7.386	0.86	0	62.3	748.5	73.8				330.2	137	108.4	15.3	12	68.3	671.2	10.2
07/06/94	13.00	6-A-R-559	173	-64	Sweeper Control	559	180	12.672	3.40	0	62.4	274.3	74.1				70.1	31.3	38.3	7	6.9	44.8	198.4	22.6
07/06/94	13.15	6-B-R-560	173	-64	Sweeper Control	560	100	30.054	3.85	0	62.5	341.7	71.7				128.9	66	38.7	4.1	3.9	26.4	268	9.9
07/11/94	11.18	2-A-R-561	383	148	Sweeper Test	561	288	17.795	5.09	0	61.9	538	75.3				206.6	64.1	51.2	9.1	7.4	122.1	460.5	26.5
07/11/94	13.58	2-A-S-571	383	148	Sweeper Test	571	288	13.631	7.54	0	61.3	426	75.2				59.1	31.2	46.2	12	13.7	186.7	348.9	53.5
07/12/94	08.42	1-A/B-R-562-S1	85	-152	Sweeper Control	562	570			1							85.9	53.6	71.1	17.5	14.6	102.6	345.5	29.7
07/12/94	08.42	1-A/B-R-562-S2	85	-152	Sweeper Control	562	570			1							80.9	49	70.5	15.4	16.2	90.9	322.9	28.2
07/12/94	08.42	1-A/B-R-562	85	-152	Sweeper Control	562	570	12.974	3.96	0	61.7	748.7	76.7				166.8	102.6	141.6	32.9	31	193.5	668.4	28.9
07/12/94	09.01	2-A-R-563	312	75	Sweeper Control	563	90	35.534	9.69	0	61.7	358.6	78.6				155	24.3	23.2	4.7	6	63.3	276.5	22.9
07/12/94	09.12	2-B-R-574	312	75	Sweeper Control	574	100	18.708	5.45	0	63.3	237.1	70.7				79	19.6	18.3	3.4	2.6	42.5	163.6	26.0
07/12/94	09.22	3-A-R-575	437	200	Sweeper Control	575	180	17.307	6.16	0	63.2	352.6	72				132.4	29.9	27.1	5.7	6.3	76.8	278.2	27.6
07/12/94	09.37	3-B-R 564	437	200	Sweeper Control	564	400	4.717	1.10	0	61.1	236.4	71.1				86.7	25.9	15	2.1	2.5	30.3	162.5	18.6
07/12/94	10.04	4-A-R-565	577	340	Sweeper Control	565	540	8.269	2.80	0	60.9	475.7	75.5				158.2	53.8	43.9	8.7	7.7	124.8	397.1	31.4
07/12/94	10.23	4-B-R-566	577	340	Sweeper Control	566	600	5.156	1.18	0	61.1	348.5	72.3				136.4	42.8	30	4.5	4.8	54	272.5	19.8
07/12/94	10.50	5-A-R-567-S1	697	460	Sweeper Control	567	720			1							147.2	66.8	53.5	9.6	7.8	98.4	383.3	25.7
07/12/94	10.50	5-A-R-567-S2	697	460	Sweeper Control	567	720			1							121.6	57.7	49.4	7.3	6.7	86.3	331	26.1
07/12/94	10.50	5-A-R-567	697	460	Sweeper Control	567	720	10.944	3.00	0	60.8	792.8	78.1				268.8	124.5	102.9	16.9	16.5	184.7	714.3	25.9
07/12/94	11.25	5-B-R-568-S1	697	460	Sweeper Control	568	800			1							127.4	47.9	36.5	5.4	5.4	40.1	262.7	15.3
07/12/94	11.25	5-B-R-568-S2	697	460	Sweeper Control	568	800			1							135.1	55.2	39.7	6.5	4.9	50.6	292	17.3
07/12/94	11.25	5-B-R-568	697	460	Sweeper Control	568	800	7.647	1.38	0	61.2	629.5	72.4				262.5	103.1	78.2	11.9	10.3	90.7	554.7	18.4
07/12/94	12.05	6-A-R-570	184	-73	Sweeper Control	570	90	17.390	5.04	0	60.5	205.9	70.6				56.1	16.3	21.1	4.9	3.8	31.7	133.9	23.7
07/12/94	12.15	6-B-R-569-S1	184	-73	Sweeper Control	569	100			2							78.1	57.2	59.8	9.8	10.7	68.7	284.3	24.2
07/12/94	12.15	6-B-R-569-S2	184	-73	Sweeper Control	569	100			2							78.1	49.9	53.1	9.8	9	61.3	259.2	23.6
07/12/94	12.15	6-B-R-569	184	-73	Sweeper Control	569	100	118.364	29.54	0	60.7	1160.3	75.7				154.2	107.1	112.9	19.6	19.7	130	543.5	23.9
07/13/94	10.45	2-A-R-572-S1	383	148	Sweeper Test	572	288			1							135.9	40.4	31	4.7	6	73	291	25.1
07/13/94	10.45	2-A-R-572-S2	383	148	Sweeper Test	572	288			1							163.7	41	28.4	5.8	4.9	73.8	317.6	23.2
07/13/94	10.45	2-A-R-572	383	148	Sweeper Test	572	288	23.491	6.11	0	61.3	669.8	76.8				299.6	81.4	59.4	10.5	10.9	146.8	608.6	24.1
07/13/94	13.58	2-A-S-573	383	148	Sweeper Test	573	288	10.460	5.50	0	60.8	341.2	76.2				49.2	25	36.6	9.7	11.2	130.2	261.9	49.7
07/14/94	08.37	1-A/B-R-576	85	-152	Sweeper Control	576	380	10.481	2.94	0	63.7	433.7	71.4				76.5	64	86	20.7	17.1	95.6	359.9	28.6
07/14/94	09.10	2-A-R-577	294	57	Sweeper Control	577	90	20.919	4.66	0	63.5	238.4	69.4				61.6	39	25.9	3.5	4.2	32.6	166.8	19.5
07/14/94	09.14	2-A-QA-578	294	57	Sweeper Control	578	90	38.371	7.50	0	63.3	387.4	69.8				111.3	67.3	47.2	6.9	7.1	55.8	295.6	18.9
07/14/94	09.18	2-B-R-579	294	57	Sweeper Control	579	200	18.975	4.61	0	62.5	377.9	70				83.3	63.8	60.9	11	8.6	77.4	305	25.4
07/14/94	09.29	3-A-R-580	459	222	Sweeper Control	580	180	15.136	5.87	0	58.6	311.7	66.9				81.8	30.7	30	6.6	7.5	85.6	242	35.4
07/14/94	09.39	3-B-R-581	459	222	Sweeper Control	581	300	5.231	1.14	0	58.6	204.4	63.9				53.4	33.7	20.5	2.5	2.7	26.2	139	18.8
07/14/94	09.55	4-A-R-582	579	342	Sweeper Control	582	380	7.134	2.03	0	58.4	297	65				78	45.5	34.5	6.2	4.6	60.6	229.8	26.5
07/14/94	10.05	4-B-R-583	579	342	Sweeper Control	583	600	4.254	0.68	0	59.3	296.4	65				102.2	51	35	5.2	4.9	32.2	230.5	14.0
07/14/94	10.30	5-A-R-584	739	502	Sweeper Control	584	540	3.726	1.06	0	58.3	245.2	64				66.8	31.3	25.6	4.7	4.1	46.9	179.4	26.1
07/14/94	10.48	5-B-R-585-S1	739	502	Sweeper Control	585	800			1							102.3	54.3	39.7	5.2	6	34.3	241.8	14.2
07/14/94	10.48	5-B-R-585-S2	739	502	Sweeper Control	585	800			1							112.9	55.1	42.7	6.4	6.6	39.2	262.9	14.9
07/14/94	10.48	5-B-R-585	739	502	Sweeper Control	585	800	6.908	1.06	0	58.8	572.2	65.1				215.2	109.4	82.4	11.6	12.6	73.5	504.7	14.6
07/14/94	11.36	6-A-R-586	158	-79	Sweeper Control	586	180	12.397	2.92	0	58.2	265.5	66.6				64	30.9	47.2	6.9	6.4	40.1	197.5	20.3
07/14/94	11.42	6-B-R-587	158	-79	Sweeper Control	587	100	38.642	5.62	0	58.6	399	68				125	83.1	63.9	7.9	6.9	42.6	329.4	12.9
07/15/94	13.32	2-A-R-588-S1	383	148	Sweeper Test	588	288										133.7	32.7	28	4.7	8.4	65.8	271.3	24.3
07/15/94	13.32	2-A-R-588-S2	383	148	Sweeper Test	588	288										114.9	31.8	24.7	5.1	4.8	60.6	241.9	25.1
07/15/94	13.32	2-A-R-588	383	148	Sweeper Test	588	288	21.080	5.71	0	52.8	616.8	71.3				248.6	64.5	52.7	9.8	11.2	126.4	513.2	24.6
07/15/94	15.30	2-A-S-589	383	148	Sweeper Test	589	288	14.834	6.33	0	59.1	458	74.4				75.7	43.2	67.2	19.1	21.2	153.5	379.9	40.4
07/27/94	08.32	1-A/B-R-590	115	-122	Mulch Control	590	540	3.773	0.49	0	58.7	248	66.2				95.6	35.5	23.6	3.7	4.1	17.1	179.6	9.5
07/27/94	08.57	2-A-R-591	293	56	Mulch Control	591	90	48.044	5.81	0	58.9	460.6	70.1				241.5	64.6	35	5.3	4.1	37.1	387.6	9.6
07/27/94	09.04	2-A-QA-592-S1	293	56	Mulch Control	592	90			1							137	37.5	22	2.9	2.8	21.5	223.7	9.6
07/27/94	09.04	2-A-QA-592-S2	293	56	Mulch Control	592	90			1							130.5	38.3	19.6	2.4	2.5	19.5	210.8	9.3
07/27/94	09.04	2-A-QA-592	293	56	Mulch Control	592	90	53.869	6.27	0	57.9	508.3	68.9				267.5	73.8	41.6	5.3	5.3	41	434.5	9.4
07/27/94	09.10	2-B-R-593-S1	293	56	Mulch Control	593	200			1							149.4	39.2	21.2	3.1	2.4	25.3	240.6	10.5
07/27/94	09.10	2-B-R-593-S2	293	56	Mulch Control	593	200			1							157.2	34.2	20.1	2.9	2.7	21.8	238.9	9.1
07/27/94	09.10	2-B-R-593	293	56	Mulch Control	593	200	26.722	3.22	0	58	554.5	70.3				306.8	73.4	41.3	6	5.1	47.1	479.5	9.6
07/27/94	09.20	3-A-R-594-S1	453	216	Mulch Control	594	90			1							223.3	35.3	20.9	3.1	3.5	23	309.1	7.4
07/27/94	09.20	3-A-R-594-S2	453	216	Mulch Control	594	90			1							228.9	35.1	19.8	3.1	2.5	22.5	311.7	7.2
07/27/94	09.20	3-A-R-594	453	216	Mulch Control	594	90	75.984	6.71	0	57.8	693.1	68.1				452.2	70.4	40.5	6.2	6	45.5	620.8	7.3
07/27/94	09.28	3-B-R-595	453	216	Mulch Control	595	100	28.525	2.27	0	59.6	324.6	65.6				197.1	25.8	15	2.2	2	15	257.1	5.8
07/27/94	09.37	4-A-R-596	583	346	Mulch Control	596	180	24.531	3.06	0	59.1	469.3	68.3				233.6	68.6	43.6	5.2	5.6	41.6	398.6	10.5
07/27/94	09.47	4-B-R-597	583	346	Mulch Control	597	200	9.790	1.03	0	59.9	241.6	65.5				113.3	27.9	15.9	2.2	2.1	13.4	174.8	7.7
07/27/94	09.57	5-A-R-598	733	496	Mulch Control	598	180	17.157	2.25	0	57.6	344.5	64.5				172.5	38	28.7	4.3	4	30.5	278	11.0
07/27/94	10.06	5-B-R-599	733	496	Mulch Control	599	200	12.287	1.25	0	57.7	288	63.6				125.4	44.1	28.1	3.5	3.2	17.2	221.5	7.8
07/27/94	10.23	6-A/B-R-600	172	-85	Mulch Control	600	380	7.000	0.65	0	58.2	305.3	65.1				130	56.7	29.2	3.8	3.3	15.6	238.8	6.6
07/27/94	10.55	7-A-R-601	237	0	Mulch Control	601	70	48.732	9.32	0	62.7	366.6	73.9				156.1	36	33.1	8.1	6.5	48.7	288.5	16.9
07/29/94	08.45	1-A/B-R-602	115	-122	Mulch Control	602	570	5.835	0.90	0	60.8	369.6	70.7				122.7	55	61	10.4	10.3	37.6	297	12.7
07/29/94	09.13	2-A-R-603	322	85	Mulch Control	603	90	35.091	4.32	0	61.2	354.6	69.1				204	28.9	16.8	3.5	3.2	28.1	284.5	9.9
07/29/94	09.20	2-B-R-604	322	85	Mulch Control	604	300	7.151	1.17	0	61.1	260.4	70.3				91.6	39.2	27	3.6	3.7	23.1	188.4	12.3
07/29/94	09.40	3-A-R-605	512	275	Mulch Control	605	360	7.846	1.11	0	61.1	323.5	70.1				152.1	38.6	25.1	4.3	4	27.9	252	11.1
07/29/94	09.55	3-B-R-606	512	275	Mulch Control	606	600			1							136.5	58.3	31.5	3.6	3.6	25.9	259.4	10.0
07/29/94	09.55	3-B-R-606	512	275	Mulch Control	606	600			1							129.5	52	28.5	3.9	3.5	23.6	239	9.9
07/29/94	09.55	3-B-R-606	512	275	Mulch Control	606	600	9.159	1.07	0	61.2	571.7	71.3				266	110.3	58	7.5	7.1	49.5	498.4	9.9
07/29/94	10.15	4-A-R-607	652	415	Mulch Control	607	360	12.400	2.33	0	60.7	475.4	73.1				162	85.9	67.3	9.5	10.8	65.4	400.9	16.3
07/29/94	10.30	4-B-R-608	652	415	Mulch Control	608	600	4.187	0.70	0	61.1	294.5	70.2				86.8	51.8	42.9	6.5	5.2	29.8	223	13.4

Elmwood wk4
Mud/Dirt Carryout Project
Project # 4601 04
Done by Mike Raile

Date	Time	Sample #	Distance From Inter (feet)	Distance from Entran (feet)	Sampling Conditions	Vacuum Bag I D #	Sample Area (ft^2)	Total Loading (grams/m^2)	Silt Loading (grams/m^2)	# of Splits	Bag Tare Weight (grams)	Bag Loaded Weight (grams)	Bag Empty Weight (grams)	Weight on 3/8 In (grams)	Weight on 4 Mesh (grams)	Weight on 10 Mesh (grams)	Weight on 20 Mesh (grams)	Weight on 40 Mesh (grams)	Weight on 100 Mesh (grams)	Weight on 140 Mesh (grams)	Weight on 200 Mesh (grams)	Weight on Pan (grams)	Total Sample Recovered (grams)	% Silt
07/29/94	11 07	5-A-R-609	782	545	Mulch Control	609	540	4 244	0 86	0	60 9	273 8	69				82 9	39 3	34 4	6 4	5 9	34 9	203 8	17 1
07/29/94	11 24	5-B-R-610	782	545	Mulch Control	610	1000	3 735	0 49	0	61 2	408 2	71 1				128 8	86 6	66 3	8 8	8 3	35 2	336	10 5
07/29/94	12 15	6-A R-611	165	-72	Mulch Control	611	180	5 442	0 86	0	61 2	152 2	66 6				33	19 2	18 9	2 9	2 4	8 9	85 3	10 4
07/29/94	12 24	6-B-R-612	165	-72	Mulch Control	612	200	12 379	1 20	0	61 7	291 7	68				97 1	64 3	38 5	5 1	4 3	15 9	223 2	7 1
07/29/94	12 38	7-A-R-613	237	0	Mulch Control	613	112	15 762	2 87	0	61 6	225 8	69 7				99 3	14	14	2 6	3 1	21 6	154 6	14 0
08/18/94	08 40	1-A/B-R-614	70	-167	Gravel Control	614	570	7 493	1 27	0	62 2	459	71				144 9	58 8	85 4	19 2	17 6	57 6	383 5	15 0
08/18/94	09 05	2-A-R-615	322	85	Gravel Control	615	270	8 320	1 83	0	63	271 7	70 8			61 9	36 8	31	22 3	3 8	4 1	37 3	197	18 9
08/18/94	09 30	2 B-R-616	322	85	Gravel Control	616	300	8 776	1 87	0	60 6	305 2	67 7			88 8	42 2	32 6	24 5	3 4	3 8	39	234 3	16 6
08/18/94	09 38	3-A-R-617	462	225	Gravel Control	617	540	8 135	1 65	0	60 7	468 8	69 9				165 9	72 5	62 8	10 8	10 4	72 7	395 1	18 4
08/18/94	09 53	3-B-R-618	462	225	Gravel Control	618	600	4 485	0 61	0	60 4	310 4	67 9				115 7	56 8	32 6	4 7	4 2	26	240	10 8
08/18/94	10 20	4-A-R 619	612	375	Gravel Control	619	540	8 356	1 44	0	59 9	479 1	69				145 3	92	83 4	11 5	12	62 6	406 8	15 4
08/18/94	10 37	4-B-R-620	612	375	Gravel Control	620	600	5 990	0 77	0	59 8	393 7	66 7				128 1	72 8	68 7	10 4	8 2	35 8	324	11 0
08/18/94	11 04	5-A-R-621	772	535	Gravel Control	621	540	4 009	0 58	0	60 5	261 6	66 4				67 9	42 6	43 3	8 5	7 2	23 1	192 6	12 0
08/18/94	11 22	5-B-R-622	772	535	Gravel Control	622	600	8 656	0 58	0	61 5	432 5	66				139 2	88 4	84 1	13 1	11 5	27 7	364	7 6
08/18/94	12 00	6-A/B-R-623	159	-78	Gravel Control	623	190	18 498	1 14	0	61 5	352 7	65 3				139 5	72 2	47 2	6	5	16 2	286 1	5 7
08/23/94	08 35	1-A/B-R-624	100	-137	Gravel Control	624	570	5 290	0 64	0	61 7	341 8	68 5				99 1	59 9	62 5	11 6	10 2	26 9	270 4	9 9
08/23/94	08 50	2-A-R-625	387	150	Gravel Control	625	360	4 964	1 15	0	61 5	227 5	69 9				87 3	15 2	15 5	3	3 9	29 3	154 2	19 0
08/23/94	09 14	2-A-QA-626	387	150	Gravel Control	626	360	8 689	1 81	0	61 8	352 2	69 4				175	24 7	24 2	4 9	5 2	45 4	279 4	16 2
08/23/94	09 25	2-B-R-627	387	150	Gravel Control	627	600	3 409	0 95	0	61 8	251 8	69 8				85 1	26 5	17	2 8	2 8	43 8	177 8	24 6
08/23/94	09 54	3-A-R-628	532	295	Gravel Control	628	450	40 416	6 16	2	61 6	1751 2	73 7				210 8	66 9	61 8	10 5	11 3	61 9	423 2	14 6
08/23/94	10 15	3-B-R-629	532	295	Gravel Control	629	500	3 475	0 40	0	61 5	222 9	66 3				94 4	28 5	14	1 9	1 8	13 5	154 1	8 8
08/23/94	10 30	4-A-R-630-S1	662	425	Gravel Control					1							118 2	49 9	48 6	9 3	8 7	50 8	285 5	17 8
08/23/94	10 30	4-A-R-630-S2	662	425	Gravel Control					1							106 1	46 4	49 7	8	8 6	48 7	267 5	18 2
08/23/94	10 30	4-A-R-630	662	425	Gravel Control	630	540	11 155	2 16	0	61 3	620 9	70 4				224 3	96 3	98 3	17 3	17 3	99 5	553	18 0
08/23/94	10 50	4-B-R-631	662	425	Gravel Control	631	800	3 879	0 41	0	61 6	350 1	68 4				120 6	87 4	54 1	7 6	5 9	23 8	279 4	8 5
08/23/94	11 20	5-A-R-632	792	555	Gravel Control	632	720	3 250	0 50	0	61 9	279 3	68 9				78	46 8	42 6	8 1	6 9	25 9	208 3	12 4
08/23/94	11 40	5-B-R-633	792	555	Gravel Control	633	800	3 448	0 29	0	62 4	318 5	67 1				101 4	64 9	52 1	7 3	6 7	17	249 4	6 8
08/23/94	12 25	6-A/B-R-634	165	-72	Gravel Control	634	360	5 621	0 46	0	61 6	249 6	65 8				95 1	40 4	27 9	4 2	3 8	11	182 4	6 0
09/07/94	08 40	1-A/B-R-642	100	-137	Gravel Control	642	570	3 477	0 53	0	61 4	245 5	67 4				78 8	35 2	28 9	5 2	4 9	21 6	174 6	12 4
09/07/94	09 05	2-A-R-643	317	80	Gravel Control	643	90	49 874	4 66	0	59 8	476 8	67 4				296 2	43 9	24 1	4 4	4 7	31	404 3	7 7
09/07/94	09 15	2-A-QA-644	317	80	Gravel Control	644	90	44 074	4 45	0	60 8	429 3	67 9				270 8	28 8	19 1	3 7	4 3	29 7	356 4	8 3
09/07/94	09 22	2-B-R-645	317	80	Gravel Control	645	100	47 901	3 48	0	60 1	505 1	66 2				322	50 9	25 5	4 9	4 8	25 9	434	6 0
09/07/94	09 34	3-A-R-646	422	185	Gravel Control	646	90	44 851	5 79	0	61 4	438 4	67 6				244 4	42 4	25 7	4 6	5	41 6	363 7	11 4
09/07/94	09 39	3-B-R 647	422	185	Gravel Control	647	100	24 370	1 70	0	61 9	288 3	65 2				162 5	26 9	13 1	2 1	2 3	12 3	219 2	5 6
09/07/94	09 51	4 A R 648	532	295	Gravel Control	648	180	19 160	1 62	0	61 8	382 2	66 5				223 7	36 8	23 1	3 5	3 5	22 2	312 8	7 1
09/07/94	10 01	4-B-R-649	532	295	Gravel Control	649	200	14 144	1 13	0	60 1	322 9	64 9				199 9	22 1	11 9	2 1	2 1	15 9	254	8 3
09/07/94	10 15	5-A-R-650	672	435	Gravel Control	650	180	26 953	2 22	0	59 4	510 1	65				294 9	66 3	39 3	4 8	5 2	31 2	441 7	7 1
09/07/94	10 25	5-B-R-651	672	435	Gravel Control	651	200	21 954	1 04	0	61 3	469 2	63 9				332 7	29 2	18 5	2 9	2 7	16 7	402 7	4 1
09/07/94	10 39	6-A/B-R-652	152	-85	Gravel Control	652	570	6 774	0 89	0	61 2	419 9	65 1				138 7	90 7	60 6	9 4	8 9	42 9	351 2	12 2
09/09/94	08 52	1-A/B-R-653	70	-167	Gravel Control	653	570	3 226	0 44	0	61 5	232 3	64 7				66 8	31 5	35 6	5 5	5 8	19 8	165	12 0
09/09/94	00 00	2-A-R-654	352	115	Gravel Control	654	270	15 927	2 59	0	59 2	458 7	64 9				222 8	83 4	34 1	5 3	5 6	58 7	389 9	15 1
09/09/94	09 39	2-B-R-655	352	115	Gravel Control	655	300	10 499	1 82	0	59 1	351 7	64 7				136 6	57 2	34 7	4 9	4 8	44 6	282 8	15 8
09/09/94	09 54	3-A-R-656	517	280	Gravel Control	656	270	9 883	0 91	0	59 6	307 5	62 8				170 2	29 2	17 2	2 6	2 9	19 3	241 3	8 0
09/09/94	10 21	3-B-R-657	517	280	Gravel Control	657	400	5 166	0 70	0	60 9	253 6	64 4				91 4	41 5	25	3 2	2 7	22 3	186 1	12 0
09/09/94	10 27	4-A-R-658	832	395	Gravel Control	658	270	13 651	1 89	0	60 3	402 7	64 7				148 1	78 8	52 3	7 7	7 1	42 8	334 8	12 7
09/09/94	10 45	4-B-R-659	832	395	Gravel Control	659	300	6 771	0 69	0	60 4	249 1	63 7				71 4	44 2	36 9	4 5	4 4	21 2	182 6	11 6
09/09/94	10 52	5-A-R-660	777	540	Gravel Control	660	270	8 777	0 80	0	60 6	230 6	63 6				83	32 7	25 1	3 5	3 2	16 8	164 3	10 2
09/09/94	11 00	5-B-R-661	777	540	Gravel Control	661	200	7 567	0 64	0	60 1	200 7	62 6				55 2	32 7	27 4	3 9	3 4	12 9	135 5	9 5
09/09/94	11 32	6-A/B-R-662	142	-95	Gravel Control	662	180	18 814	1 63	0	60 4	375	63 8				151 5	78 8	45 9	5	5	23 6	307 8	7 7
09/09/94	14 26	2-A-R-663	372	135	Sweeper Test	663	270	4 276	0 83	0	62 1	169 4	64 7				60 1	12 3	8 4	1 5	1 7	17 8	101 8	17 5
09/09/94	15 15	2-A-S-664-S1	372	135	Sweeper Test					1							11 6	16 4	48 8	19 7	23 5	224 5	344 5	65 2
09/09/94	15 15	2-A-S-664-S2	372	135	Sweeper Test					1							11 3	15 4	51 6	17 1	23 3	214 3	333	64 4
09/09/94	15 15	2-A-S-664	372	135	Sweeper Test	664	270	27 525	17 92	0	61 9	752 3	68 2				22 9	31 8	100 4	36 8	46 8	438 8	677 5	64 8

APPENDIX D

QUALITY ASSURANCE PROJECT PLAN

Date Submitted: 4/11/94 QTRAK No.: 93026

Revision No.: 1 Project Category: III

Title: Characterization of Mud/Dirt Onto Paved Roads from Construction and Demolition Activities

Project/Task Officer: Charles Masser (MD-62)

Contractor Name/Address/Phone No. Midwest Research Institute
425 Volker Boulevard
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Contract No.: 68-D2-0159 Task No.: I-04 Duration: 4/94 to 9/94

APPROVALS

	Signature	Date
John S. Kinsey Contractor Project/Task Manager	[signature]	4/11/94
Carol L. Green Contractor QA Manager	Carol L. Green	4/11/94
Charles Masser AEERL Project/Task Officer	Charles C. Masser	6/1/94
Nancy Adams AEERL QA Manager	Nancy H. Adams	6/1/94

CONTENTS

Distribution of QAPjP:

MRI: R. Neulicht, C. Green, G. Muleski, J. Kinsey, M. Raile
Client: C. Masser, N. Adams

SECTION A1

PROJECT DESCRIPTION AND OBJECTIVES

The following section provides a brief overview of the project and its objectives. Further details can be found in the test plan.

A1.1 PROJECT DESCRIPTION

Several areas of the country that are in violation of the National Ambient Air Quality Standard (NAAQS) for PM-10 (particles ≤ 10 µm in aerodynamic diameter) have conducted studies to identify the sources of these emissions. A primary source of PM-10 in urban areas is the fugitive dust generated by vehicular traffic on paved streets and highways.

In a recent EPA guidance document (EPA-450/2-92-004), information is presented on the emissions from paved roads and methods for their control. Relationships are also provided which describe PM-10 emissions as a function of source variables such as vehicle speed and weight, traffic volume, and surface silt loading (particles < 75 µm in physical diameter determined by dry sieving). However, few data are currently available on the amount of material deposited on paved roads as a result of mud/dirt carryout from activities such as construction and demolition. The purpose of this work assignment is to characterize the mud/dirt carryout process and to evaluate selected methods for its control.

The test site initially selected for evaluation in the program is a small landfill located on U.S. 69 Highway (NW Platte Road) in Riverside, Missouri. This site is described in detail in Section 2.2 of the test plan.

Road surface samples will be collected at six different points on U.S. 69 as shown in Figure 3-1 of the test plan. Separate samples, designated as "A" and "B," will be collected from the driving (or outside) and passing (or inside) lane, respectively. This scheme is illustrated in Figure 3-2 of the test plan for eastbound U.S. 69.

Paved road surface samples will be collected before and after implementation of selected mud/dirt carryout control methods. The control methods to be evaluated include: street sweeping; installation of a gravel apron (buffer) at the site access point; and installation of a paved apron at the same point. Details on the application of these control techniques and associated sampling activities are provided in Section 2.3 of the test plan. The samples will be analyzed for moisture content (if necessary), total surface loading, and silt content. The emissions of PM-10 will then be estimated using the test data.

A1.2 OBJECTIVES

The primary objectives of this work assignment are to characterize the mud/dirt carryout representative of active construction and demolition sites and to evaluate the efficacy of various methods for its control. A secondary objective is to establish a correlation between source parameters and increases in silt loading.

As defined by the AEERL quality procedures manual (Ford, 1991), this is a Level III project. The data quality objectives (DQOs) for this work are:

* Completeness: a minimum of 100 silt loading samples and 4 collocated QA samples will be collected
* Precision: a maximum of ±50% for collocated silt loading samples, calculated as range percent (Eq. A8-1 in Section A8).

SECTION A2

PROJECT ORGANIZATION AND RESPONSIBILITIES

A project organizational chart is shown in Figure A2-1. All MRI personnel in Kansas City may be reached by telephone at (816) 753-7600, and MRI personnel in North Carolina may be reached at (919) 677-0249.

A2.1 PROGRAM MANAGEMENT

Mr. Roy Neulicht (North Carolina Ext. 5126) will serve as Program Manager. He will:

- Ensure that all necessary resources are available.
- Review all communication from the Quality Assurance Manager (QAM) regarding the project.
- Ensure that any problems, deviations, and so forth, reported by the QAM receive immediate corrective action.
- Ensure that the financial standing of the project is fully reported to the EPA Project Officer.
- Review all technical reports for overall accuracy.

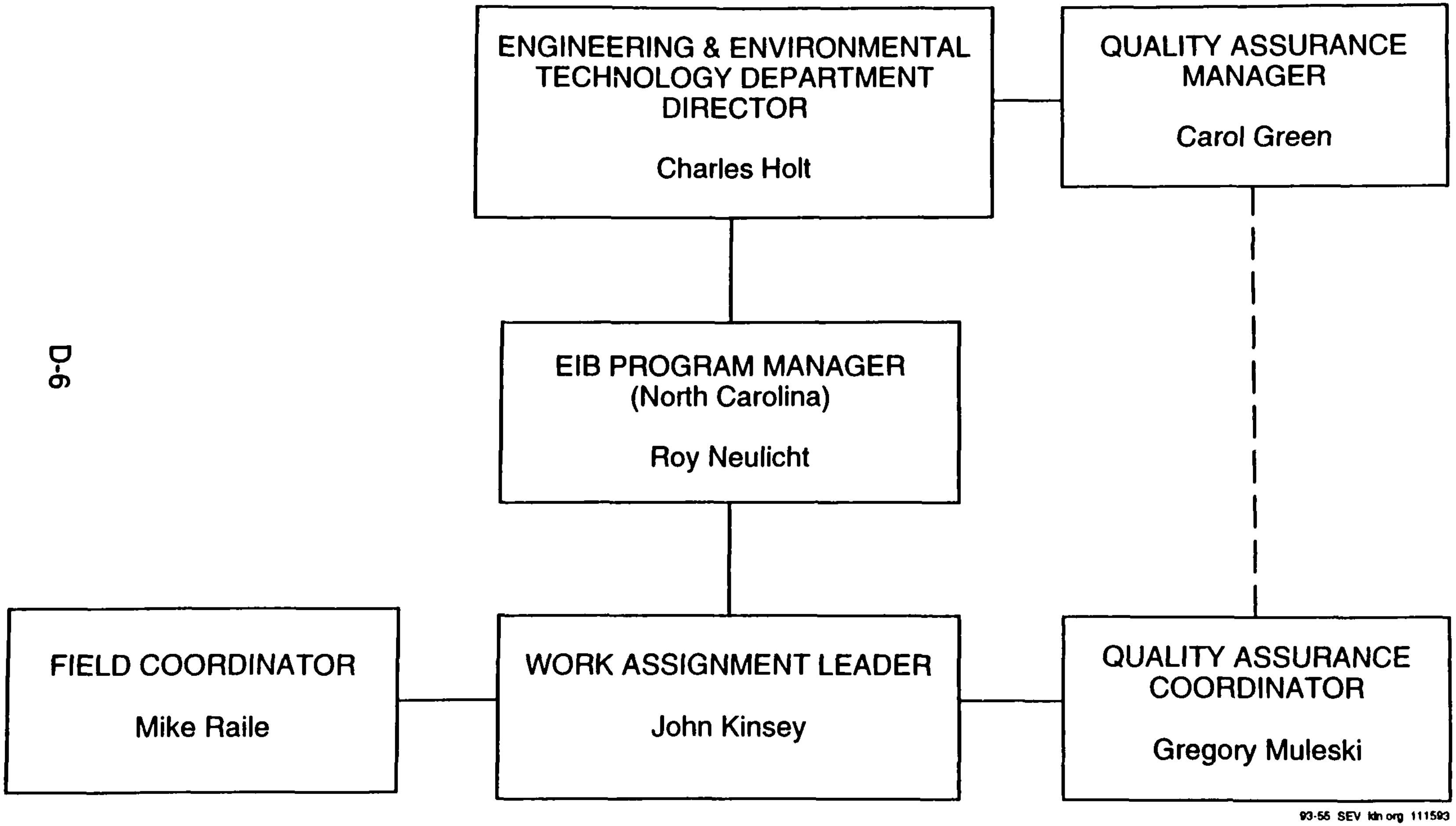

Figure A2-1. Project organization structure.

A2.2 QUALITY ASSURANCE MANAGER (QAM)

Ms. Carol Green, Senior Quality Assurance Officer (Kansas City Ext. 1344), will serve as the QAM and will:

- Assure MRI management that the facilities, equipment, personnel, methods, records, and controls are consistent with project objectives/requirements by conducting general audits and reviewing audits conducted by the work assignment QA coordinator (QAC).

- Help resolve quality and compliance problems and report any unresolved problems to department and corporate management for final resolution.

A2.3 WORK ASSIGNMENT LEADER

Mr. John Kinsey (Kansas City, Ext. 1122) will be the Work Assignment Leader (WAL). He will:

- Help prepare the project QA plan.

- Ensure that all personnel are informed of project QA policy.

- Be responsible for training staff, where required.

- Ensure that the QAC and QAM are fully informed and involved in the project.

- Be responsible for sample receipt and custody.

- Enforce instrument calibration and maintenance procedures, as required.

- Maintain document control of lab data, notebooks, records, and other hard copy information.

- Review and approve all data prior to submittal to the EPA Work Assignment Manager (WAM).
- Review/validate raw data (e.g., notebooks, forms, etc.).
- Ensure that any major deviations from plans or procedures that could affect the quality of the data are approved by the WAM, documented, and reported.
- Ensure that any assumptions or interpretations are documented and reported.
- Take corrective action on any quality or compliance problems and communicate them in writing to the QAM, program management, and department management.
- Prepare and submit reports.

A2.4 FIELD COORDINATOR (FC)

Mr. Mike Raile (Ext. 1208) at MRI's main facility in Kansas City will act as coordinator of the field sampling program. He will:

- Assist the WAL in site selection and control technology implementation.
- Supervise the collection of road surface samples in the field.
- Provide guidance in the application of the test method and subsequent data analysis.
- Assist in data reduction, interpretation, and reporting.

A2.5 QUALITY ASSURANCE COORDINATOR (QAC)

Dr. Gregory Muleski (Kansas City Ext. 1596) will serve as the QAC. He will:

- Conduct the planned and scheduled audits and report the results to the QAM, program management, and department management.
- Assist the WAL in understanding and complying with program QA requirements.

SECTION A3

DATA QUALITY INDICATOR GOALS FOR CRITICAL MEASUREMENTS

Data Quality Indicator (DQI) goals are defined by AEERL as the quality needed for each data component in order to meet the DQOs of the final data. The individual accuracy, precision, completeness, representativeness, comparability, and sensitivity requirements or goals for each part of the sampling and analysis project are described below, where appropriate.

The sampling procedures for this work assignment are very basic and do not require calibration or monitoring of sampling equipment. The only subjective requirement of the sampling operation is the determination of the sampling area. The area to be sampled will be judged at the time of sampling by the FC. The length of the sampling area along the roadway can vary between 0.3 to 3 m (or greater), depending on surface dust loading. Collocated samples will be taken under the same conditions.

The accuracy of the sampling area will not be determined. However, silt-loading precision, as range percent, will be measured for collocated samples. The collocated samples will be taken under the same conditions, and thus comparable sampling methods will be used.

One collocated QA sample will be collected for every 25 surface samples. An embedded sampling approach will be used, as illustrated in Figure A3-1. In this approach, two sets of sampling areas at the same nominal location along the roadway are used, one to collect the field sample and the other to obtain the collocated sample. The field sample and its collocate are taken through the same analysis procedure. The range percent silt loading (the product of silt content and total loading) for each set of field and collocated samples is expected to be a maximum of ±50%. The range percent will be used to assess the precision of sampling and the representativeness of the silt loading and not to reject data.

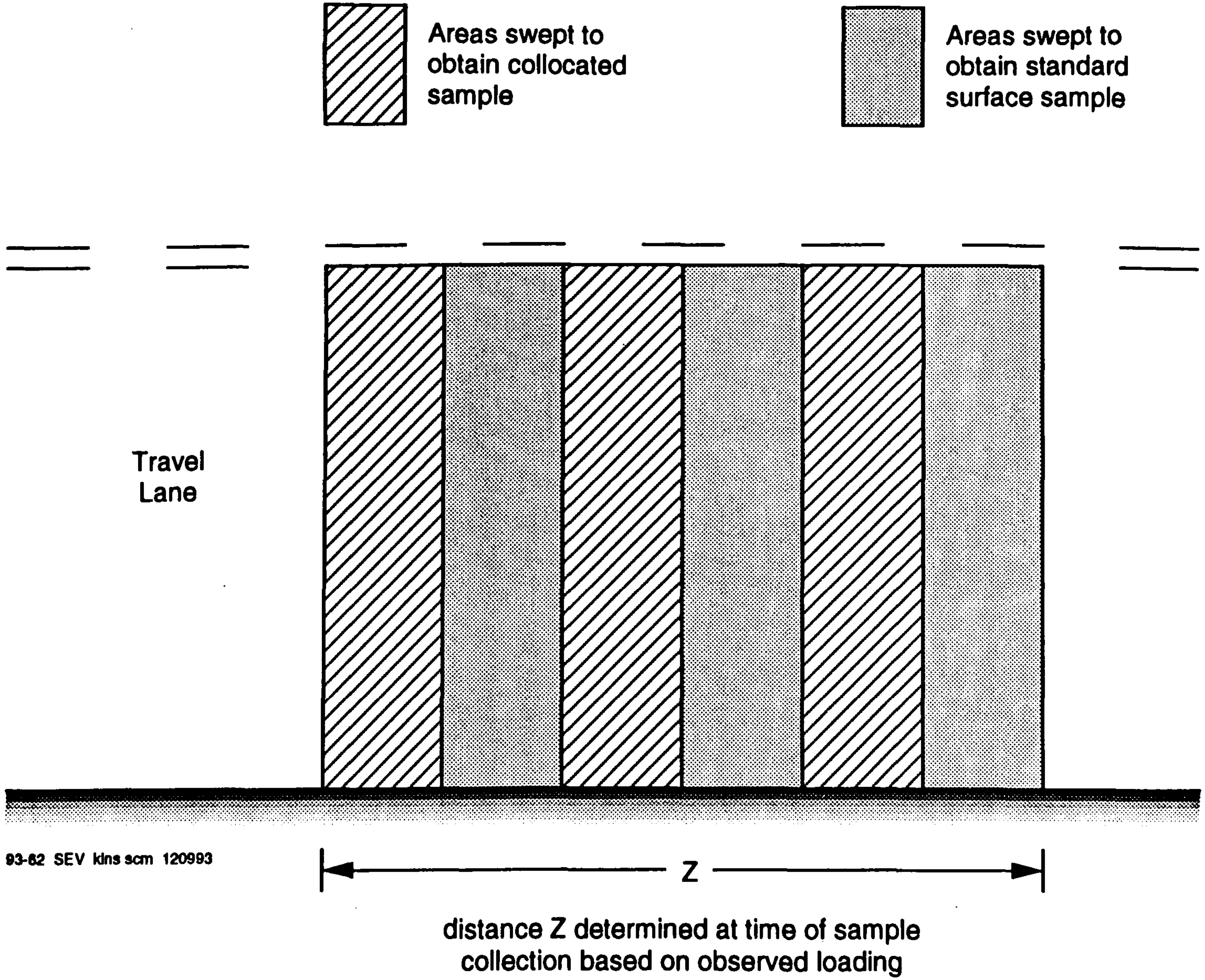

Figure A3-1. Sampling scheme for collocated samples.

Five percent of the total samples processed through the materials laboratory will be also analyzed as QA riffling and sieving procedure samples. The QA samples will be split samples from selected locations where a large enough quantity of material is obtained. The field sample will be initially split into two subsamples (regular sample and QA sample) using the riffling procedure described in Section 3.2.2 of the test plan. Then, each split will be taken through the analysis procedure in the normal manner. The two silt contents will be compared using the QA measure of "relative value":

$$RV = 1 - S_{QA}/S_{reg} \quad \text{(A3-1)}$$

where: RV = relative value (dimensionless)
S_{QA} = silt content (fraction) found for the QA sample
S_{reg} = silt content (fraction) found for the "regular" sample

RV values are expected to fall in the range of 0.95 to 1.05 and will be used only to assess the overall precision of the riffling and sieving procedures and not to reject data.

All samples will be weighed using an analytical balance, which is checked and calibrated as required by SOP EET-611, "Balance Operations for Weighing Bulk Aggregate Samples" (Appendix B). Balance accuracy will be checked before samples are weighed and at the end of the weighing event or 8-hr day, whichever is first. Class S weights will be used to bracket the expected sample weights. The balance accuracy acceptance criterion is ±0.1% for all expected weights.

SECTION A4

SAMPLING PROCEDURES

The field coordinator will assure that the following requirements are met and that the field data are documented, as required, and are correct and complete.

A4.1 SAMPLING PROCEDURES

The sampling site was described in Section 2.2 of the test plan. The type of samples to be collected during each sampling event were summarized in Section 3.1 of the test plan.

The procedures used for collecting and analyzing surface loading samples are detailed in Section 3.2 of the test plan. These include: sampling procedures for surface loading; procedures for sample splitting and moisture analysis; and analytical methods for silt content. The required sample packaging, transport, and storage procedures are described below.

The broom-swept surface samples, if any, will be split as necessary in the field to a suitable size according to the procedures outlined in Section 3.2 of the test plan. Each broom sample will then be quantitatively transferred to screw-top plastic containers and sealed using electrical tape. The surface (i.e., vacuum bag) samples collected in the field will be packaged into a sealed container for shipment back to MRI for analysis. The containers will be transported in the same truck as the test equipment. Upon arrival at MRI, the samples will be taken to the Materials Laboratory for analysis. After silt analysis, the sample separates will be placed into clean, sealed containers for storage.

A4.2 SAMPLING DOCUMENTATION

The following information will be recorded on specially designed reporting forms (Figures 3-3, 3-7, and 3-8 of the test plan): Sampling location; area sampled; pavement type and condition; amount, type, and ID number of samples collected; time of day; and traffic count by vehicle type.

A4.3 SAMPLE CONTROL

Each vacuum bag will be issued a unique identification (ID) number that will be printed on both the bag and the sample container (envelope). Once the vacuum bag contains a sample, it will be further identified by a number of the form: X-TT-YY-ZZZ. X is a 1 digit code for the sampling point (see Figure 3-1), TT is a code identifying the lane(s) sampled (A, B, or A&B), YY is a code identifying the type of sample (R = regular sample, QA = collocated sample), and ZZZ is the 3-digit bag ID number.

The sample number will be recorded on a data form (Figure 4A-1) along with the date the sample was obtained. This form will be used to track the samples. Other pertinent information to be recorded on the form include: shipment date; laboratory receipt date; any special instructions or notations on sample condition and type; and signatures of personnel who receive the sample for analysis.

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Facility Code ______ Page ___ of ___

FIELD TRACKING				LABORATORY TRACKING	
Sample Id.	Collection Date	Shipment Date	Custodian	Receipt Date	Custodian

Figure 4A-1. Sample tracking form.

SECTION A5

ANALYTICAL PROCEDURES

A5.1 MOISTURE ANALYSIS

Only broom-swept samples handled separately from the vacuum bag samples are analyzed for surface moisture content. Because the test plan calls for combining any broom-swept material with the vacuum sample, no moisture analyses are contemplated for this project. If, however, circumstances require the collection of a sample from a fairly damp surface, moisture analysis may be necessary. In that case, analysis will follow the step-by-step procedure outlined in Section 3.2.2 of the test plan. The drying procedure uses an oven set at about 110°C. The balance operating procedure (including calibration checks) used for the gravimetric analysis of the wet and dried samples is specified in SOP No. EET-611 (Appendix B).

Using the applicable wet and dry weights of each broom swept sample (or split sample) collected, the percent moisture content will be determined according to the expression:

$$M = \frac{S_w - S_d}{S_w} \times 100 \qquad \text{(A5-4)}$$

where:

	M	=	Moisture content of the sample (weight %)
	S_w	=	Wet sample weight (g)
		=	$(W_p + W_{ws}) - W_p$
	W_p	=	Weight of the pan (g)
	W_{ws}	=	Weight of the wet sample (g)
	S_d	=	Dry sample weight (g)
		=	$(W_p + W_{ds}) - W_p$
	W_{ds}	=	Weight of the dry sample (g)

The same calculation scheme shown in Equation A5-1 has also been included on the moisture analysis form in Figure 3-5 of the test plan.

A5.2 TOTAL LOADING AND SILT ANALYSIS

The broom swept sample (if any) and the surface dust sample collected by vacuuming at each location will be combined for the determination of total surface loading and silt content (i.e., percent less than 200 mesh or 75 µm physical diameter). From the net weight of each sample collected (SOP No. EET-611), the total surface loading is determined using the following expression:

$$L = M_T/a \quad \text{(A5-5)}$$

where:	L	=	Surface loading (g/m^2)
	M_T	=	Total mass (g) of the sample (i.e., before any splits)
	a	=	Total surface area (m^2) sampled = $l \times w$
	l	=	Length of road surface sampled (m)
	w	=	Width of travel lane (m)

The silt content of each combined sample will also be measured using the sieving procedure provided in Section 3.2.3 of the test plan. The procedure to be used for the gravimetric analysis of the material collected on each sieve is provided in SOP No. EET-611 (Appendix B).

An overall silt content is found by dividing silt loading by the total loading by:

$$s_O = sL/L = [\, s \bullet (M_T - M_N) + M_N]/M_T \quad \text{(A5-6)}$$

where:	s_O	=	Overall silt content of the surface loading
	sL	=	Silt loading
	L	=	Surface loading
	s	=	Silt content of the recovered (possibly split) sample
	M_T	=	Total mass of the sample (i.e., before any splits)
	M_N	=	Nonrecoverable mass (see Figure 3-6)

A5.3 CALCULATION OF SILT LOADING AND CONTROL EFFECTIVENESS

The procedure to be used for calculating silt loading and the effectiveness of each control measured is provided in Section 3.4 of the test plan.

SECTION A6

DATA REDUCTION, VALIDATION, AND REPORTING

A6.1 DATA REDUCTION

The data reduction procedures for the analytical procedures were described in Section A5.

A6.2 VALIDATION

The only calibration required is for the analytical balance. No quality control samples will be used. The quality assurance samples (i.e., the collocated samples obtained in the field and riffling/sieving splits) will be used only to help decide if major procedural problems were present in those activities and not to reject data. The records used to document sampling and analysis must be complete and accurate. All calculations must also be accurate. The WAL will verify that all the above requirements were met and that the QA samples were properly used to assess precision.

A6.3 REPORTING

The reporting requirements for this work assignment are a monthly report submitted as part of the program contractual obligation and a final report summarizing the results of the study. Any other additional reporting requirements will be based upon agreements between the WAL and the WAM.

SECTION A7

AUDITS AND REPORTS TO MANAGEMENT

No technical system or performance audits will be performed. However, all records, including calibration and the results of the duplicate field and riffling/sieving samples, will be reviewed by the QAC. Selected data will be traced and recalculated. A general audit, covering compliance to MRI and project requirements, will also be conducted by the QAM. These audits will be conducted before the final report is released. A quality assurance section of the final report will be prepared by the QAC.

The results of the audits will be provided in a report to the QAM, WAL, and department management. If any quality or compliance problems were found, they will be so noted in the report.

SECTION A8

CALCULATION OF DATA QUALITY INDICATORS

Accuracy, expressed as relative percent difference (RPD), of the balance calibration will be determined by the expression:

$$RPD = \frac{(\text{Standard} - \text{Found})}{\text{Standard}} \times 100 \qquad \text{(A8-1)}$$

where: RPD = relative percent difference (%)
Standard = value of Class S weight
Found = weight measured by the balance

Precision, as range percent (R%), will be determined using the relationship:

$$R\% = \frac{X_1 - X_2}{\bar{X}} \times 100 \qquad \text{(A8-2)}$$

where: X_1 = highest value determined
X_2 = lowest value determined
$\bar{X}$ = mean value of the data set
$= \frac{X_1 + X_2}{2}$ for paired data

The calculated R% for each set of field and QA samples will then be evaluated by the WAL.

SECTION A9

CORRECTIVE ACTION

The Work Assignment Leader (WAL) has the primary responsibility for taking corrective actions. If the WAL is unavailable, the Program Manager and/or the QAM will be contacted for instructions. Any problems resulting in the loss of data or data integrity must be immediately reported to the WAL and QAM.

The only quality problem that might be anticipated is the calibration of the analytical balance. Both acceptance criteria and remedial action are built into the SOP. If the criteria are not met, another balance must be obtained and acceptably calibrated.

Unanticipated problems may include noncompliance to the test or QA plan. If such problems are detected by anyone, the reason must be determined and corrective actions must be taken to prevent recurrence of the problem. The WAL is responsible for investigating any such problems and reporting the problem, reason, and action taken to the QAM, program management and department management.

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

1. REPORT NO. EPA-600/R-95-171	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Characterization of Mud/Dirt Carryout onto Paved Roads from Construction and Demolition Activities		5. REPORT DATE December 1995
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Michael M. Raile		8. PERFORMING ORGANIZATION REPORT NO. MRI-ENVIRON/R4601-04.RPT
9. PERFORMING ORGANIZATION NAME AND ADDRESS Midwest Research Institute 425 Volker Boulevard Kansas City, Missouri 64110-2299		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-D2-0159, Task 1-04
12. SPONSORING AGENCY NAME AND ADDRESS **EPA, Office of Research and Development Air Pollution Prevention and Control Division Research Triangle Park, NC 27711**		13. TYPE OF REPORT AND PERIOD COVERED Task Final; 1-12/94
		14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES APPCD project officer is Charles C. Masser, Mail Drop 62, 919/541-7586.

16. ABSTRACT The report characterizes fugitive dust generated by vehicular traffic on paved streets and highways resulting from mud/dirt carryout from unpaved areas as a primary source of PM-10 (particles = or < 10 micrometers in aerodynamic diameter), and evaluates three technologies for effectiveness in controlling the carryout from an unpaved construction access area onto an adjacent paved road. The first control used a street sweeper to mechanically sweep the dirt and debris from the paved road surface. The second applied a 6- to 12-in. (15- to 30-cm) layer of woodchip/mulch material onto the access area of the construction site to a distance 100 ft (30 m) from the paved road. The third applied a 6-in. layer of gravel over the access area. Street sweeping was found to be only marginally effective (approximately 20%) in reducing average silt loading on the paved road lanes. Treatment of the access area with a buffer of woodchip/mulch was moderately effective, reducing average silt loading by 38 to 46%. The gravel buffer showed the greatest effectiveness, reducing the average silt loading by 57 to 68%. These silt loading reductions result in the following calculated PM-10 reductions: street sweeping, 14%; woodchips, 27 to 33%; and gravel, 42 to 52%.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Pollution	Dirt	Pollution Control	13B	
Dust	Construction	Stationary Sources	11G	13M
Dust Control	Demolition	Fugitive Dust	05E	19A
Particles	Mulches	Particulate	14G	02A
Roads	Gravel	Paved Roads		13C
Mud		Sweeping	08G, 08M	
		Woodchips		

18. DISTRIBUTION STATEMENT **Release to Public**	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 101
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

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