No. FHWA/RD-81/044

ISTITUENTS OF HIGHWAY RUNOFF

Vol. III. Predictive Procedure for Determining Pollutant Characteristics in Highway Runoff

February 1981

Final Report

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Prepared for
FEDERAL HIGHWAY ADMINISTRATION
Offices of Research & Development
Environmental Division
Washington, D.C. 20590

FOREWORD

This report is composed of six volumes: Volume I documents the constituents of highway stormwater runoff and their pollutional effects; Volume II contains detailed procedures for conducting a monitoring and analysis program for highway runoff pollutant data; Volume III describes a simple predictive procedure for estimating runoff quantity and quality from highway systems; Volume IV is the research report discussing research approach and findings; Volume V contains the computer users manual for a highway runoff data storage program and Volume VI is an executive summary. The report will be of interest to planners, designers and researchers involved in evaluation of highway stormwater runoff contributions to nonpoint sources of water pollution.

Research in Water Quality Changed due to Highway Operations is included in the Federally Coordinated Program of Highway Research and Development as Task 3 of Project 3E, "Reduction of Environmental Hazards to Water Resources Due to the Highway System". Mr. Byron N. Lord is the Project and Task Manager.

Sufficient copies of the report are being distributed to provide a minimum of one copy to each FHWA Regional office, Division office and State highway agency. Direct distribution is being made to the Division offices.

D. Solomon
for Charles F. Scheffey
Director, Office of Research
Federal Highway Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/RD-81/044		

4. Title and Subtitle
Constituents of Highway Runoff
Volume III, Predictive Procedure for Determining Pollution Characteristics in Highway Runoff

5. Report Date
February 1981

6. Performing Organization Code

7. Author(s)
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8. Performing Organization Report No.

9. Performing Organization Name and Address
Envirex Inc., (A Rexnord Company)
Environmental Sciences Division
5103 West Beloit Road
Milwaukee, Wisconsin 53214

10. Work Unit No. (TRAIS)
FCP-33E3-014

11. Contract or Grant No.
DOT-FH-11-8600

12. Sponsoring Agency Name and Address
Federal Highway Administration
Office of Research and Development
U.S. Department of Transportation
Washington, D.C. 20590

13. Type of Report and Period Covered
Final Report - Volume III
February 1975 - July 1978

14. Sponsoring Agency Code

15. Supplementary Notes

FHWA Contract Manager: Byron N. Lord (HRS-42)

16. Abstract

This report documents the development and application of a simple predictive procedure (model) for determining the runoff quantity and quality from highway systems based on the data gathered from 5 monitoring sites around the country. Equations for 3 highway site types were developed to predict runoff volume and pollutant wash-off coefficients for 17 water quality parameters based on total rain, rainfall duration and dry days. Analysis indicated that pollutant accumulation rates within highway systems can be best predicted using average daily traffic values.

The titles of the volumes of this report are:

FHWA-RD-	Subtitle	
81/042	Vol. I	State-of-the-Art Report
81/043	Vol. II	Procedural Manual for Monitoring of Highway Runoff
81/044	Vol. III	Predictive Procedure for Determining Pollutant Characteristics in Highway Runoff
81/045	Vol. IV	Characteristics of Runoff from Operating Highways, Research Report
81/046	Vol. V	Highway Runoff Data Storage Program and Computer User's Manual
81/047	Vol. VI	Executive Summary

17. Key Words
Highway runoff, Water pollution, Environment, Salting, Urban storm water, Water quality, Runoff, Water quality, Modeling

18. Distribution Statement
This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	205	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

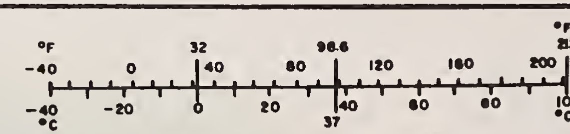
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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TABLES (continued)

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ACKNOWLEDGEMENTS

Acknowledgement is given to numerous State highway and U.S. Geological Survey representatives as well as individual experts who provided assistance during the progress of the study and preparation of the final report. It is not possible to name all who participated in this research study and therefore only a few key agencies and persons are listed below.

The following State highway agencies provided technical assistance, sites for field investigations, traffic and maintenance data:

Colorado State Department of Highways
Louisiana Department of Transportation and Development
Pennsylvania Department of Transportation
Tennessee Department of Transportation
Wisconsin Department of Transportation

District offices of the U.S. Geological Survey in Colorado, Pennsylvania, Tennessee and Wisconsin provided technical assistance in equipment installation and site operation.

Review and assistance in the preparation of the final reports was provided by: Richard Howell, California Department of Transportation and Roderick Moe, Texas State Department of Highways and Public Transportation.

In addition to those agencies and individuals acknowledged above, sincere appreciation is expressed for the work of Frank K. Stovicek, (deceased), FHWA, Office of Research who thoroughly reviewed the final report.

SECTION I
INTRODUCTION

The following report describes the development of a predictive procedure for determining the quantity and quality of storm generated runoff from highway areas. The development of the procedure is based upon the monitoring program carried out in 1976 and 1977 at sites in Milwaukee, Wisconsin; Harrisburg, Pennsylvania; Nashville, Tennessee; and Denver, Colorado. Complete details of the monitoring programs at these sites can be found in Volume IV of this document series (1). Data summaries and monitoring results related to the development of the predictive procedure are presented in the Appendices of this report. (See Table of Contents).

PURPOSE

The purpose of the predictive procedure is to provide highway designers and other interested individuals or agencies with a simplified tool to estimate the quantity and quality of storm generated highway runoff. The predictive procedure is comprised of a series of equations which can be computerized to form a math model. The procedure is made up of four components corresponding to the following functions:

- Rainfall - runoff
- Pollutant buildup
- Pollutant wash-off
- Constituent loadings

The predictive procedure can be used for Environmental Impact Statements (EIS) or to determine the loadings for analysis of the pollutant discharge effects of various design storms at a particular site. The predictive procedure is not meant to be an all-inclusive model which predicts hydrographs and concentrations versus time but rather an easy to use method of determining the total volume of runoff and total pounds of a pollutant discharged from a highway area. The highway area under consideration is defined as the paved roadway and total nonpaved area which contributes to a particular discharge point. The standard data available to highway designers such as average daily traffic, site length, percent paved and curb type are used to define each area of investigation.

In addition to EIS applications, the procedure can also be used to evaluate existing highway systems. Thus, the effects of increased traffic, changes in the curb or barrier configuration or modifications to the nonpaved area can be determined as they relate to the total pollutant loading. Design storm analyses can also be conducted on an existing highway drainage area using the predictive procedure. The pollutant loadings, as predicted for these storms, can then be used to evaluate different water quality impacts through mass balance or modeling analyses. In this manner, the pounds of a pollutant discharged from a highway drainage area can be compared to other pollutant sources within the area. Model use for evaluating receiving water impacts is discussed in Section V of this report.

FORM OF THE PREDICTIVE PROCEDURE

The predictive procedure presented in the following portions of this report will be available to the user in two separate forms. Because of the requirement of being easy to use, the first form of the procedure is presented as a series of equations and tables with a detailed step-by-step list of instructions for implementation. These equations require the user to select a number of coefficients corresponding to particular site characteristics and to select a rainfall period for analysis. Directions on the selection of coefficients and examples of the various applications are included.

The second form of the predictive procedure is a computerized version for use in long term applications which require the analysis of extended rainfall periods. Here the procedure takes on the form of a simulation model which performs the calculations based upon the user supplying the appropriate input data. Again, suitable documentation is included with the model. Further descriptions of the input requirements for each form of the model are presented in Section III. A listing of the computer program statements is contained in the Appendices of this report.

SECTION II
PREDICTIVE PROCEDURE DEVELOPMENT

The development of the functional relationships between the individual sets of data from the monitoring program comprise the framework for the predictive procedure. The modules of the procedure represent the build-up of pollutants on the right-of-way surfaces, the wash-off of these pollutants during runoff and the determination of the discharge loads for selected pollutant constituents. Although the pollutant build-up process occurs prior to the rainfall-runoff process, the latter is discussed first in order to evaluate the length of time in which the pollutant accumulation actually occurs and to determine the amount of material remaining on the right-of-way after the previous rainfall event. The period of buildup and washoff from previous storms are collectively referred to as the prestorm history throughout this report.

RAINFALL-RUNOFF RELATIONSHIPS

The volume and duration of runoff from highway right-of-way are calculated within this module of the predictive procedure. The average runoff rate (volume of runoff per hour) is then used to remove (wash-off) a portion of the pollutants that have accumulated during the prestorm history. The prediction of the average runoff rate is based upon the characteristics of the highway drainage area and the rainfall volume and duration of each event under analysis.

The rainfall volume (R) for each storm and the associated runoff volume (Q) when expressed in the same units, provide a means of calculating the runoff coefficient which can be written as;

$$\text{runoff coefficient} = \frac{\text{volume of runoff}}{\text{volume of rain}} = Q/R \text{ ratio}$$

The runoff coefficient or Q/R ratio as used in this report, relates the total volume of runoff from both the paved and nonpaved portions of the drainage area to the amount of rain causing the runoff. Appendix Tables A-1 - A-5 on pages 99-114 present the rainfall and runoff data from the monitoring sites. Table 1 presents a summary of the monitoring site characteristics, rainfall data, and runoff data. These data used to develop the predictive procedure are only for the nonwinter months, April through October. Runoff during the winter months, November through March, is difficult to characterize, especially in the northern climates where snowfall and frozen ground conditions are prevalent. Runoff during the winter months in these areas is a function of snowfall, snowpack and temperature.

As can be seen from Table 1, some of the Q/R ratios are greater than 1.0, which indicates that the amount of runoff from these sites is greater than the rainfall that falls on the drainage area. This phenomenon is, of course, impossible unless an external source of flow is contributing to the monitoring site. The logical explanation for these large values is likely due to the accuracy of the instruments used for measuring the rainfall and flow volumes. A 10 to 15 percent error is enough to affect each Q/R value at the all-paved Milwaukee I-794 site so that the ratios are greater than 1.0. Because the percent error can be positive or negative for each parameter, the Q/R values which are greater than 1.0 will remain in the analyses since the effects of these values will be negligible when averaged with the remaining data.

Table 1. Site characteristics, rainfall - runoff summary.

Site	Drainage area, acres	Percent paved	Average[a] Q/R	Range[a] Q/R
Milwaukee I-794	2.1	100	0.87	0.20-1.21
Milwaukee Hwy. 45	106.0	31	0.40	0.10-0.91
Harrisburg I-81	18.5	27	0.49	0.02-1.09
Nashville I-40	55.6	37	0.48	0.10-0.90
Denver I-25	35.3	37	0.42	0.08-0.68

a. April through October
metric units: acres x 0.405 = hg
in. x 2.54 = cm

The site characteristic referred to as percent paved in Table 1 is a measure of that part of the drainage area which is normally concrete or asphalt. The driving lanes and most shoulder areas, as well as exit and entrance ramps that are part of the total drainage area are considered paved. Since the predictive procedure is meant to be applied to all highway areas which may or may not have characteristics the same as those listed in Table 1, a general site characteristics classification was developed.

The Milwaukee I-794 site is unique in that the elevated bridge deck that comprises this drainage area is completely paved with impact barriers containing each set of lanes. This type of site is characteristic of many urban freeway systems which have a number of bridge decks passing over interchanges or depressed areas.

The Milwaukee Hwy 45 site, the Nashville I-40 site, and the Denver I-25 site characterize those highway drainage areas which contain paved roadway and shoulder areas and grassy or nonpervious side areas. These sites also contain mountable curbs with inlets spaced along the roadway surface. The percent of the drainage area that is paved generally ranges from 30 to 40 percent.

The final type of drainage area that can be encountered is the rural, flush shoulder type of highway which is characterized by the Harrisburg I-81 site. This site has flush shoulders which receive the runoff from the paved traffic lanes and which conveys the runoff to inlets spaced along the grassy side ditches of this rural site. Generally this type of site has a smaller part of the drainage area that is paved ranging from 20 to 30 percent.

These general site characteristics will be classified as follows for all remaining predictive procedure applications:

Type I sites: Urban, elevated bridge deck, 100 percent paved with impact barriers containing each set of lanes; Milwaukee I-794.

Type II sites: Mountable curb with paved and nonpaved drainage area; Milwaukee Hwy. 45, Nashville I-40, Denver I-25.

Type III sites: Rural sites with flush shoulders, paved and non-paved runoff through ditches; Harrisburg I-81.

The predictive procedure calculates the volume of runoff for a given rainfall event using equations which were developed for each site type from the monitoring data at the five drainage areas listed in Table 1. Using this table, the I-794 site had an average Q/R ratio of 0.87 which means that for each inch (2.54 cm) of rain that fell on that site, an average of 0.87 inches (2.2 cm) of runoff were measured at the outlet of the drainage area. Similarly for the Nashville I-40 site, 0.48 inches (1.22 cm) would be discharged. The differences in these values can be accounted for by the site characteristics of each drainage area with the I-40 site being 37 percent paved and I-794 being 100 percent paved.

The range of Q/R values presented in Table 1 varies from 0.02 to 1.2. The variation in these ratios between sites is caused by the differences in rainfall intensities and durations and most significantly the differences in the characteristics of the drainage areas such as percent paved and soil cover within the unpaved area. The variations in the ratio at a particular site are related to four possible sources:

1. Rainfall intensity and duration.
2. Prestorm history.
3. Monitoring instrumentation.
4. Variation in vehicular splash-off.

Two rainfalls at a particular site may have the same volume but occur over significantly longer durations which effects the amount of runoff. For example, one inch (2.54 cm) in 30 minutes should produce more runoff than one inch (2.54 cm) in 5 hours due to the latter storm having more opportunity to infiltrate the nonpervious portions of the drainage area.

The prestorm history relates the conditions of the drainage area prior to the storm under consideration. Thus, the 5 hour storm above would produce more runoff if it had been preceeded by a large amount of rain a day earlier than if there were no rain for an extended period prior to the storm. The prestorm history is thus related to the soil moisture conditions of the nonpaved portions of the drainage area and their ability to provide a base for infiltration of a part of the potential runoff volume.

The prestorm history of the all-paved I-794 site has little effect on the runoff volumes. Although the surface storage or surface wetting component can effect the volume of runoff as a function of the prestorm history, it will be considered constant for each event at this site (Type 1) and not included in the analysis.

Another source of variation in the Q/R ratios could be attributable to the accuracy of the monitoring instrumentation. Small rainfall and flow volumes can approach the detectable limits of the raingauges and stage recorders used at the monitoring sites. This may cause a variation of as much as 20 percent. These variations must be regarded as implicit to the data collection effort and will be assumed to be relatively constant for the events monitored in this project.

A final source of variation in Q/R ratios may be due to variations in vehicular splash-off. Splash-off varies with the velocity (speed) and quantity of traffic. Generally, the traffic volume and velocity are highest during daylight hours and lowest at night. Therefore a storm occurring during daylight hours will probably produce less runoff (more splash-off) than the same storm occurring at night. In urban areas, traffic volume is greatest during the early morning and late afternoon (commuter traffic) while traffic velocity is often lowest at the peak of the "rush-hour". A storm which occurs just prior to or immediately following peak "rush-hour" traffic would probably produce less runoff (more splash-off) than the storm occurring at other times of the day. The effect of splash-off on Q/R ratio is probably greatest for Type I and Type II sites.

Determination of Runoff Volumes

Type I Sites - Two approaches were initially investigated for predicting the volume of runoff from the Milwaukee I-794 site. The first approach used an average Q/R ratio of 0.87 (Table 1) as a coefficient which when multiplied times the rainfall volume produced the volume of runoff. Thus, an equation of the following form was produced:

$$Q = 0.87\ R$$

where Q = runoff volume
R = rainfall volume

This form of the equation is similar to the rational formula approach which predicts that a constant fraction of the rainfall is converted into runoff for all rainfall events. The data from this site showed the volume of runoff to vary from storm to storm as previously mentioned. In order to account for this variation, the runoff volumes were correlated to the rainfall volumes using simple regression techniques. The resulting equation, significant at the 95 percent confidence limits, was:

$$Q = 0.969\ R - 0.019 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Q = runoff volume (inches)
R = rainfall volume (inches)

The correlation coefficient for this equation was 0.95 with an R^2 value of 0.91 which indicates that 91 percent of the variation in the total runoff at this site can be attributed to total rain using equation 1. Other forms of the equation using nonlinear techniques produced less significant relationships. Equation 1 produced runoff volumes and Q/R ratios which vary with the volume of rainfall as listed in Table 2. This form of the equation is used in the predictive procedure for all Type 1 sites.

Table 2. Predicted Q/R ratios for various rainfall volumes.

Rainfall - R (inches)	0.1	0.2	0.5	1.0	2.0
Predicted Runoff-Q (inches)	0.078	0.175	0.466	0.950	1.92
Q/R	0.78	0.78	0.93	0.95	0.96

metric units: in. x 2.54 = cm

Type II Sites - Type II sites are characterized as those sites with both paved and non paved (pervious) areas. Because of these pervious areas, dry days are an essential parameter in evaluating the relationship between rainfall and runoff volumes. Long dry periods prior to a rainfall will allow the non paved portions of the drainage area to absorb more of the rainfall than conditions where rainfall has been recent or significant enough to saturate those areas. Thus, long dry periods generally reduce runoff volume and lower the runoff coefficient (Q/R ratio).

Two methods of quantifying the prestorm history were attempted in the development of the predictive procedure. The first method was to count the number of days of dry weather prior to the event under consideration. This "dry days" (DD) value is a measure of the length of time prior to the event when no rain fell on the drainage area. The second method measures the number of days prior to the rainfall event in which the cumulative amount of rainfall equaled one inch (DDI). DDI takes into consideration the amount of rain that fell in the prestorm period as well as the amount of time that was necessary to accumulate one inch (2.54 cm) of rain. Other volumes of rainfall were considered but the one inch value accounted for more of the large rainstorms than smaller values, while larger cumulative values resulted in extremely large DDI values for arid sites such as Denver. The two methods of quantifying the prestorm period may be significantly different in their estimates.

Table 3 presents a hypothetical rainfall record to illustrate the difference in dry day estimates using the DD and DDI methods. If the storm prior to the storm under consideration is greater than or equal to one inch (2.54 cm), DD and DDI have the same value (storm on April 3). However, if rainfall events less than one inch (2.54 cm) occur in the rainfall record, the two values become significantly different (storms on April 5,7,9 and 11). The cumulative value DDI provides an estimate of the length of time that was required to accumulate one inch of rainfall prior to the event under analysis.

Table 3. Dry day calculations for DD and DDI using a hypothetical rainfall record.

Storm date	Rainfall, in.	DD, days	DDI, days
April 1	1.05	--	--
April 3	0.30	2	2
April 5	0.45	2	4
April 7	0.20	2	6
April 9	0.50	2	8
April 11	0.10	2	6

metric units: in. x 2.54 = cm

Regression analyses were used to evaluate both methods of characterizing prestorm history (DD and DDI) for each of the three Type II sites. The results of the regression analyses using both linear and log transformed data are presented in Table 4. All correlation coefficients (R values) for the resulting equations are significant at the 95 percent confidence level when compared to a table of critical values for correlation coefficients (2). The regression analyses also show that equations using DD or DDI variables for individual sites are not significantly different in explaining the data variance for runoff volume (R^2 values differ by less than 0.04). This indicates that equations using the DD variable will predict runoff volume as well as equations utilizing the DDI variable. Because regression analyses indicate no advantage in using the DD or DDI variable, the DD variable was used for the predictive procedure since it is the common way of relating prestorm conditions.

The log form of the equation using the DD variable was used for Type II sites, because this form of the equation explains slightly more of the data variation (R^2 values) than does the linear form (Table 4). Also, the regression coefficient of the DD variable in the linear equation for Milwaukee Hwy. 45 site is a small positive value (0.001). This equation will predict larger runoff volumes as the number of dry days increases, which is counter to what is commonly expected in hydrology.

The form of the predictive equation to be used for Type II sites is a combination of the Milwaukee Hwy. 45 and Denver sites as determined through a multiple regression analysis. The Nashville data were not included in this task because the data from that site tended to skew the resulting equation away from the high significance levels that were obtained in the individual correlations. The Nashville data could be highly correlated as is shown in Table 4. However, when these data were combined with data from the other two sites in one regression analysis, the Nashville data were different than the other sites and the resulting equation was unacceptable. Appendix H (page 193) presents a series of scatter diagrams (Figure H-1, H-2, H-3, H-4) plotting flow versus total rainfall and dry days to show how the Nashville data differs from the Milwaukee Hwy. 45 and Denver sites and how the Nashville data tends to cluster. The reason for the variance in the Nashville data can be explained by two factors. The storm history for this site occurs such that a dry period of five to ten days is followed by four or five rainfall events in a short period. This same pattern is repeated two or three times as can be seen in the monitoring data of Appendix Table A-3 on pages 106 to 108. Another factor is the problem of rainfall measurement which was evident in the early portions of the monitoring program. Because of the length of the drainage area and since there was only one raingauge at this site in the initial phase, there were instances where flow was measured although rainfall was not recorded on the gauge. This could

Table 4. Results of regression analyses[a] using DD and DD1 values for Type II sites.

		R	R^2
Milwaukee Hwy 45			
DD			
linear	$Q = 0.746\ R + 0.001\ DD - 0.199$	0.88	0.78
log	$= 0.366\ R^{1.43}\ DD^{0.06}$	0.94	0.89
DD1			
linear	$Q = 0.768\ R - 0.005\ DD1 - 0.099$	0.91	0.82
log	$= 0.413\ R^{1.44}\ DD1^{-0.007}$	0.94	0.89
Denver I-25			
DD			
linear	$Q = 0.509\ R - 0.002\ DD - 0.026$	0.91	0.83
log	$= 0.565\ R^{1.34}\ DD^{-0.175}$	0.91	0.83
DD1			
linear	$Q = 0.482\ R - 0.002\ DD1 + 0.033$	0.92	0.84
log	$= 0.713\ R^{1.254}\ DD1^{-0.183}$	0.89	0.80
Nashville I-40			
DD			
linear	$Q = 0.557\ R - 0.01\ DD + 0.022$	0.92	0.85
log	$= 0.522\ R^{1.028}\ DD^{-0.107}$	0.87	0.75
DD1			
linear	$Q = 0.555\ R - 0.003\ DD1 + 0.019$	0.91	0.83
log	$= 0.592\ R^{1.02}\ DD1^{-0.109}$	0.87	0.76

[a]All equations are significant at the 95 percent confidence limits.

Note: Q = runoff (inches)
R = rainfall volume (inches)
DD = dry days to last rain
DD1 = cumulative days to one inch of rain
metric units: in. x 2.54 = cm

account for the variability in the data. Further details of the monitoring aspects of this site can be found in Volume IV of this document series (1).

Using rainfall volume (R) and dry day (DD) data for Milwaukee Hwy. 45 and Denver, the Type II site equation to predict runoff volume (Q) was developed:

$$Q = 0.470\ R^{1.369}\ DD^{-0.0858} \qquad \frac{R}{0.92} \qquad \frac{R^2}{0.85}$$

The Type II site equation is further explained in Section III of this report and is significant at the 95 percent confidence limits (2).

<u>Tyep III Sites</u> - The Harrisburg I-81 site was used to characterize Type III sites. Data were investigated in the same manner as Type II sites with the results of the DD and DDI variables being the same as Type II and the log equation showing more significance when compared to the linear equation. Using rainfall volume (R) and dry day (DD) data for Harrisburg, the Type III site equation to predict runoff volume (Q) was developed using regression analysis:

$$Q = 0.845\ R^{1.892}\ DD^{-0.654} \qquad \frac{R}{0.93} \qquad \frac{R^2}{0.86}$$

The Type III site equation is further explained in Section III of this report and is significant at the 95 percent confidence limits (2).

Runoff Duration

Once the total volume of runoff has been calculated using site specific equations, the duration of this runoff must be predicted to determine the average runoff rate. A total of one inch (2.54 cm) of runoff may occur at a particular site over a duration of one hour to possibly six hours. The average intensity of one inch (2.54 cm) per hour should wash off more pollutant than a one-sixth of an inch (0.42 cm) per hour event, assuming uniform rainfall intensity. The predictive procedure developed in this report requires an average runoff rate to remove pollutants from the drainage area. Ideally, discrete rates at individual points within the runoff event should be used to remove the pollutants, however, this methodology is too sophisticated for the purposes of this procedure.

Data for the duration of runoff at each monitoring site are presented in Appendix A, Tables A-1 to A-5. These data were used to develop an equation relating rainfall duration (RD) to runoff (flow) duration

(FD). Each site's data were analyzed using linear regression analysis to determine an equation relating the durations. Table 5 presents the resulting equations for each of the five sites, a combination of the Type II sites, (Milwaukee Hwy. 45, Nashville and Denver) and all sites combined.

The equations of Table 5 are all significant at the 95 percent confidence level (2) and give a good indication of the typical duration of runoff for a given rainfall event. The last column of the table presents the predicted runoff duration for a two hour rainfall. These data show that the shortest runoff duration is predicted for the Milwaukee I-794 site (Type I site), while the longest runoff duration is predicted for the Harrisburg site (Type III site). Runoff durations predicted for Milwaukee Hwy 45, Nashville and Denver (Type II sites) are very similar and fall between the predicted values for Milwaukee I-794 and Harrisburg. This would be expected considering the drainage (hydraulic) characteristics for these three site types.

Table 5. Correlation analysis results for rainfall-runoff durations.

Site	Runoff duration equation	Correlation coefficient R	Runoff duration (FD) for RD = 2 hrs
Milwaukee I-794	FD = 1.12 RD + 0.69	0.95	2.93
Milwaukee Hwy 45	FD = 1.50 RD + 1.31	0.91	4.31
Nashville I-40	FD = 1.33 RD + 1.60	0.89	4.26
Denver I-25	FD = 1.16 RD + 1.72	0.90	4.04
Harrisburg I-81	FD = 1.65 RD + 6.27	0.75	8.57
Hwy 45, I-40, I-25 combined	FD = 1.36 RD + 1.63	0.90	4.35
All sites combined	FD = 1.62 RD + 2.10	0.77	5.34

Note: RD = rainfall duration in hours
FD = runoff duration in hours

The determination of the average runoff rate is critical to the accuracy of the washoff equation of the predictive procedure, therefore further investigation of the effects of prestorm history was undertaken. The data of the Type II and III sites was analyzed to determine if longer runoff durations were associated with fewer dry days. This relation was thought to occur since the pervious (non-paved) areas would contribute more to the total runoff volume as the number of dry days decreased. Since these areas have significantly longer time of concentrations than paved portions of the drainage area, possibly runoff duration would increase for equal duration rainfalls.

The analyses were run for two separate groups of data corresponding to a certain number of dry days thought to show a significant difference in rainfall/runoff durations. The first dry day estimates investigated were those events with dry day periods equal or greater than 5 days and those less than 5 days. Regression analyses were run on each set of data for each site to determine if there were large differences in the ratios of the flow duration-to-runoff duration. The regression equations that resulted showed very little difference between each of the groups of data. The next analysis was to use the dry day period of 10 days to determine if any differences resulted. Regression analyses for these data showed greater differences than the 5 day estimate and the resulting equations are presented in Table 6. All equations are significant at the 95 percent limits (2).

Table 6 presents the calculated runoff duration for a two hour rainfall. The Harrisburg site shows the longest runoff duration for this storm. The difference in the duration for DD greater than 10 and less than 10 is more than 3 hours. The Nashville site shows the smallest difference between the DD estimates, but this characteristic may be a function of the raingauge problems discussed earlier. These equations will be used to categorize the runoff duration for the site types which contain nonpaved portions of the drainage area.

Table 7 shows the results of combining the three Type II sites while the Type I and III sites use the individual equations for the Milwaukee I-794 and Harrisburg sites, respectively. The equations for the two dry day groups in Table 7 are identical for Type I sites because a completely paved drainage area was assumed to be unaffected by prestorm history.

Table 7. General equations relating rainfall and runoff durations.

Type of site	Dry days greater than or equal to 10 days	Dry days less than 10 days
Type I	FD = 1.12 RD + 0.69	FD = 1.12 RD + 0.69
Type II	FD = 1.06 RD + 1.79	FD = 1.27 RD + 2.16
Type III	FD = 1.92 RD + 4.18	FD = 1.48 RD + 8.28

Note: FD = runoff duration
RD = rainfall duration

The duration of runoff predicted with these equations is used with the previously calculated runoff volume to produce the average

Table 6. Rainfall-runoff duration equations.

Site	Dry days greater or equal to 10	Runoff duration (FD) for RD = 2	Dry days less than 10	Runoff duration (FD) for RD = 2	Drainage site length, ft x 10^3
Milwaukee Hwy 45	FD = 1.16 RD + 1.59	3.91	FD = 1.08 RD + 3.70	5.86	9.5
Nashville I-40	FD = 0.92 RD + 2.23	4.07	FD = 1.43 RD + 1.62	4.48	6.2
Denver I-25	FD = 0.60 RD + 2.05	3.25	FD = 1.13 RD + 1.94	4.20	3.6
Harrisburg I-81	FD = 1.92 RD + 4.18	8.02	FD = 1.48 RD + 8.28	11.24	2.0

Note: FD = runoff duration in hours
RD = rainfall duration in hours
metric units: ft x 0.3 = meters

volume of runoff per hour for a given rainfall event.

POLLUTANT ACCUMULATION EQUATION

The pollutant accumulation equation of the predictive model is as follows:

$$P = P_o + (K_1 \times HL \times T) \quad \text{.....................} \quad (2)$$

Where; P = pollutant level after build-up, lb (kg)
P_o = initial surface pollutant load, lb (kg)
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
T = time of accumulation, days (20 day maximum)
HL = highway length, mi (km)

The pollutant accumulation equation predicts the highway surface pollutant load (P) which accumulates during a selected time period (T) at a specified rate (K_1). Surface pollutants are those which accumulate on the surface of all-paved sites (e.g. elevated bridge sections) and on the paved and unpaved surfaces of highway sections which have right-of-way areas (e.g. gravel shoulders, grassy areas, etc.). For purposes of the predictive model, pollutant load refers to that fraction of the total highway load which is available for wash-off.

The monitoring data from this study were "end-of-the-pipe" wash-off data which are not a direct measure of pollutant buildup. Therefore, monitoring data could not be used to establish whether pollutant buildup on highways is linear, exponential or some other mathematical function. The pollutant accumulation equation (2) assumes that pollutants build up linearly during the accumulation period. This equation is similar to that used in the Storage, Treatment, Overflow, Runoff Model (STORM) (3) which is based on a linear pollutant build-up relationship developed from a study on urban runoff in Chicago (4).

The surface pollutant accumulation variable, K_1, is the rate at which the carrier pollutant, total solids, accumulates in pounds per mile per day (kg/km/day). A carrier pollutant is that pollutant which exhibits the highest degree of association with all other pollutants being considered. In many mathematical models, the predicted quantity of carrier pollutant is used to estimate the quantity of all other pollutants being modeled. This method eliminates the need for each pollutant to be predicted separately by the model, greatly reducing the number of calculations required. Total solids was chosen as the carrier pollutant for the predictive model developed in this study because total solids showed the highest correlation with the other monitored quality parameters when regression analyses were performed. Volume IV, of this document series, "Characteristics of Runoff From Operating Highways Research Report", presents the results of these regression analyses (1). In this report the term total solids (TS) refers to total suspended solids (TSS) plus total dissolved solids (TDS). Under the new nomenclature of Standard Methods (5), total solids as used in this study is defined as total residue.

Highway planners usually know in advance the length of the highway and the design average daily traffic. For this reason, K_1, is expressed as pounds per mile - day (kg/km-day). The unit, miles, refers to the actual length of highway section in the contributing drainage area. This is in contrast to curb mile or lane mile, which is a multiple of the highway length. The highway designer then inputs to the model the highway length (HL) and the appropriate K_1 factor. K_1 is site specific and its value may be based upon actual monitoring data, if it exists, or its value can be estimated from average daily traffic. K_1 selection based on average daily traffic is discussed at the end of this section.

The initial surface pollutant load (P_o) is the pounds of pollutants on the surface at the beginning of the accumulation period. The accumulation period can be intervals within an actual rainfall record, intervals within a series of design storms, or the period prior to a single design storm event.

If an accumulation period follows a large storm event, the initial surface pollutant load will be considered zero (P_o=0). The definition of a large storm is based upon that used in the Stormwater Management Model (SWMM) for the rate of pollutant removal during a storm event (6). For purposes of the predictive procedure, a large storm event is defined as one with greater than one inch (2.54 cm) of total rainfall and having at least one hour in which the average intensity is 0.5 inches per hour (1.27 cm/hr). For such a storm, it is assumed in SWMM that approximately 90 percent of the surface pollutants available for wash-off have been removed. For the remainder of this report, any storm meeting the above rainfall requirements is referred as to a large storm event.

For succeeding rainfall events in a continuous rainfall record, P_o is the surface pollutant load remaining after wash-off from the previous rainfall event. For rainfall records which do not follow a large storm event or for design storms, the initial surface pollutant load must be estimated using a site specific K_1 value, site length and a specified period of build-up. An analysis of monitored wash-off data and rainfall records during the subject study suggests that dry periods greater than 20 days over-estimate the surface load. The initial surface pollutant load for a site with a K_1 of 80, and a site length of 5 miles would be:

$$80 \frac{\text{lbs}}{\text{mi-day}} \times 5 \text{ mi.} \times 20 \text{ days} = 8{,}000 \text{ lbs } (3{,}629 \text{ kg})$$

However, the model user may choose any accumulation period based upon site specific data or design criteria. For any site, a maximum accumulation period is governed by wind, traffic, curb type, sweeping and other site specific factors which limit the pollutant load within a highway system. This analysis will assume 20 days to be the maximum.

The flow diagram of Figure 1 depicts the steps leading to an estimation of the pollutant level after build-up for any period of accumulation. This diagram also shows the various methods of estimating the initial surface pollutant load, P_o.

Surface Pollutant Accumulation Variable (K_1) Development

K_1 was developed from monitored data using one of the following methods depending upon available data records:

Method 1. Uses a period between two large storm events in which all of the storm events were monitored. Assuming the two large storm events wash off essentially all of the surface pollutants, then the wash-off data in pounds (kilograms) from all the monitored events should account for all pollutants accumulated during this period.

Method 2. Uses a period between two large storm events in which only some of the storm events were monitored. The monitored wash-off data are used to estimate pollutant wash-off for unmonitored events. Estimated and actual wash-off data should provide a reasonable value for total surface pollutants accumulated between the two large rainfall events.

Method I is preferred for estimating K_1 because it is based entirely on monitored data. The required monitoring data and a sample calculation of a K_1 value using Method I for the Milwaukee I-794 site are presented in Table 8.

The storm event on 7/30/76, 1.59 inches (4.04 cm) of rainfall, was large enough to wash off essentially all surface pollutants. The pounds of total solids accumulated during this period is the sum of all total solids monitored, ending with the 1.05 inches (2.67 cm) of rainfall on 8/28/76 which is assumed to wash off all remaining surface pollutants. K_1 is calculated by dividing pounds of total solids washed off by highway length in miles (kilometers) and the number of days during the accumulation period. Figure 2 displays this accumulation, wash-off relationship. The second method for developing K_1 was used for sites where runoff quality for all storm events between two large rainfalls was not monitored, however runoff volume and duration was available. The first step was to express all pollutant wash-off data for monitored events in terms of runoff intensity, lbs/(in./hr) (kg/(cm/hr)). Runoff rates were chosen as the units for data normali-

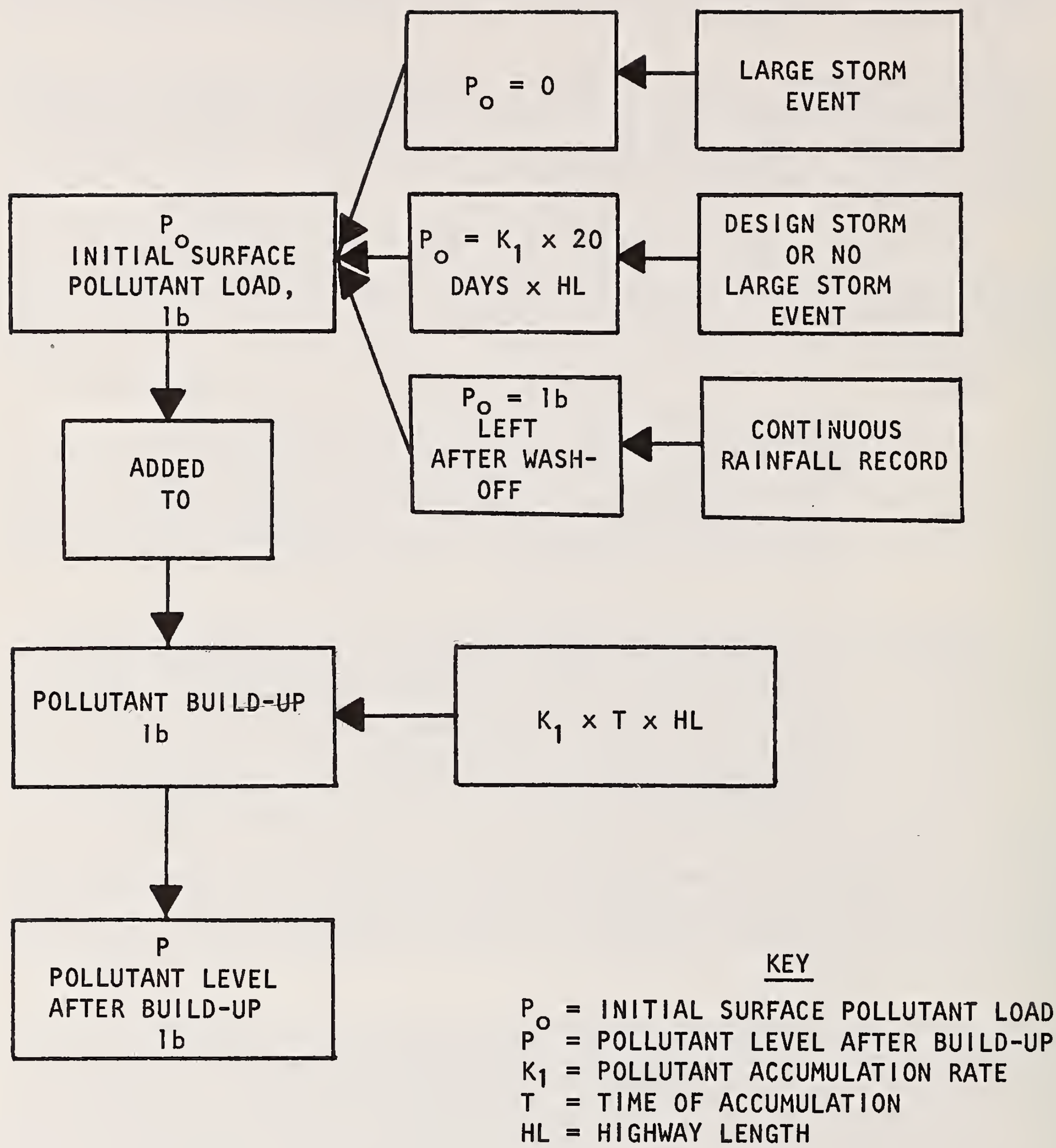


Figure 1. Estimation of pollutant level after build-up.

Table 8. Example of rainfall record and monitoring data needed to develop K_1 using Method 1.

Date	Total rainfalls, inches	Maximum intensity during any one hour of rainfall, in./hr	Total solids monitored, lb
7/30/76	1.59	1.02	--
8/5/76	0.05	--	14
8/13/76	0.64	--	94
8/25/76	0.14	--	29
8/28/76	1.05	0.74	135
			272 lb accumulated

K_1 = 272 lb/(0.15 mi (highway length at I-794)/29 days) = 62.5 lb/mi-day (17.6 kg/km-day).

metric units: in. x 2.54 = cm
lb x 0.454 = kg

zation because rate of runoff is the controling mechanism which carries pollutants within the drainage system. Monitored events with associated pounds of pollutants per runoff rate, were then grouped into three rainfall categories as listed in Table 9: 0.05 to 0.10 inches (0.13 to 0.25 cm), 0.11 to 1.00 inches (0.28 to 2.54 cm) and greater than 1.00 inch (2.54 cm). Any rainfall less than 0.05 inches (0.13 cm) is considered a trace of rain which will not produce runoff of sufficient volume and rate to effect pollutant wash-off. An average pounds per runoff rate from each of the three rainfall categories was then applied to the appropriate unmonitored rainfall event for which runoff rate was calculated. The pounds of total solids, monitored and estimated, are then summed for the entire period. An example of K_1 development using Method 2 is presented in Table 9. As in Method 1, the assumption is used that the two large storm events wash off essentially all of the surface pollutants. The summed pounds of total solids (monitored and estimated) should therefore account for all pollutants accumulated during this period. Using the sum of predicted and monitored total solids wash off, (Table 10), the K_1 factor can be estimated as follows:

K_1 = 1400 lbs ÷ (0.15 mi. (highway length at I-794 x 153 days)
= 62.7 lbs/mi-day (17.7 kg/km-day)

If the three rainfall categories are not used, pollutant wash-off predictions for small rainfalls, 0.05 to 0.10 inches (0.13 to 0.25 cm) are high and pollutant wash-off predictions for large rainfalls, >1.00 inch (2.54 cm), are low. The range of mean values, total solids per runoff rate, for the three rainfall categories of Table 9 indicate

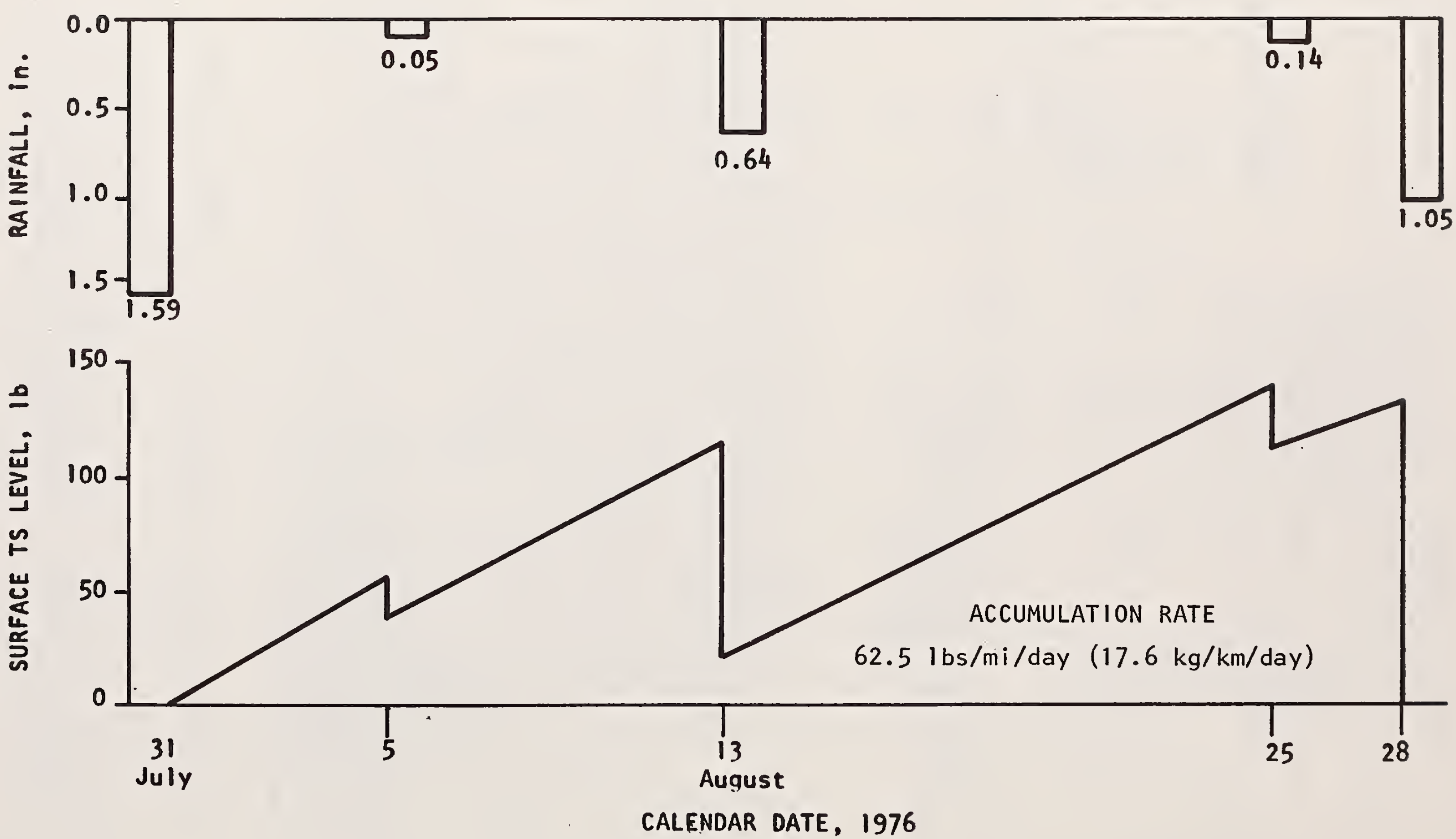


Figure 2. Surface total solids level, Milwaukee - Hwy I-794.

Table 9. Total solids per runoff rate by rainfall category at the Milwaukee, I-794 site, 1976.

Total rainfall category, in.	Date	Total rain, in.	Runoff rate in./hr	Total solids monitored, lb		Total solids per runoff rate, lb/(in./hr)
0.05 - 0.10	8/5	0.05	0.053	14		264.2
0.11 - 1.00	6/18	0.90	0.213	87		408.5
	7/28	0.33	0.093	45		483.9
	8/13	0.64	0.107	94		878.5
	8/25	0.14	0.063	29		460.3
	9/9	0.85	0.124	98		790.3
	9/19	0.30	0.032	28		903.2
					Mean	654.1
>1.00	7/30	1.59	0.341	359		1052.8
	8/28	1.05	0.225	135		600.0
					Mean	826.4

metric units: inches x 2.54 - cm
lb x 0.454 = kg

Table 10. Total solids washoff using Method 2 at the Milwaukee, I-794 site, 1976.

Date	Total rainfall, in.	Runoff rate, in./hr	Predicted total solids wash-off, lb	Monitored total solids wash-off, lb
5/5	2.15	0.581	--	
5/10	0.15	0.187	122	
5/15	0.90	0.074	48	
5/28	0.63	0.240	157	
5/30	0.10	0.290	8	
6/13	0.58	0.138	90	
6/18	0.90	0.213	139	87
6/24	0.05	0.021	6	
6/27	0.05	0.027	7	
7/28	0.33	0.093	61	45
7/30	1.50	0.341	282	359
8/5	0.05	0.053	14	14
8/13	0.64	0.170	70	94
8/25	0.14	0.063	41	29
8/28	1.05	0.225	186	135
9/1	0.39	0.091	60	
9/9	0.85	0.124	81	98
9/19	0.30	0.032	21	28
10/5	1.20	0.064	53	
			1440' lbs accumulated[a]	

a. Sum was calculated substituting monitored values for predicted values whenever possible.

metric units: in. x 2.54 = cm
lb x 0.454 = kg

why errors in estimating pollutant wash-off occur if only one average is used.

The minimum runoff duration that can be used in calculating average runoff intensity is 0.5 hours. Short duration flows, less than 0.5 hours, are often the result of small storms producing less than 0.1 inches (.25 cm) of flow. Using the high average runoff rates calculated from such storms gives more weight to the pollutant wash-off ability of a small storm than occurs. For this reason, all storms used in the predictive procedure were considered to have a duration of at least 0.5 hours, eliminating overestimates of total solids wash-off for short duration storms. For example, a storm producing 0.05 inches (.12 cm) of runoff in 0.17 hours (10 minutes) would have an average runoff rate calculated using an adjusted runoff duration of 0.5 in./hr as follows:

$$\text{Average runoff rate} = 0.05 \text{ inches of flow} \div 0.5 \text{ hours}$$
$$= 0.10 \text{ in.hr } (0.25 \text{ cm/hr})$$

Otherwise the average rate calculated from the actual runoff duration (0.17 hr) would be 0.29 in./hr (0.73 cm/hr) and would cause a large overprediction of pollutant wash-off.

Comparison of predicted total solids wash-off to monitored total solids wash-off of Table 10 shows that values comparable to estimated total solids are obtained using the rainfall category breakdown and short duration storm adjustment for wash-off of unmonitored events.

K_1 factors developed from monitored data during the subject study are listed in Table 11.

Method 1 (all events monitored) and Method 2 (all events not monitored), give comparable results at I-794 and Hwy 45. Use of Method 2 appears to give reasonable estimates of pollutant accumulation (K_1) when Method 1 cannot be implemented. However, Method 2 does not provide good K_1 estimates when dry periods of greater than 20 days are contained within the period of analysis. The factor, pounds of pollutants per runoff rate, does not account for dry days. Using Method 2, estimated total pounds of pollutant wash-off for an unmonitored event with a 0.5 in./hr (1.27 cm/hr) runoff rate and one dry day will be the same as an unmonitored event with a 0.5 in./hr (1.27 cm/hr) runoff intensity and forty dry days. Method 2 will under-predict where long dry periods are involved.

Denver, having an arid climate, is an example of a site where Method 2 cannot be used with confidence. During the summer monitoring period of 1976, only two large storms appeared in the rainfall record. This period was used to calculate K_1, 189.3 lb/mi-day (53.4 kg/km-day). Within this rainfall record was a 42 day dry period. K_1 is probably

Table 11. K_1 values for monitoring sites.

Site	Average daily traffic, vehicles	K_1 value, lb/mi-day			
		1976		1977	
		All events monitored	All events not monitored	All events monitored	All events not monitored
I-794	53,000	63.5	62.7	96.3	100.0
Hwy 45	85,000	172.5	120.2	367.7	368.9
Harrisburg I-81	24,000	*	270.2	*	62.8
Nashville I-40	88,000	*	210.8	*	347.3
Denver I-25	149,000	*	189.3	*	90.0

K_1 = lb/mi-day = (0.28 kg/km-day)
* - The rainfall record did not contain a period between two large storms for which all events were monitored.

underestimated as this site has an average daily traffic almost three times that of I-794 in Milwaukee. During 1977, there was only one large storm event in the Denver rainfall record. The calculated K_1 value of 90.0 lb/mi-day (25.4 kg/km-day), was estimated using the largest available rainfall, 0.65 inches (1.65 cms) over a 13.5 hour duration, at the start of the analysis period. Because of the long dry periods and lack of large storms in the rainfall record, the site specific K_1 values for Denver were not acceptable for use in the predictive procedure, rather, a general K_1 for Type II sites was used.

Construction activity occurred near the monitoring sites at Hwy. 45 (Milwaukee) and I-40 (Nashville) in 1977. K_1 values for this period reflect this construction activity, and these values were not used in the development of the predictive model. At Harrisburg, 1976 was the first year of highway use after construction and this probably influenced the high K_1 value for this site. The K_1 value appears to reflect some residuals from highway construction, and therefore, was not used in the development of the predictive model.

The 1976 K_1 value for Nashville, 210.8 lb/mi-day (59.4 kg/km-day), is based upon the only available data for the year, the month of October. Findings at Milwaukee I-794 indicate little variation in accumulation rates during summer periods. At I-794 the K_1 calculated using Method I for the period 6/18/76 - 7/30/76 was 64.1 lb/mi-day (18.1 kg/km-day) and the K_1 for the period 7/31/76 - 8/28/76 was 62.5 lb/mi-day (17.6 kg/km-day). Therefore, the Nashville 1976 K_1 value is probably representative of the entire summer period. The 1976 K_1 value is used at Nashville for predictive procedures because of the construction activity which occurred during 1977. Based upon average daily traffic (Table 11), the 1976 K_1 value at Nashville appears reasonable.

The K_1 values used in predictive model for nonconstruction events are listed in Table 12.

Table 12. Predictive procedure K_1 values.

Site	K_1, lb/mi.-day	Value obtained by:
Milwaukee I-794	75.6	Weighted average for K_1 values (Method 1), 1976-77
Milwaukee Hwy 45	172.5	1976 K_1 value (Method 1)
Harrisburg I-81	62.8	1977 K_1 value (Method 2)
Nashville I-40	210.8	1976 K_1 value (Method 2)

metric units: lb x 0.454 = kg
mi x 1.609 = km

Wherever possible the Method I K_1 value is used to the exclusion of K_1 values estimated using unmonitored events (Method 2). It is felt that the K_1 values in Table 12 best represent the total solids accumulation within the monitored highway systems under normal maintenance and operation.

K_1 Values in the Literature

The total solids accumulation rates for streets and highways which appeared in a literature review of water quality impacts of highway operations and maintenance (7) are presented in Table 13.

When making comparisons of the above total solids accumulation data, two things must be kept in mind: 1) city streets generally accumulate more total solids because of increased sources from which total solids may be obtained, and 2) sweeping or a combination of sweeping and flushing usually accounts for more total solids than an analysis of surface runoff. The K_1 values developed in this report reflect total solids available to be washed off in surface runoff.

Previously developed K_1 factors (Table 12), which ranged from 62.8 lb/mi-day at the Harrisburg site to 210.8 lb/mi-day at the Nashville site (17.7 to 59.4 kg/km-day) were derived from runoff analysis data. These K_1 factors appear comparable to the total solids accumulation values reported in the literature (Table 13).

Table 13. Published K_1 values.

Total solids accumulation rate, lb/mi-day	Location	Solids collection techniques	Ref.
1580	Chicago City Sts.	Sweeping	(4)
1180	11 U.S. City Sts.	Combined sweeping and flushing	(8)
10.4	Seattle Highway	Runoff analysis	(9)
382	Washington, D.C. Hwy.	Vacuuming and flushing	(10)
69.4	Seattle Highway	Runoff analysis	(11)
26.6	Seattle Highway	Runoff analysis	(12)

metric units: lb x 0.454 = kg
mi x 1.609 = km

A total solids accumulation rate of 54.5 lb/mi-day (15.4 kg/km-day) was calculated from runoff analysis data reported in a highway runoff study in Dallas, Texas (13) using an average Q/R of 0.90 and Method 1. The Texas study site is characterized as Type 1. The elevated highway section at this site drains slightly more than two acres (0.8 ha). The total solids accumulation rate at the I-794 site (Milwaukee) was 75.6 lb/mi-day (21.3 kg/km-day) which appears comparable to the Texas accumulation rate if the differences in average daily traffic of 53,000 vehicles per day at Milwaukee are compared to the 30,000 vehicles per day at Texas.

K_1 Selection Based on Site Characteristics

A comparison of total solids accumulation values (K_1) with site characteristics for four of the monitoring sites is presented in Table 14.

These accumulation rates represent those that are derived from "normal" highway operation and maintenance. As explained previously, K_1 factors for years which had construction activity on or near the monitoring site were not used. The rainfall record at the Denver site prevented a reliable estimate of K_1, and therefore, those total solids accumulation rates will not be used in the regression analyses to develop equations relating K_1 to site characteristics. The selection of a K_1 value for sites other than those listed above require some type of relationship for the predictive procedure to calculate a site specific K_1. Regression analyses using the data from the sites monitored during this project were used to develop an equation to predict K_1. The results of regression analysis using K_1 as the dependent variable, and average daily traffic (ADT) and dustfall as the independent variables are presented in Table 15.

Table 14. Comparison of total solids accumulation rates and site characteristics.

Site	Total solids accumulation, lb/mi-day	Average daily traffic, vehicles/day	Dustfall, $g/m^2/day$	Barrier type
Harrisburg I-81	62.8	24,000	0.06	Flush
Milwaukee I-794	75.6	53,000	0.43	Barrier
Milwaukee Hwy 45	172.5	85,000	0.21	Mountable curb
Nashville I-40	210.8	88,000	0.31	Mountable curb

metric units: lb x 0.454 = kg
mi x 1.609 = km

Table 15. Regression analysis results for K_1 (dependent variable), and ADT and dustfall (independent variables).

Variable relationship	Independent variable	Sign of regression coefficient	R	R^2
Linear	ADT	+	0.93	0.87
	Dustfall	+	0.17	0.03
	ADT, Dustfall	+,-	0.96	0.93
Semilog	ADT	+	0.87	0.75
	Dustfall	+	0.41	0.17
	ADT, Dustfall	+,-	0.95	0.91
Log	ADT	+	0.90	0.81
	Dustfall	+	0.14	0.02
	ADT, Dustfall	+,-	0.97	0.95

Because of the small number of cases (n-4), nothing can be said statistically about the correlation of K_1 with average daily traffic and dustfall. The purpose of performing the regression analysis was to provide the best equation with the available data. However, average daily traffic appears to show a strong relationship with K_1 values when these two parameters are graphed (Figure 3). The computed K_1 for Dallas (13) was included as an additional point for comparison. Based upon the graph, ADT within the range of 25,000 to 90,000 vehicles per day appears to give reasonable estimates of K_1.

Regression analyses using the monitored dustfall data obtained during this study, show dustfall to be a poor estimator of K_1 (low R^2 values). In fact, when analyzed in combination with ADT, the regression analyses show a negative relationship to K_1 (negative regression coefficient). This means that as the dustfall increases the accumulation of total solids decreases. This relationship is contrary to the positive relationship which would be expected between dustfall and K_1. These results are probably due to the small number of sites (n=4) which could be used in the regression analyses. Therefore, no equation is used in the predictive procedure to predict K_1 from dustfall alone (because of low R^2 values) or in combination with ADT (because of negative regression coefficients).

Barrier type is difficult to quantify, but probably has some effect on total solids accumulation. With a flush shoulder on a highway, there is nothing to restrict total solids from being blown off. Mountable curbs provide some restriction while side barriers help to retain a greater proportion of the total solids than mountable curbs or flush shoulders. Because of the limited data, an evaluation of the effect of curb type on K_1 values estimated for the study sites cannot be made.

For those cases in which a site specific K_1 value is not available, the predictive procedure uses ADT to calculate the appropriate total solids buildup rate using the following equation;

$$K_1 = (ADT^{0.89})\ 0.007 \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

WASH-OFF COEFFICIENT (K_2) DEVELOPMENT

The coefficient K_2 is used in the predictive procedure to remove a portion of the carrier pollutant from the surface of the drainage area. The general wash-off equation that is used in the Corps of Engineers STORM model (3) and EPA Stormwater Management Model (14) is used in this procedure in the following form:

$$P_D = P\ (1-e^{-K2r}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where: P_D = pounds (kilograms) of pollutant discharged
P = surface load at start of the runoff event (Equation 2)
K_2 = wash-off coefficient
r = average runoff rate, in./hr (cm/hr)

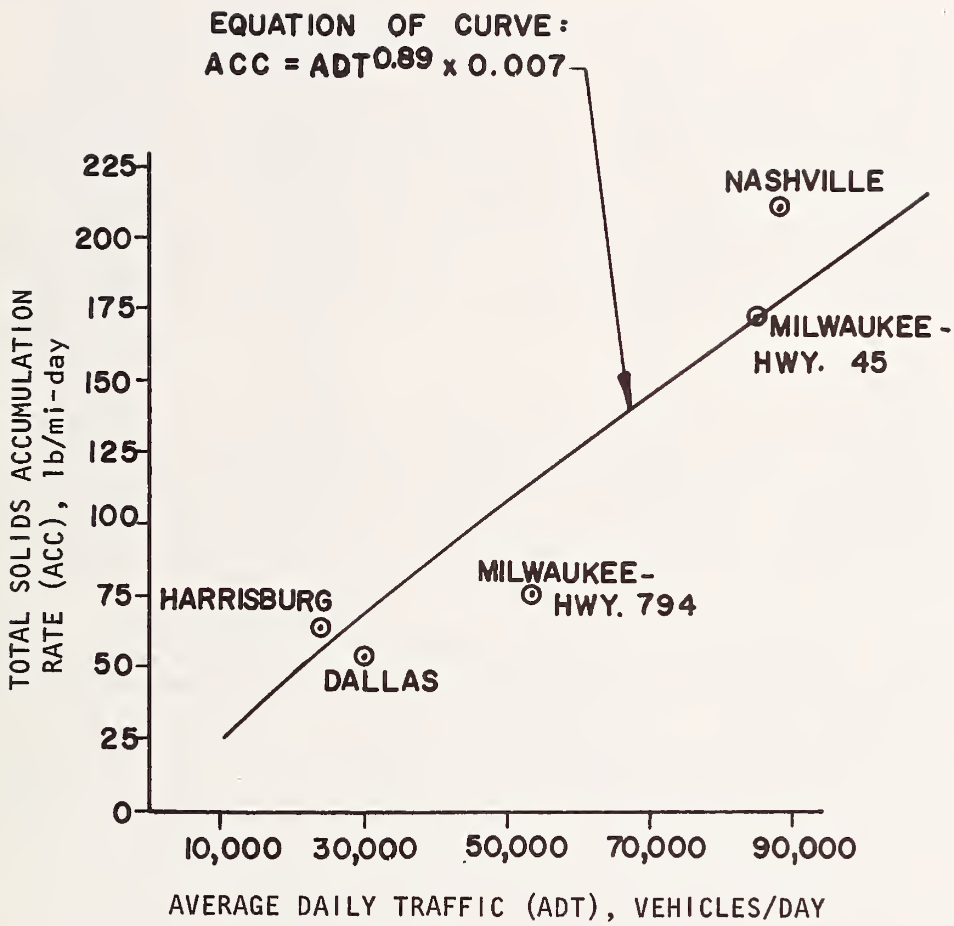


Figure 3. Selected total solids accumulation rates versus average daily traffic.

The terms of Equation 4 were determined in the following manner. P is the calculated pounds of the carrier pollutant, total solids, on the surface of the drainage area from Equation 2. The average runoff rate (r) is calculated using Equation 1 and the equation for flow duration. K_2 is selected based upon the drainage area configuration (Type I, II or III). Equation 4 utilizes the average runoff rate because it showed the best correlation to discharge loads monitored at each site.

A sensitivity analysis based upon a comparison of predicted and measured total solids was used to develop K_2 values for each site. For a series of monitored events at a particular site, the build-up and wash-off equations (2 and 4) were applied using different K_2 values to determine the best fit for the total of all events. For the preliminary analysis, a range of K_2 values from 1 to 20 was selected because this range was thought to include the wash-off potential that could be expected for highway sites. A K_2 of 1 will remove 22 percent of the available pollutant land when r is equal to 0.25 inches per hour (0.63 cm/hr), while a K_2 of 20 removes 99 percent with the same r value.

Table 16 presents the results of applying a K_2 value of 1 and 20 to actual runoff and dry day data for the Milwaukee I-794 site. The K_1 value used in this analysis was 63 lb/mi-day (17.2 kg/km-day) as developed previously. This sensitivity analysis shows that a K_2 value of one washes off 777.3 lb (352.6 kb) of total solids, while a K_2 value of 20 approximately doubles the pounds washed off.

Figure 4 shows a graph of the measured total solids discharged for nine monitored events and the corresponding computed values during 1976 at Milwaukee I-794. To determine the operating range of K_2, values (1, 5, 8 and 20) were selected for analysis in order to under and over predict the measured data. From the Figure, it can be seen that the K_2 values of 1 and 20 did not provide good estimates of the total solids washed off, while K_2 values of 5 and 8 provided better estimates. This same procedure was used for the other monitoring sites. The monitored rainfall events in which total solids were measured at each site were compared to predicted total solids using K_2 values that ranged from 1 to 20. Those values that were closest to the sum of the measured values were then graphically compared to individual events as shown in Figures 4 to 11. The range of K_2 values that were selected for each site are presented in Table 17.

For purposes of the predictive procedure, a single K_2 value was required for each of the three site categories. The values in Table 17 are generally in the range of 5-8 with the exception of Harrisburg. Based upon the comparison of individual K_2 values with actual monitoring data, the K_2 value of 6.5 was selected as representative of the Milwaukee Highway 45, Nashville and Denver sites which contain some type of curb or barrier, structured drainage and grassy right-of-way (Type II). For the Harrisburg site a value of 12 was selected as

Table 16. K_2 sensitivity at Milwaukee I-794.

Date	Runoff, in.	Dry days	K_2=1, pounds washed-off	K_2=20, pounds washed-off
5/10/76	0.187	5	8.1	46.1
5/15/76	0.074	5	6.2	37.4
5/28/76	0.240	13	43.3	132.8
5/30/76	0.290	2	5.0	8.7
6/13/76	0.138	14	39.3	134.4
6/18/76	0.213	5	60.3	55.6
6/24/76	0.021	6	6.4	19.5
6/27/76	0.027	3	8.6	27.4
7/28/76	0.093	31	54.6	280.0
7/30/76	0.341	2	167.7	70.7
8/5/76	0.053	6	24.4	37.2
8/13/76	0.107	8	51.0	77.7
8/25/76	0.062	12	34.6	88.3
8/28/76	0.225	3	114.1	63.1
9/1/76	0.091	4	42.7	32.3
9/9/76	0.124	8	61.0	75.0
9/9/76	0.031	10	17.1	47.2
10/5/76	0.064	16	42.9	148.5
Total	--	--	777.3	1371.9

metric units: lb x 0.454 = kg
in. x 2.54 = cm

Table 17. Range of K_2 values for each monitoring site.

Site	K_2
Milwaukee I-794	5-8
Milwaukee Hwy 45	5-8
Harrisburg I-81	4-20
Nashville I-40	5-8

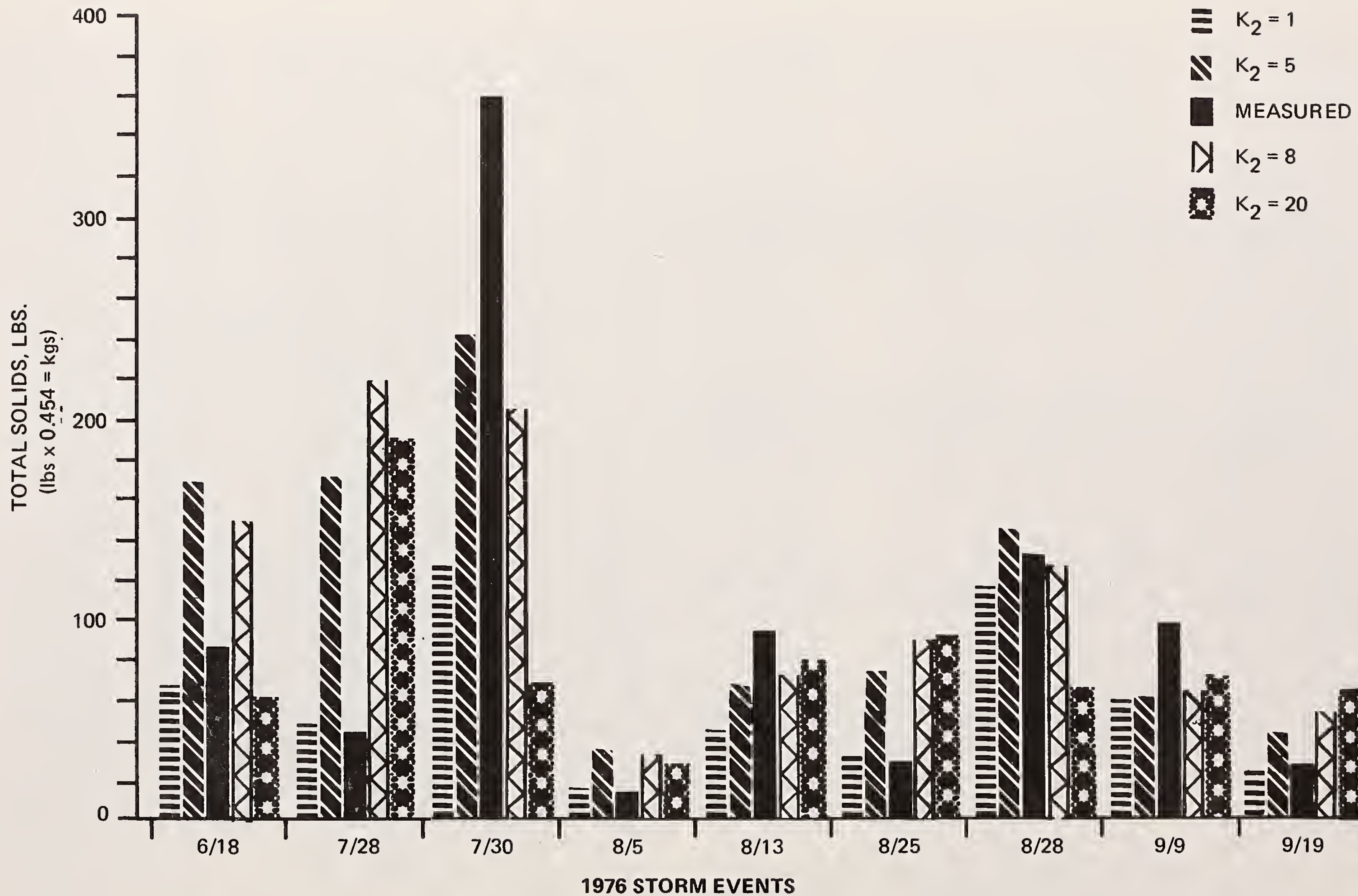


Figure 4. Milwaukee I-794 K_2 sensitivity, 1976.

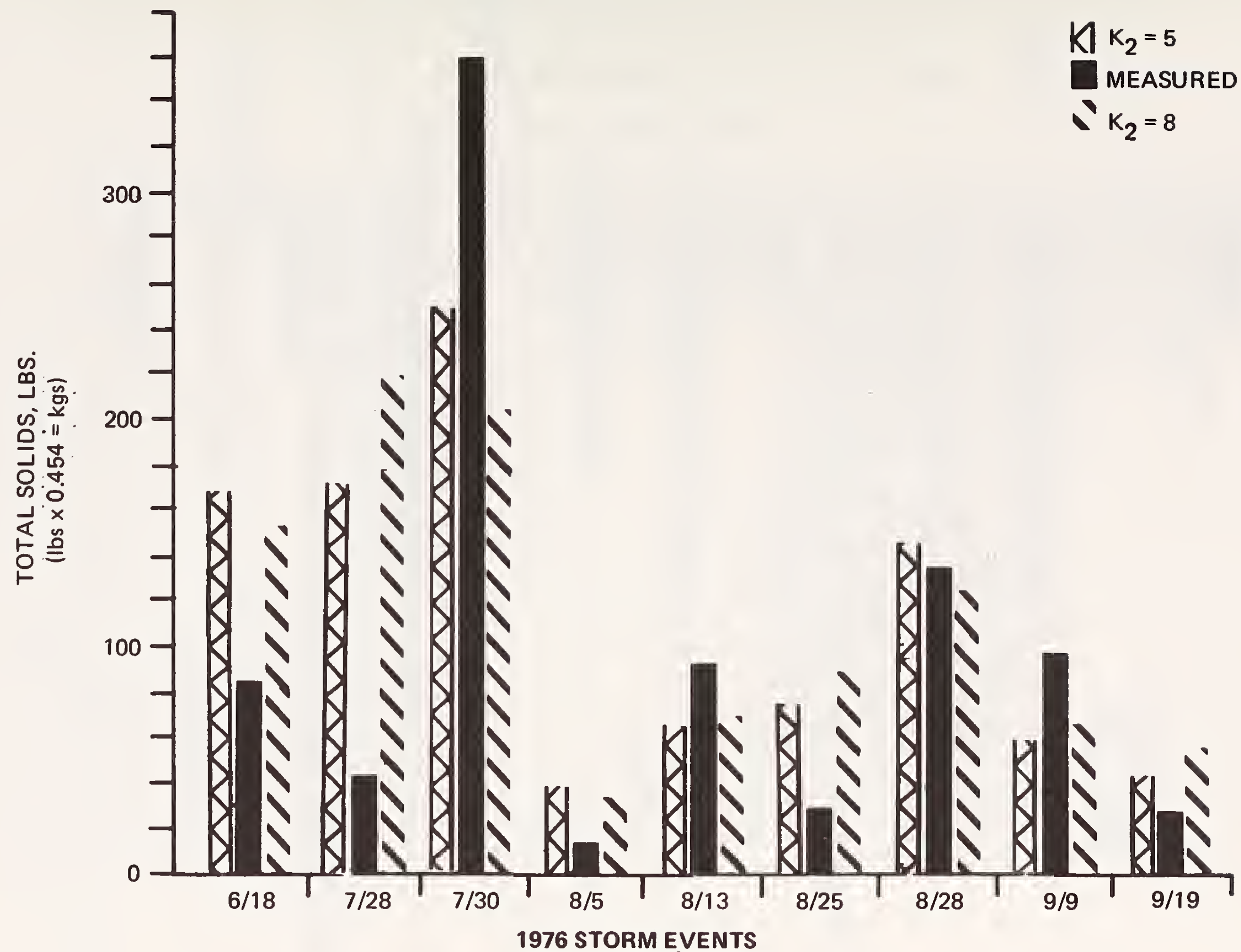


Figure 5. Milwaukee I-794 K_2 selection, 1976.

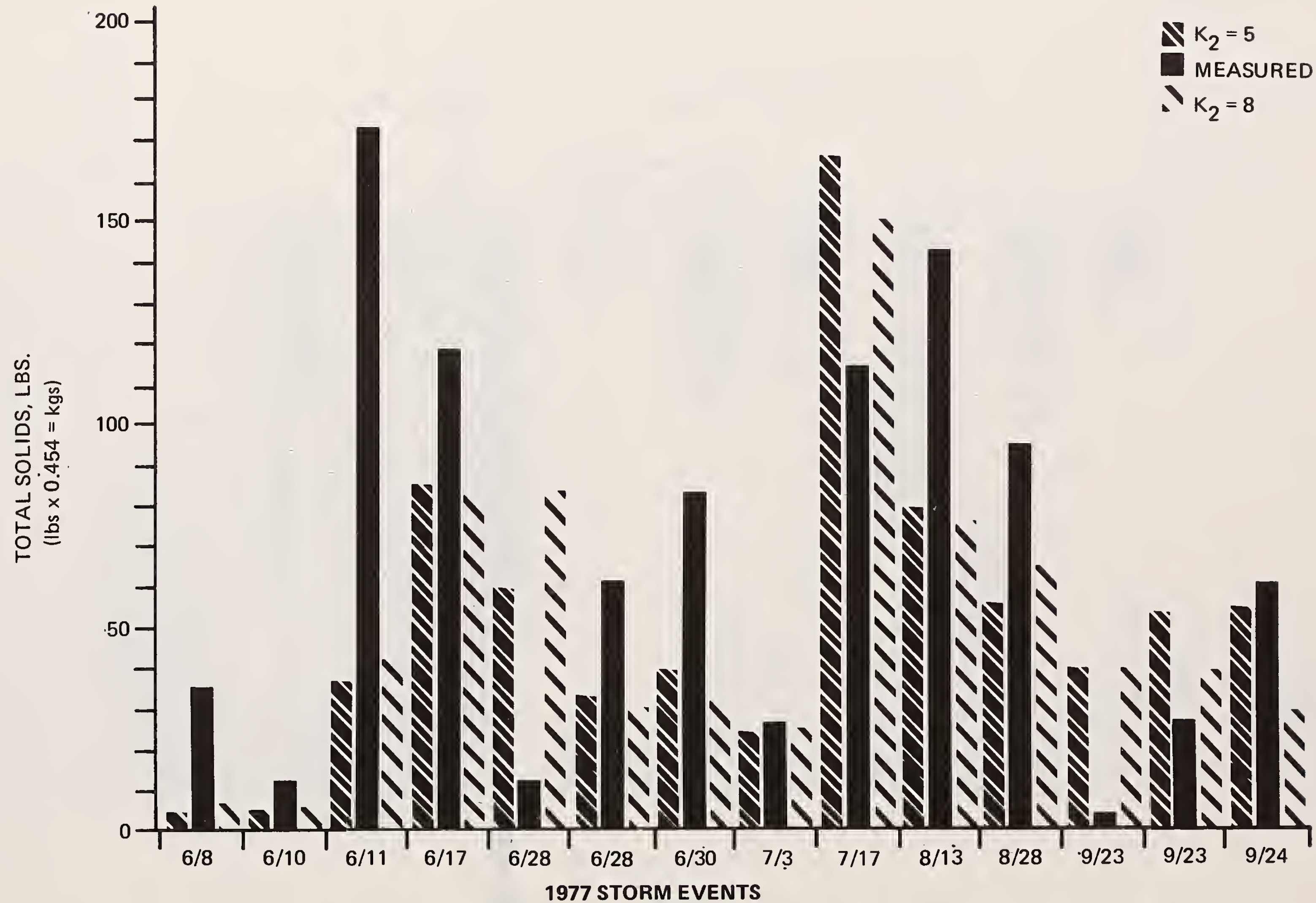


Figure 6. Milwaukee I-794 K_2 selection, 1977.

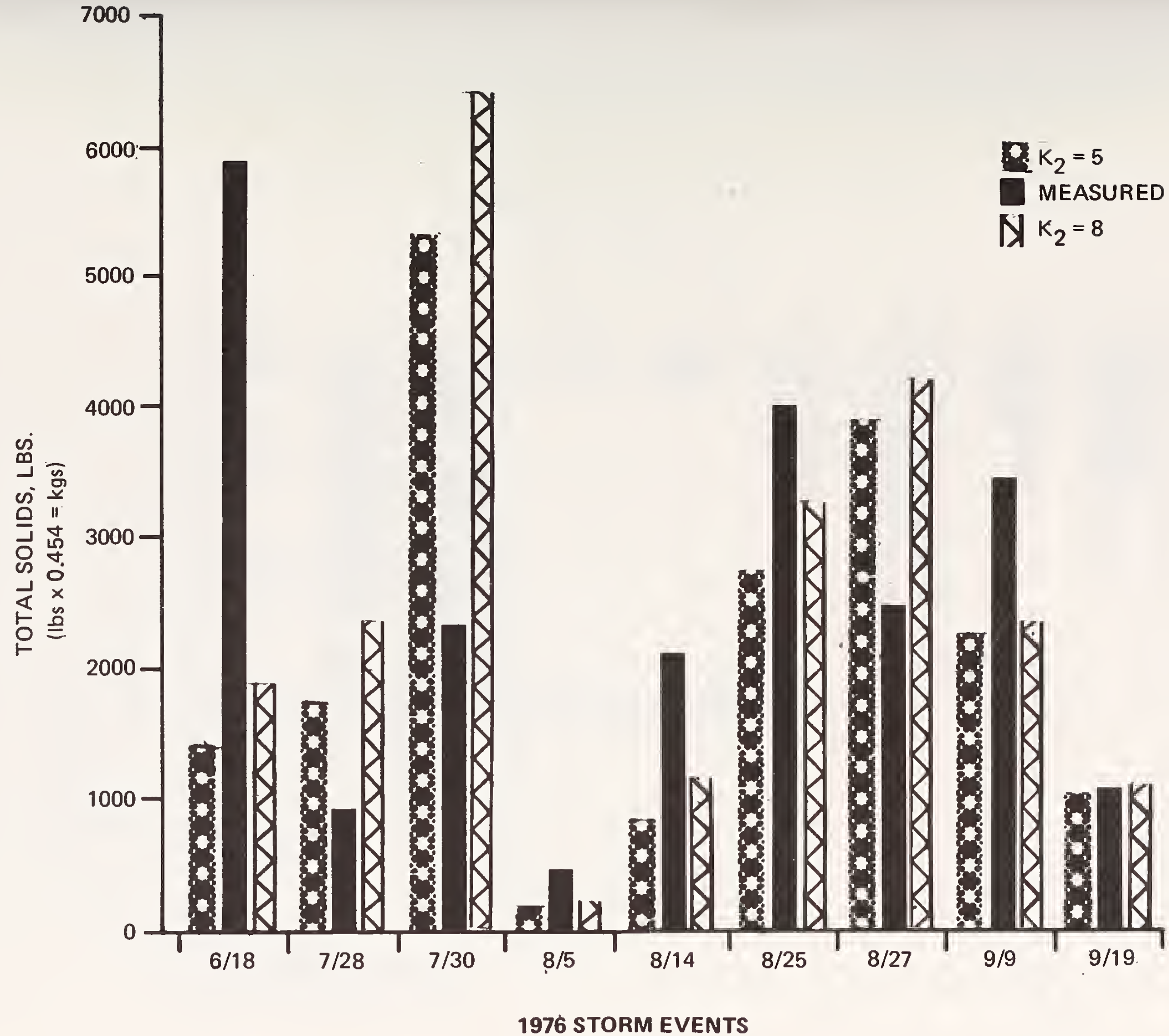


Figure 7. Milwaukee Hwy. 45 K_2 selection, 1976.

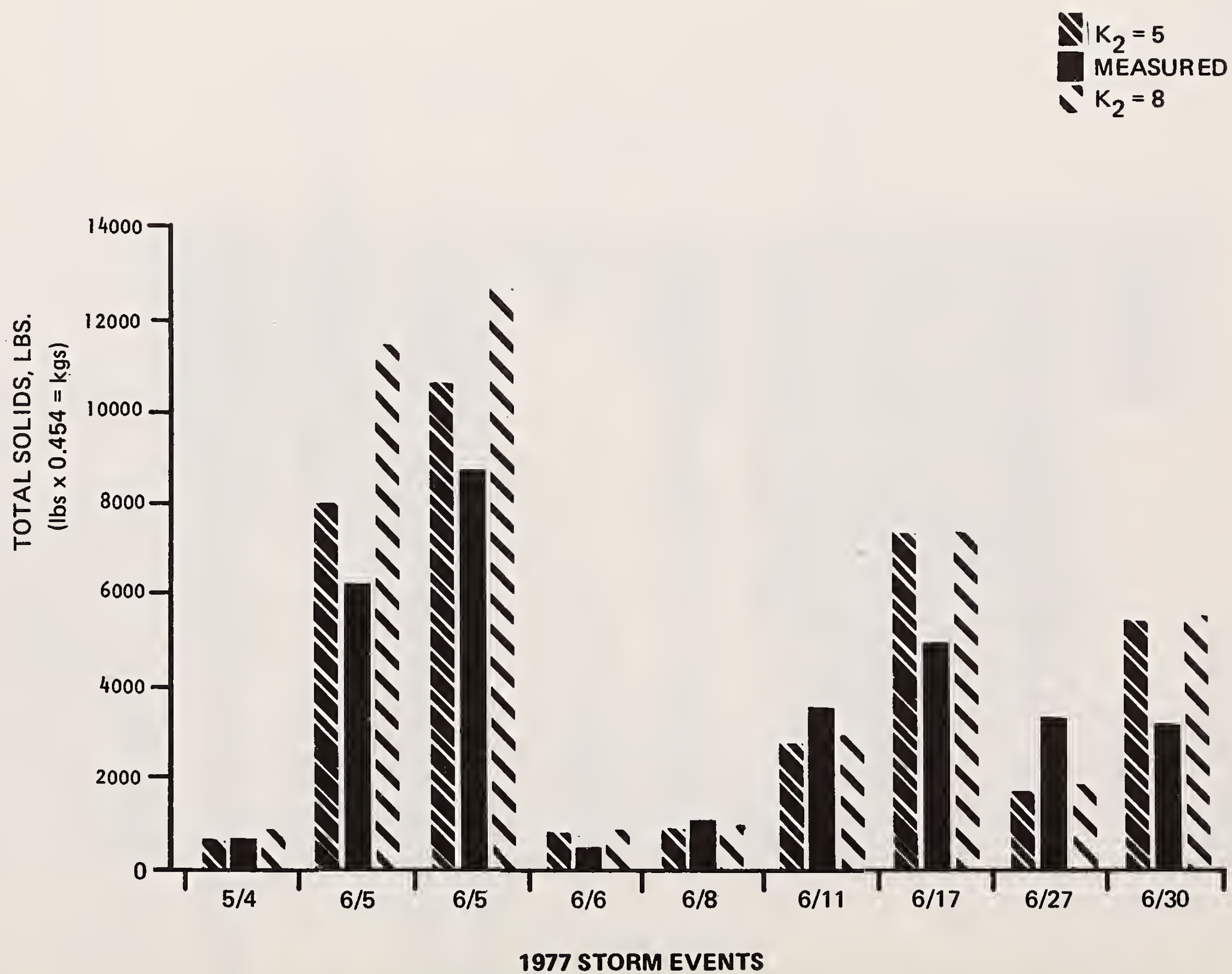


Figure 8. Milwaukee Hwy. 45 selection, 1977.

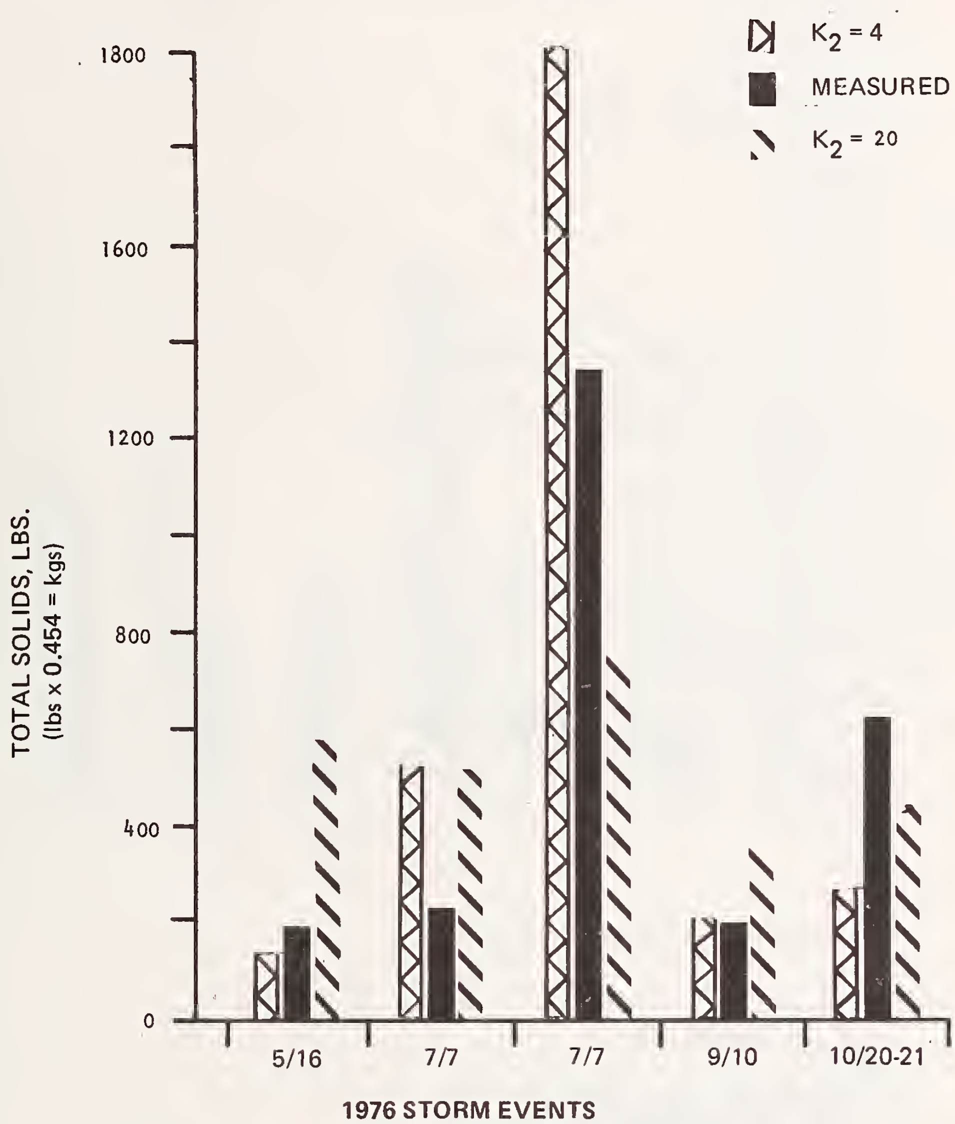


Figure 9. Harrisburg K_2 selection, 1976.

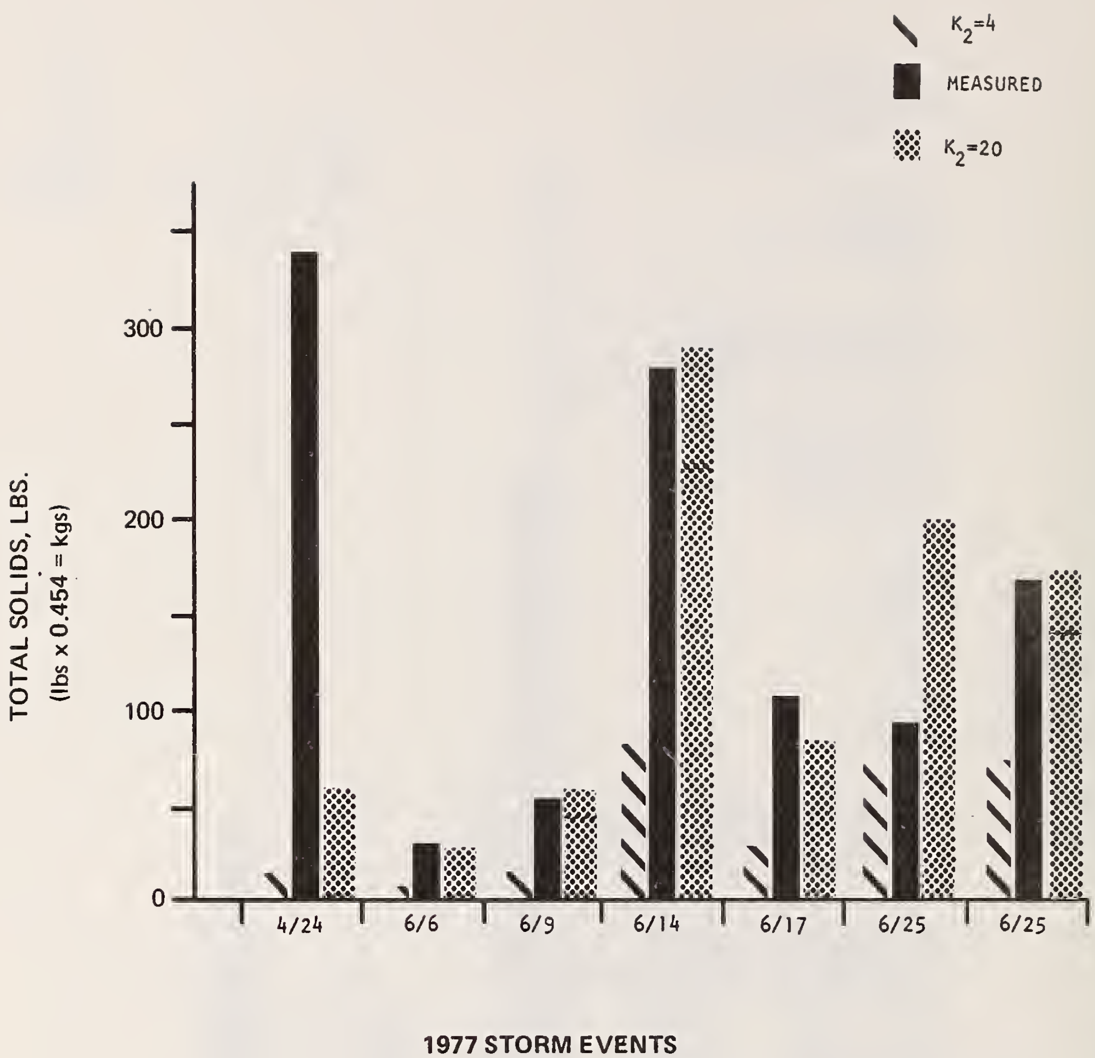


Figure 10. Harrisburg K_2 selection, 1977.

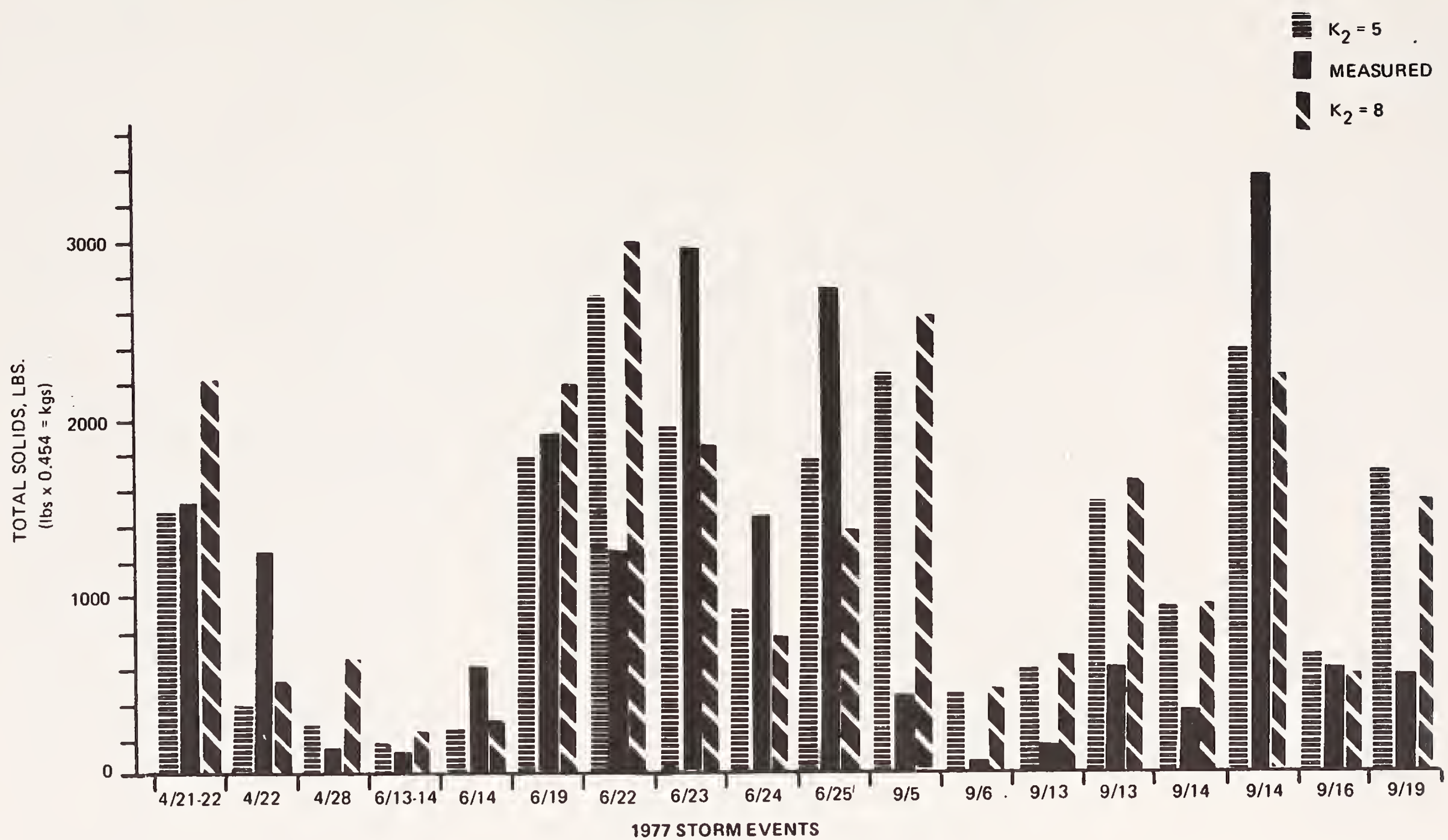


Figure 11. Nashville K_2 selection, 1977.

representative of a rural, flush shouldered site which uses grassy ditch conveyance for the surface runoff. A K_2 value of 5.0 was selected for the Milwaukee I-794 site. This value will be used for all elevated bridge decks which are completely paved. A summary of these values for each site type is presented in Table 18.

Table 18. K_2 values used in predictive procedure.

Site type	K_2
Type I	5.0
Type II	6.5
Type III	12.0

The Type III site requires the highest K_2 value in order to wash off larger amounts of the pollutant load per runoff volume than other sites. The flush shoulder and the nonpaved drainage conditions which characterize this site type probably account for the high value in that more pollutant wash-off is required per event to remove the pollutant load contained within the grassy areas adjacent to the roadway. The Type I site has the lowest K_2 value which indicates that it is easier to wash off pollutants from a site which is all paved than a site which has both paved and unpaved areas (Type II and III).

The data used in the selection of these K_2 values are listed in Appendix B, Tables B-1 - B-4. These tables present the predicted and measured total solids values for each K_2 in the selected range of values on Table 17. It must be pointed out that the values in these tables are based upon nonwinter conditions and that more emphasis is placed upon nonconstruction years (1976 at Milwaukee Hwy. 45 and 1977 at Nashville). Small differences between individual total loads for each K_2 value were neglected in assigning the three site specific K_2 values.

CONSTITUENT LOADINGS

The final component of the predictive procedure transforms the pounds of total solids washed off into pounds of lead, COD, suspended solids or any other of the 16 quality constituents available in the model. The resulting loadings may be used to evaluate the impact of these discharges on the receiving water or to evaluate the loads as required by special model application. A general approach for determining the relative impact of these loadings on the receiving water is discussed in Section V (page 88).

The prediction of heavy metals, nutrients, solids and other parameters for individual storm events relies upon the correlation of measured total solids loads to the measured loads for each of the remaining parameters. Tables 19 and 20 present the results of each of these linear regressions in the form of an equation for predicting each parameter as a function of the total solids load for each site. For

Table 19. Constituent equations developed for Type I and Type III sites.

Parameter		Type I Milwaukee I-794	Type III Harrisburg I-40
SS	=	0.53TS - 3.2*	0.32TS - 36.8*
VSS	=	0.191TS + 0.2*	0.061TS-3.3*
TVS	=	0.221TS + 13.3	0.32TS - 32.3*
TKN	=	3.3×10^{-3} TS + 0.16	3.1×10^{-3}TS+ 0.55*
BOD	=	0.023TS + 1.5*	N/A
TOC	=	0.057TS + 0.80*	0.068TS - 5.85*
COD	=	0.202TS + 5.47*	0.087TS + 0.65*
TN	=	1.37×10^{-3} TS + 0.12	1.83×10^{-3} TS+0.054*
TPO_4	=	1.0×10^{-3} TS + 3.0×10^{-4}	2.15×10^{-3}TS - 0.245
Cl^-	=	0.034TS + 2.59	0.135TS + 2.6*
Pb	=	5.6×10^{-3}TS - 0.024	4.1×10^{-4}TS - 0.029*
Zn	=	8.4×10^{-4}TS + 0.014	2.67×10^{-4}TS-0.011*
Fe	=	0.015TS + 0.59	0.014TS - 1.61*
Cu	=	2.9×10^{-4}TS+7.3×10^{-4}	7.4×10^{-5}TS+8.78×10^{-3}*
Cd	=	1.4×10^{-4}TS-1.4×10^{-3}	4.0×10^{-5}TS+0.007
Cr	=	1.6×10^{-4}TS+1.2×10^{-3}	2.3×10^{-4}TS-0.028
Hg	=	-7.6×10^{-7}TS+8.8×10^{-4}	-5.8×10^{-6}TS+0.015*

Note: TS = total solids (lb)
* - Variables correlate at the 95 percent confidence level.
metric units: lb x 0.454 = kg

Table 20. Constituent equations developed for Type II sites.

Parameter	Milwaukee Hwy. 45	Nashville I-80	Denver I-25
SS	0.70TS - 525*	0.48TS - 4.3*	0.71TS - 33.7*
VSS	0.132TS + 36*	0.214TS - 5.6*	0.109TS + 10.2*
TVS	0.204TS + 680	0.423TS + 3.34*	0.163TS + 46.9*
TKN	8.1×10^{-3}TS + 4.8	7.9×10^{-3}TS - 0.86*	5.4×10^{-3}TS - 0.08*
BOD	0.0065TS + 26.4*	0.058TS - 9.56*	0.026TS + 11.5*
TOC	0.027TS + 30*	0.045TS + 27.3*	0.096TS + 18.4*
COD	0.083TS + 129*	0.17TS + 96.5*	0.326TS + 49.8*
TN	7.1×10^{-4}TS + 1.8*	9.9×10^{-4}TS + 0.59*	2.2×10^{-3}TS - 0.25*
TPO_4	7.66×10^{-4}TS - 0.41*	4.7×10^{-3}TS - 0.49	1.3×10^{-3}TS - 0.05*
Cl	0.084TS + 232*	0.017TS + 17.5*	0.025TS + 10.5*
Pb	9.9×10^{-4}TS - 0.05*	8.7×10^{-4}TS + 0.25	1.2×10^{-3}TS - 0.08*
Zn	3.67×10^{-4}TS + 0.199*	5.25×10^{-4}TS + 0.09*	8.6×10^{-4}TS - 0.02*
Fe	0.021TS - 12.4*	0.013TS - 0.67*	0.025TS - 1.43*
Cu	6.0×10^{-4}TS + 0.128*	1.1×10^{-4}TS + 0.09	2.4×10^{-4}TS - 0.026*
Cd	2.7×10^{-5}TS + 0.057*	6.2×10^{-5}TS + 0.01*	3.6×10^{-5}TS - 2.3×10^{-3}*
Cr	3.3×10^{-5}TS + 0.103	2.4×10^{-5}TS + 0.01*	6.9×10^{-5}TS - 4.1×10^{-3}*
Hg	4.8×10^{-6}TS + 2.8×10^{-4}	1.66×10^{-6}TS + 1.2×10^{-3}	8.6×10^{-7}TS + 1.7×10^{-3}*

Note: TS = total solids (lb)
* - Variables correlate at the 95 percent confidence level
metric units: lb x 0.454 = kg

example, the determination of the COD load for the Milwaukee I-794 site is as follows:

COD (lb) = 0.202 TS + 5.47
where: TS = total solids in pounds

The asterisk in Tables 19 and 20 next to some equations indicates significance at the 95 percent confidence limits (1). This indicates that one can be 95 percent confident that the sample was not selected from a population for which no correlation exists (i.e. that the coorelation coefficient R is equal to zero). An equation may still provide good estimates even if the variables in that equation do not show a significant correlation at the 95 percent confidence level. In fact, an equation developed using regression techniques is the best fit model of the data being analyzed. For this reason, all the equations developed to predict various pollutant parameters from total solids will be used in the predictive procedure. The asterisks were used in Tables 19 and 20 only to indicate the relative strength of the correlation between the variables in each equation. However, most of the variables did show a correlation at the 95 percent confidence level.

The predictive procedure will use a separate constituent equation for each general site type. Individual equations are required to account for differences between sites in drainage and solids retention characteristics. Table 21 provides the calculated loading for each of the five monitoring sites using individual constituent equations from Tables 19 and 20 and a general site equation for Type II areas. Suspended solids, COD, lead, iron, and TPO_4, are listed to evaluate the individual loadings. A given range of total solids loads varying from 500 to 10,000 pounds is used to determine the constituent load for the above parameters. The numerical average of the three locations comprising Type II sites, as well as the results for a general Type II site equation from Table 20 are also listed to provide an indication of the accuracy of each approach. The site specific equations provide zero loadings for the Milwaukee Hwy. 45 site for some parameters when less than 500 pounds of total solids are available. The regression equations used to develop these relationships are based upon actual monitoring data which did not include a runoff event with less than 490 pounds of total solids. In the same manner, the TPO_4 loads are not accurate at the 2,000 to 10,000 pound load range since no actual data points of this magnitude were available to produce the predictive equation. To account for these differences, the average equation of Table 22 will be used in the predictive procedure for the Type II sites.

The use of the general Type II site equation as compared to individual Milwaukee, Nashville and Denver equations was checked by comparing the general equation to the site specific equation using the t test. The two equations did not differ at a 95 percent confidence level and

Table 21. Predicted constituent loads using site specific equations and average equations.

Total solids pounds	Milwaukee I-794	Harrisburg I-40	Nashville I-80	Denver I-25	Milwaukee Hwy 45	Average load Nash + Den + Milw 45	General type II site equation for Nash - Den - Milw 45 combined
				SUSPENDED SOLIDS - pounds			
500	261	124	237	319	0	185	165
1,000	525	285	479	671	176	442	471
2,000	1053	607	962	1376	877	1071	1084
10,000	5277	3183	4826	7016	6485	6109	5988
				COD - pounds			
500	29	29	182	213	170	188	223
1,000	58	63	267	376	212	285	267
2,000	115	132	437	702	294	478	354
10,000	572	682	1797	3310	954	2020	1049
				LEAD - pounds			
500	2.98	0.17	0.51	0.52	0.45	0.49	0.57
1,000	5.98	0.37	1.12	1.11	0.95	1.06	1.05
2,000	11.97	0.77	1.98	2.30	1.95	2.07	2.01
10,000	56.50	4.07	8.90	11.80	9.87	10.20	9.71
				IRON - pounds			
500	6.75	5.19	6.08	11.02	0	5.70	5.40
1,000	14.10	11.99	12.83	23.47	8.20	14.80	14.80
2,000	28.80	25.59	26.33	48.37	29.30	34.70	33.60
10,000	146.40	134.39	134.33	247.57	198.10	193.30	148.00
				TPO_4 - pounds			
500	0.51	0.83	1.87	0.60	0	0.82	1.77
1,000	1.03	1.90	4.25	1.25	0.36	1.95	2.21
2,000	2.06	4.05	8.98	2.55	1.11	4.21	3.09
10,000	10.30	21.20	46.90	12.95	7.25	22.36	10.12

metric units: lb x 0.454 = kg

Table 22. Constituent equations developed for Type II sites.

Parameter	Equation
SS	$0.63TS - 188$
VSS	$0.152TS + 13.5$
TVS	$0.263TS + 243$
TKN	$5.46x10^{-3}TS + 1.28$
BOD	$3.0x10^{-2}TS + 28.3$
TOC	$5.6x10^{-2}TS + 25.2$
COD	$0.193TS + 275.3$
TN	$1.3x10^{-3}TS + 0.713$
TPO_4	$2.25x10^{-3}TS - 0.32$
Cl	$0.042TS + 87$
Pb	$1.02x10^{-3}TS + 0.04$
Zn	$5.84x10^{-4}TS + 0.103$
Fe	$1.96x10^{-2}TS - 5.0$
Ni	N/A
Cu	$3.16x10^{-4}TS + 0.064$
Cd	$4.16x10^{-5}TS + 0.021$
Cr	$4.3x10^{-5}TS + 0.036$
Hg	$2.44x10^{-6}TS + 1.006x10^{-6}$

Note: TS = total solids (lb)
metric units: lb x 0.454 = kg

are used in the model for Type II sites. Large differences in the equations for suspended solids, especially at the Milwaukee 45 site, presents difficulties at low total solids levels. For those events in which the total solids load is less than 300 pounds (136 kg), the suspended solids equation results in negative numbers or zero load. Construction activity at this Milwaukee site during 1977 is the primary reason for the large discrepancy between sites.

Tables 23, 24 and 25 list the calculated and measured lead, and suspended solids values for some of the sites using the Type I site specific and Type II general equations. These data points are determined using the actual measured total solids load for determining each of these parameters. Later discussions in Section IV show how the computed total solids, lead and suspended solids data using the model compares to the corresponding measured data.

Applying the Type I site equation to Milwaukee I-794 monitored total solids data (Table 23) produced calculated values for suspended solids and lead which were comparable to measured values on an event basis. A comparison of the sum for all events of calculated and measured values shows that the Type I site equation over-predicts lead by 3 percent. Similar results were obtained for the Milwaukee Hwy. 45 site (Table 24) using the general Type II site equation. Summing the values for all events showed that suspended solids and lead were over-predicted by 7 and 6 percent respectively.

The Nashville data (Table 25) present a worst case example where a general equation (Type II site) is applied to construction year data. The data show that calculated suspended solids are generally lower than measured suspended solids on an event basis, especially for those events which had low monitored total solids wash-off (less than 100 lb (45 kb)). However, when calculated and measured values for suspended solids were summed for all events, calculated suspended solids were only 8 percent lower than measured. Although considerable variation between calculated and measured suspended solids wash-off occurred on an event basis, the general equation still provided reasonable estimates of suspended solids for the construction year. Overall predicted lead values were 14 percent lower than measured values. A 14 percent difference is acceptable for model prediction.

Table 23. Milwaukee I-794 calculated suspended solids and lead loadings using Type I site equations.

Date	Total solids, lb measured	Suspended solids, lb		Lead, lb	
		Measured	Calculated	Measured	Calculated
6-18-76	87	62	43	0.69	0.46
7-28-76	45	15	21	0.14	0.23
7-30-76	*	*	--	*	--
8-5-76	14	2	4	0.02	0.05
8-13-76	94	40	47	0.85	0.50
8-25-76	29	10	12	0.10	0.14
8-28-76	135	97	68	1.00	0.73
9-9-76	98	36	49	0.37	0.52
9-19-76	28	8	12	0.11	0.13
6-8-77	35	21	15	0.19	0.17
6-10-77	12	3	3	0.03	0.04
6-11-77	173	69	88	0.66	0.94
6-17-77	119	49	60	0.61	0.64
6-28-77	12	4	3	*	--
6-28-77	62	42	30	*	--
6-30-77	84	39	41	0.40	0.45
7-3-77	27	10	25	*	--
7-17-77	115	21	58	*	--
8-13-77	143	*	73	*	--
8-28-77	96	48	48	*	--
9-23-77	5	3	--	*	--
9-23-77	28	13	12	*	--
9-24-77	62	34	30	*	--
Total		623	669	5.17	5.00

Note: * No data available.
metric units: lb x 0.454 = kg

Table 24. Milwaukee Hwy 45 calculated suspended solids and lead loadings using Type II site equations.

Date	Total solids, lb measured	Suspended solids, lb		Lead, lb	
		Measured	Calculated	Measured	Calculated
6-18-76	5886	4306	3520	6.67	6.04
7-28-76	943	518	406	1.43	1.00
7-30-76	2371	1290	1306	2.76	2.46
8-5-76	470	127	108	0.20	0.52
8-14-76	2120	805	1148	2.04	2.20
8-25-76	4029	601	2350	1.56	4.15
8-27-76	2490	1636	1381	4.27	2.58
9-9-76	3498	2010	2016	4.67	3.61
9-19-76	1109	492	511	0.80	1.17
5-4-77	742	135	279	0.40	0.80
6-5-77	6149	3891	3686	8.40	6.31
6-5-77	8670	6151	5274	7.30	8.88
6-6-77	490	82	121	0.20	0.54
6-8-77	1123	428	519	0.80	1.19
6-11-77	3524	1402	2032	1.80	3.63
6-17-77	4849	2974	2867	4.60	4.99
6-27-77	3388	859	1946	2.50	3.49
6-30-77	3173	1416	1811	3.20	3.28
Total		29123	31281	53.60	56.84

metric units: lb x 0.454 = kg

Table 25. Nashville I-40 calculated suspended solids and lead loadings using Type II site equations.

Date	Total solids, lb measured	Suspended solids, lb		Lead, lb	
		Measured	Calculated	Measured	Calculated
4-21&22-77	1559	922	794	2.23	1.63
4-22-77	1265	626	609	1.27	1.33
4-28-77	156	77	0	0.22	0.20
6-13-77	134	28	0	0.11	0.18
6-14-77	605	278	193	0.78	0.66
6-19-77	1943	1272	1036	4.73	2.02
6-22-77	1246	555	597	1.05	1.31
6-23-77	2944	1630	1667	4.10	3.04
6-24-77	1486	777	748	1.52	1.56
6-25-77	2767	1835	1555	4.05	2.86
9-5-77	427	220	81	0.46	0.48
9-6-77	78	30	0	0.09	0.12
9-13-77	170	66	0	0.19	0.21
9-13-77	595	135	187	0.52	0.65
9-14-77	368	161	44	0.42	0.42
9-14-77	3378	1504	1940	1.89	3.48
9-16-77	597	249	188	0.33	0.65
9-19-77	555	327	161	0.80	0.61
Total	20273	10692	9800	24.76	21.39

metric units: lb x 0.454 = kg

SECTION III
INPUT REQUIREMENTS AND OUTPUT FORMAT

This section of the report contains the detailed listing of the predictive procedure, as well as the description of the output. Recommendations for use of the procedure in both single event and long term application are included.

GENERAL INPUT REQUIREMENTS

The predictive procedure requires input data describing the highway system under consideration and the rainfall record being evaluated. The procedure can be manually operated using a calculator or run on a small computer for each application. The description that follows will concentrate on the desktop approach since the computer application follows the same procedure but relies upon the computer to manipulate constants and equations. Appendix C (page 119) lists the computer program and Appendix D (page 134) lists the step-by-step input requirements.

Site Description

The highway system that is to be analyzed must be defined as to its total drainage area. Total drainage area for an existing system can be that area comprising both paved and nonpaved surfaces whose runoff contributes to a single storm sewer or drainage ditch discharge. Thus, the evaluation of an existing highway system may be comprised of a series of small drainage areas within the discharge point. This type of evaluation is important in those applications which are meant to compare actual flow measurements with the output of the model. For more general evaluations, the total area contained within the highway right-of-way will be sufficient for analysis.

The length of the highway system must also be defined, ie. the actual distance of the highway section from one end of the drainage area to the other end. This is in contrast to curb mile or lane mile, which is a multiple of highway length.

Curb Configuration

This parameter describes the general type of drainage configuration used to remove the paved area runoff from the surface of the highway. Within the development of the model, the monitoring data showed considerable differences in hydraulics between sites which were found to be related to these drainage structures. Harrisburg I-81 is characterized by flush shoulder areas which disperse the paved runoff to drainage ditches alongside the highway and then by overland flow to the inlets of the storm sewer system. Milwaukee Hwy 45, Nashville I-40 and Denver I-25 have mountable curbs which channel the runoff alongside the curb to inlets of the storm sewer system. Figure 12

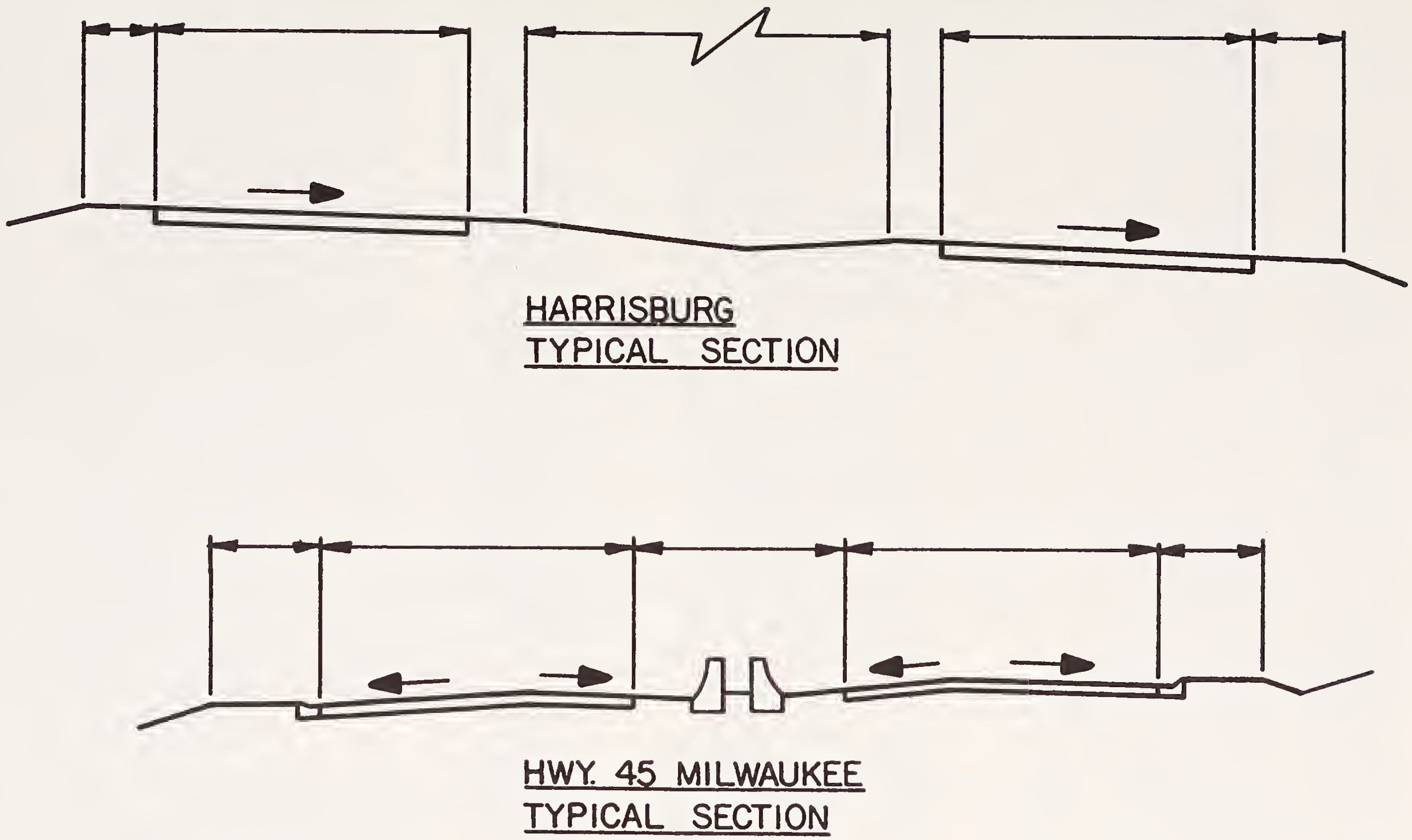


Figure 12. Typical paved area cross-sections.

presents typical cross-sections for Harrisburg I-81 and Milwaukee Hwy 45. A more complete description of each of these sites is available in Vol. IV, "Characteristics of Runoff From Operating Highways, Research Report", of this document series (1).

For purposes of analysis, three types of curb or drainage types are used in the predictive procedure; the flush shoulder which characterizes the rural Harrisburg site, mountable curbs with inlets along these curbs for removal of the paved surface runoff, and the mountable curb with impact barriers adjacent to each set of lanes as is characteristic of the elevated bridge deck at the Milwaukee I-794 site. These three configurations are used throughout the predictive procedure application.

Average Daily Traffic

ADT or average daily traffic refers to that volume of vehicles which passes through the highway system on a per day basis. The average value as used is determined over a long period of time to account for weekday, weekend and seasonal variations. ADT is used to select the proper accumulation rate for the runoff quality predictions. The average volume of traffic is used since the build-up of pollutants before a rainfall event is a result of an unknown time period to the last storm exhibiting 100 percent wash-off. Further descriptions of ADT and pollutant accumulations have been discussed in the K_1 component development.

CONTINUOUS APPLICATIONS

The application of the predictive procedure or model can be utilized for single rainfall events or for a continuous simulation of annual or seasonal rainfall. The continuous mode of operation using the computer model will be explained first since the single event procedure relies upon the same data requirements.

An effective evaluation of highway runoff water quality includes the simulation of a number of continuous rainfall events. The time period spanned by these rainfall events depends largely on the climatic region of the highway area. An arid climate might require several to many years of rainfall data to evaluate highway runoff water quality, while a single year of continuous rainfall data might be sufficient in humid areas, depending upon the objective of the simulations. Since the procedure is not meant to evaluate winter snow melts and frozen ground conditions, only nonwinter periods should be evaluated. An example would be in the Milwaukee area where frost and snow cover conditions are possible between November and March of each year. In areas of the country where frost and snow cover is not present, the simulation can be used for the entire year.

Rainfall Selection

The rainfall data required for the model are total volume of rainfall and the corresponding duration for each event. The date of each event is also required so that the days of pollutant accumulation between storms can be evaluated. These data are usually available from the local weather service, or listings of hourly rainfall may be obtained from the U.S. Department of Commerce. (Address: U.S. Department of Commerce, National Climatic Center, Federal Building, Asheville, N.C. 28801).

The selection of a period of record to be used to evaluate the water quality affects of the highway can become quite complicated if ten or twenty years of record are available. In order to assist the highway engineer in selecting which period should be utilized for the simulation, the following suggestions are provided:

1. Analyze with the predictive procedure as many continuous, complete periods as budget and time allow.

2. Based on a ranking of total rainfall volumes for each period, average rainfall per storm and number of storms with average intensities greater than one inch (2.54 cm) per hour, select one or two periods of high, medium and low rankings in each category. This provides a representation of the rainfall record from which one or two periods can be quickly analyzed.

3. The highest loadings to the receiving water may not be associated with those periods of highest rainfall but rather those of highest intensity after long buildup periods. Selection of extreme periods should reflect these criteria.

An example of the selection of one or two years of rainfall record for analysis with the predictive procedure can be found in Table 26. Ten periods of rainfall for a hypothetical area are listed according to total rain, number of storms, average rain per storm and storms with average intensities greater than one inch per hour. According to the data in this Table, 1969 contained the highest volume of rainfall and number of storm events, while 1976 contained the lowest volume of rainfall and lowest average rain per storm. The year 1974 contained the highest average rainfall per storm. The average values for each of these columns provide an indication of typical conditions and the year which most closely represents typical conditions is marked by an asterisk.

Based upon the data of Table 24, a typical and extreme year can be selected for each of the categories. The extreme year representing the number 1 ranking in each category can be used to evaluate the most

Table 26. Nonwinter rainfall summaries for a hypothetical area.

Year	Total rain, (in.)	Number of events	Average rain per event, in.	Number of events >1 in./hr
1968	15.8	38 (5)	0.42	2
1969	16.4 (1)	48 (1)	0.34	0
1970*	14.3 (5)	35	0.41	1
1971	15.9	41	0.39	3
1972	11.4	32 (10)	0.36 (5)	1
1973	12.8	39	0.33	0
1974	15.6	35	0.45 (1)	2
1975	11.1	38	0.29	0
1976	10.2 (10)	37	0.28 (10)	1
1977	16.0	37	0.43	3
Average	13.95	38	0.37	1.3

Note: (1) = extreme - high
(5) = typical
(10) = extreme - low
* = typical year
metric units: in. x 2.54 = cm

significant water quality impact. The category of average volume of rain per storm would best represent this need and, therefore, 1974 would be selected. The year 1977 also might be selected for the same purposes since it has the second highest volume of rain per storm but also has three storms of average intensity greater than one inch. A typical year such as 1970 and 1972 can be used to represent the entire period of record. Thus, if time or budget do not allow the analysis of all 10 years, then a typical year could be analyzed to provide an indication of the annual load. For the example in Table 26, the typical year selected would best be represented by 1970 since it has values very close to the average values for the period of record for categories of total rain and average volume of rain per storm. Also, there were not a large number of storms with an average intensity of greater than one inch per hour during 1970.

The period of rainfall selected for analysis is used to evaluate the response of the existing or proposed system for the total period and for individual rainfall events within the period. Later descriptions of individual storms will require a look at the long term rainfall to set prestorm conditions as close to the actual prestorm surface load as possible.

MODEL OPERATION AND INPUT REQUIREMENTS

The detailed input data formats are listed in Appendix D (page 134) to provide the model user with a step-by-step procedure. A more general approach is discussed in this section of the report. Figure 13 represents the flow diagram for the model operation.

Site Characteristics

The first requirement of the model is to specify the size and type of site that is to be analyzed. The site description is as follows:

	Description	Units
1.	Size of total drainage area	Acres (ha)
2.	ADT	Vehicles per day
3.	Type of site TYPE I - All paved, bridge or overpass Type II - Paved and unpaved with curbs and inlets along the paved area. Type III - Rural sites with flush shoulders, grassy ditch conveyance to inlets.	
4.	Site length, i.e., distance from one end of drainage area to the other end.	Miles (km)

Rainfall Record

The rainfall record selected for analysis is input to the predictive procedure in the following manner:

	Description	Units
1.	Number of rainfall events to be evaluated (1 to N).	--
2.	Month, day and year of each event.	--
3.	Rainfall for each event.	Inches (cm)
4.	Duration of each rainfall.	Hours
5.	Dry days prior to each rainfall.	Days

The rainfall record relies upon the total volume of rain for each event and the date on which the rainfall started. Thus, even though the rainfall may extend over two days, the starting date is the reference point. The dry day variable refers to the number of days

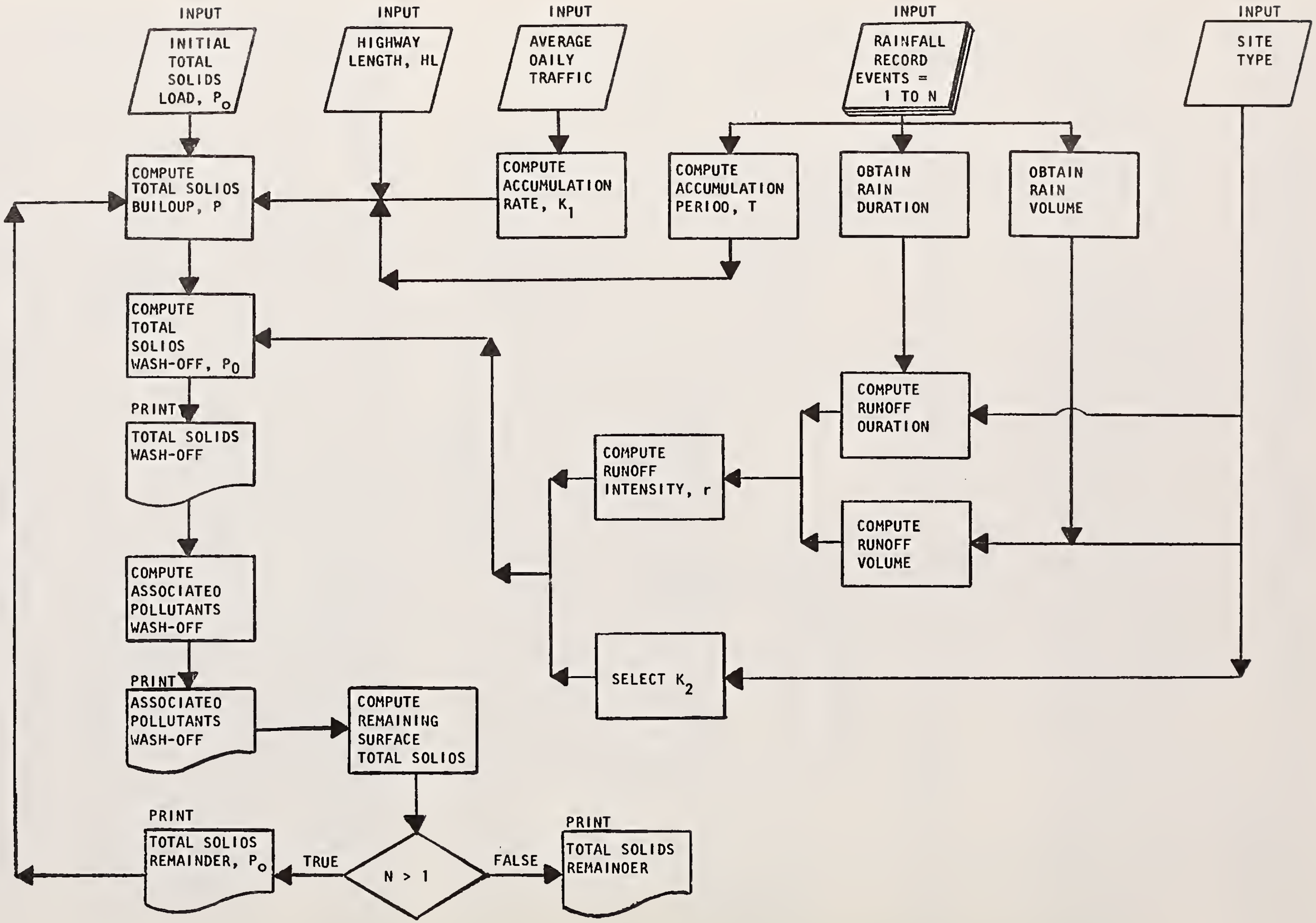


Figure 13. Predictive procedure flow diagram.

prior to this event in which accumulation occurred. For example, a rainfall on Saturday, July 22th that was preceded by a rainfall that ended on Sunday, July 16th, would have six days of accumulation.

Model Operation

The actual operation of the model or predictive procedure is as follows:

Runoff Volume - The volume of runoff in inches (cm) is determined by the solution of one of following equations depending on site type.

Type I

$$Q = 0.969\ R - 0.0187$$

Type II

$$Q = R^{1.369}\ DD^{-0.0858} * 0.470$$

Type III

$$Q = R^{1.892}\ DD^{-0.654} * 0.845$$

where; Q = runoff in inches (cm)
R = rainfall in inches (cm)
DD = dry days to last rainfall (minimum = 1 dry day)

For example, a TYPE II site having 0.25 inches (0.63 cm) of rain (R) after 6 dry days (DD) would produce the following total runoff (Q):

$$Q = R^{1.369}\ DD^{-0.0858} * 0.470$$

$$Q = (0.25^{1.369})\ (6^{-0.0858})\ (0.470)$$

$$Q = 0.06 \text{ inches of runoff } (0.15 \text{ cm})$$

Runoff Rate - The duration of the rainfall event is used to determine the length of the runoff period for that event. The following equations (dependent on site type) describe this procedure:

TYPE I

$$FD = 1.12\ RD + 0.69$$

TYPE II

Dry days ≥ 10

$$FD = 1.06\ RD + 1.79$$

Dry days < 10

$$FD = 1.27\ RD + 2.16$$

Type III

Dry days ≥ 10

$$FD = 1.92\ RD + 4.18$$

Dry days < 10

$$FD = 1.48\ RD + 8.28$$

where; FD = runoff duration in hours
RD = rainfall duration in hours

Thus for the example above, if the 0.25 inches (0.63 cm) of rainfall lasted for 50 minutes, then the duration of runoff for TYPE II and six dry days would be:

$$FD = 1.27\ RD + 2.16$$

$$= 1.27\ \frac{50}{60} + 2.16$$

$$= 3.22\ \text{hours}$$

The average runoff rate (r) for this event would be calculated as follows:

$$r = Q/FD$$

$$r = \frac{0.06\ \text{in.}}{3.22\ \text{hr}} = 0.019\ \text{in./hr}\ (0.05\ \text{cm/hr})$$

Runoff Quality - The next block of equations in the model is related to pollutant quality determinations. The first step in this process is to determine the pollutant accumulation rate for the site being modeled. The general equation for this variable is defined as:

$$K_1 = (ADT^{0.89}) * 0.007$$

where; K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
ADT = average daily traffic, vehicles/day

Continuing with the example application, if the site has an ADT of 30,000 vehicles per day, the K_1 value that results would be:

$$K_1 = (30{,}000^{0.89}) * 0.007$$
$$= 67.6\ \text{lb/mi-day}\ (19.1\ \text{kg/km-day})$$

The calculated K_1 value is next used to predict the pounds of total solids on the surface of the drainage area at the start of the storm event.

$$P = P_o + (K_1 \times HL \times T)$$

where; P_o = initial surface pollutant load, lb
P = pollutant level after build-up, lb
K_1 = pollutant accumulation rate, lb/mi-day (kg/km-day)
HL = highway length, mi (km)
T = time of accumulation, days (20 day maximum)

The variable P_o is a function of the amount of pollutants left on the surface after the last runoff event. In the long term program, this loading is carried through the calculations on an interative basis by subtracting the pounds washed off from the previous pollutant load. The build-up rate, K_1 is then used for each dry day to add to this initial level until the pollutant level at the storm start is determined.

The initial estimation of a P_o is made easier if the first storm to be evaluated follows a storm of average rainfall intensity greater than 0.5 inches (1.27 cm) per hour. This large storm is assumed to wash-off essentially all of the available total solids load on the surface. The succeeding dry days are then used to build up the available surface load to the start of storm conditions. Further descriptions of P_o and K_1 are included in the components description of this report.

Continuing with the example application, if the accumulation period is six days, the highway length is 6.5 miles, K_1 is 67.6 lb/mi-day (19.1 kg/km-day) (predicted from an ADT of 30,000 vehicles/day) and P_o is zero (assume accumulation period started with a large storm), the pollutant level after build-up (P) would be:

$$P = P_o + (K_1 \times HL \times T)$$
$$= 0.0 + (67.6 \times 6.5 \times 6)$$
$$= 2{,}636 \text{ pounds (1,196 kg) of total solids available at the start of event number one}$$

If a large rainfall event does not occur at the beginning of the initial accumulation period, P_o must be estimated. One method is to evaluate local climatic data to determine the average number of dry days between rainfall events. P_o can then be estimated using average number of dry days, K_1 and highway length. In the example above, if a large storm did not precede the initial accumulation period, and if the average number of dry days between storms was determined to be four, an estimate of P_o could be calculated as follows:

$$P_o = K_1 \times HL \times T$$
$$= 67.6 \times 6.5 \times 4$$
$$= 1{,}758 \text{ lb (797 kg)}$$

The next step in the predictive procedure is to remove a portion of the surface load P using the average runoff rate (r) calculated previously.

The standard wash-off equation that is used in the model is:

$$P_D = P(1-e^{-K_2 r})$$

where; P_D = pollutant load discharged (total solids), lb (kg)
P = pollutant load at the storm start, lb (kg)

K_2 = wash-off coefficient
r = average runoff rate - in./hr (cm/hr)

K_2 is selected based upon site characteristics as follows:

$$K_2 = \frac{\text{Type I}}{5.0} \qquad \frac{\text{Type II}}{6.5} \qquad \frac{\text{Type III}}{12.0}$$

Continuing with the example for a Type II site, the pounds of total solids removed would be determined as follows based upon the values previously calculated for P and r:

$$\begin{aligned} P_D &= P\ (1-e^{-K_2 r}) \\ &= 2{,}636\ (1-e^{-(6.5)(0.019)}) \\ &= 306 \text{ lb of total solids discharged (139 kg)} \end{aligned}$$

The surface load after the storm would be calculated as follows:

$$\begin{aligned} P_o &= P - P_D \\ &= 2{,}636 - 306 \\ &= 2{,}330 \text{ lb of total solids remaining (1,057 kg)} \end{aligned}$$

P_o for event number two is 2,330 lb (1,057 kg). Another cycle of calculations can now begin.

The determination of any of the remaining 16 parameters available in the model is based upon the equations of Tables 19 and 20. Thus, to determine the pounds of lead for this storm, the equation is:

$$\begin{aligned} Pb &= 1.02 \times 10^{-3}\ (P_D) + 0.04 \\ &= 1.02 \times 10^{-3}\ (306) + 0.04 \\ &= 0.35 \text{ lb of lead discharged (0.16 kg)} \end{aligned}$$

The remaining quality parameters can be calculated using the appropriate equations.

The above example of the predictive procedure provides the methodology for calculating the pounds of total solids and lead for one storm event. The event under consideration may be a design storm or single rainfall event which was monitored for flow and quality. In either case, the prestorm history for determining the surface total solids load at the start of the storm is as important as the rainfall data. Continuous records of rainfall are important in any application and should be used to set the individual prestorm conditions.

SECTION IV
PREDICTIVE PROCEDURE RESULTS

Previous descriptions of the ability of the predictive procedure to match measured data have been presented for individual components. Within this portion of the report, the entire model is applied to the sites which were used to develop the relationships of the model as well as one site independent of this project's data. The final portion of this section presents a discussion of the limitations of the predictive procedure.

MODEL APPLICATIONS

The use of rainfall records from each of the five monitoring sites within this project, as well as the data from another study at Dallas, Texas (13) will be used to evaluate model accuracy. Those events which have been monitored for various quality parameters will be compared with the model output to determine its accuracy. Summaries of the input data and output results are listed in the Appendix G (page 146) for all storms used in the continuous simulation. Input data for each site is volume of rainfall, duration of rainfall, and number of dry days prior to each event. The K_1 values calculated in Section II for each site will be input to the model for all sites except Denver where the model will calculate K_1. The rainfall record at the Denver site prevented a reliable estimate of K_1. Differences between user supplied and calculated K_1 values will be discussed.

Milwaukee I-794

The predictive procedure was run for the nonwinter rainfall events in 1976 and 1977. Each simulation was started after a significant rainfall event occurred which was assumed to wash off the surface pollutant load to base conditions. There are a total of 33 events used for comparison of the predicted and monitored runoff quality. Appendix G (pages 146 to 154) presents the model output data for these events with the rainfall volume and duration plus the K_1 value determined in Section II as the model input. The model output provides rainfall and runoff summaries, as well as surface loadings before and after each event.

Table 27 lists the measured and computed quality results for total and suspended solids, TPO_4, COD, lead and iron. Figures 14 and 15 graphically represent the total solids and lead comparisons. The total solids data for these events shows reasonable accuracy when the two year total of 1862 lb (845 kg) is compared to the predicted value of 1640 lb (745 kg). Individual events within this period however, show a substantial variation between predicted and monitored values. For example, the first three events in 1976 show large variations in the predicted versus monitored total solid values.

Table 27. Model results for Milwaukee I-794, 1976 and 1977.

Date	Total solids, lb		Suspended solids, lb		TPO_4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
6/18/76	87	130	62	66	0.21	0.13
7/28	45	133	15	67	0.04	0.13
7/30	359	189	*		*	
8/5	14	19	2	7	0.01	0.02
8/13	94	70	40	34	0.09	0.07
8/25	29	69	10	33	0.02	0.07
8/28	135	152	97	77	0.15	0.15
9/9	98	69	36	33	0.05	0.07
9/19	28	44	8	20	0.02	0.04
6/8/77	35	5	21	0	0.03	0.01
6/10	12	4	3	0	0.007	0.004
6/11	173	38	69	17	0.16	0.04
6/17	119	83	49	41	0.13	0.08
6/28	12	52	4	24	*	
6/28	62	37	42	17	*	
6/30	84	51	30	24	0.11	0.05
7/3	27	25	10	10	*	
7/17	115	167	21	85	*	

Note: *Not monitored
Metric units: lb x 0.454 = kg

(continued)

Table 27. Model results for Milwaukee I-794, 1976 and 1977 (continued).

Date	Total solids, lb		Suspended solids, lb		TPO_4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
8/13	143	83	*		*	
8/28	96	83	48	41	*	
9/23	5	25	3	10	*	
9/23	28	52	13	24	*	
9/24	62	60	34	28	*	
Total	1862	1640	570	658	1.03	0.86
	COD, lb		Lead, lb		Iron, lb	
6/18/76	18	32	0.69	0.71	1.9	2.54
7/28	17	32	0.14	0.72	5.12	2.58
7/30	*		*		*	
8/5	4	9	0.02	0.08	0.05	0.88
8/13	41	20	0.85	0.37	3.03	1.64
8/25	11	19	0.10	0.36	0.42	1.62
8/28	32	36	1.00	0.83	2.68	2.87
9/9	20	19	0.37	0.36	1.02	1.62
9/19	12	14	0.11	0.22	0.38	1.25
6/8/77	19	7	0.19	0.01	0.87	0.67
6/10	3	6	0.03	0.00	0.11	0.64

Note: *Not monitored
Metric units: lb x 0.454 = kg

(continued)

Table 27. Model results for Milwaukee I-794, 1976 and 1977 (continued).

Date	COD, lb		Lead, lb		Iron, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
6/11	36	13	0.66	0.19	2.33	1.16
6/17	27	22	0.61	0.44	2.39	1.84
6/28	*		*		*	
6/30	31	16	0.40	0.26	2.64	1.35
7/3	*		*		*	
7/17	*		*		*	
8/13	*		*		*	
8/28	*		*		*	
9/23	*		*		*	
9/24	*		*		*	
Total	271	245	5.17	4.55	22.94	20.66

Note: *Not monitored.
Metric units: lb x 0.54 = kg

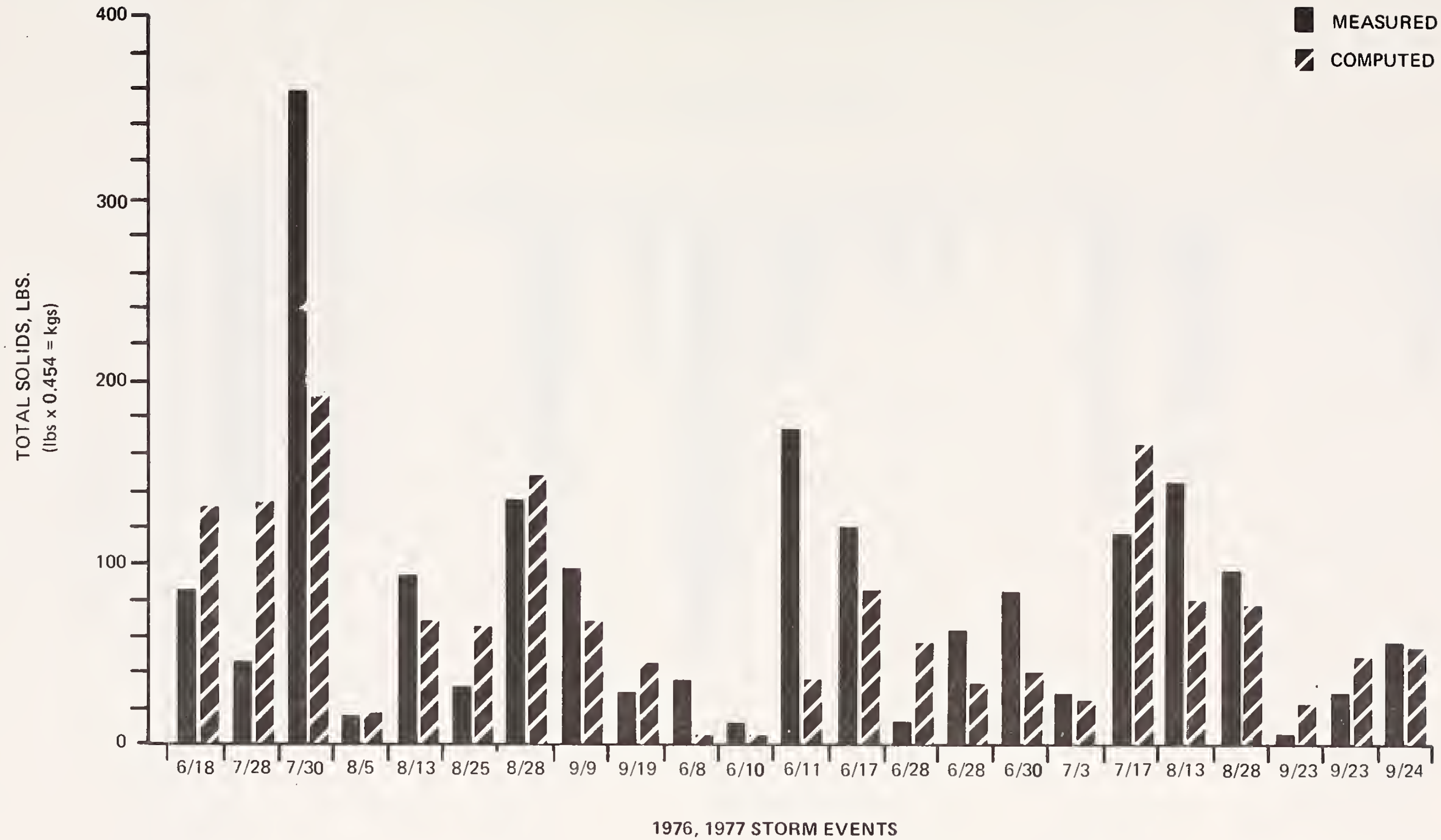


Figure 14. Measured versus computed total solids at Milwaukee I-794, 1976 and 1977.

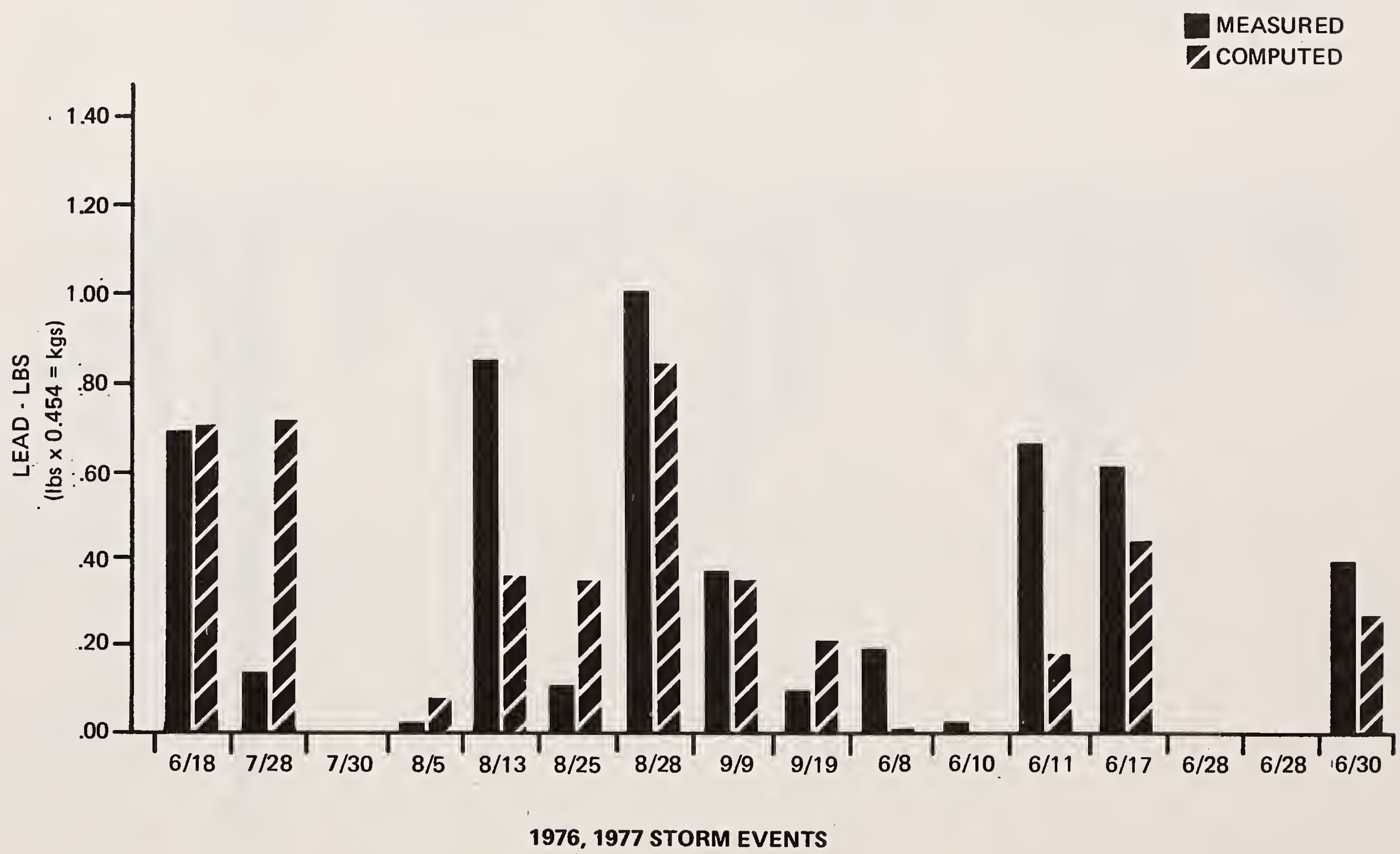


Figure 15. Measured versus computed lead at Milwaukee I-794, 1976 and 1977.

The total solids comparisons of Figure 14 show five storms which account for the majority of the differences between the predicted and actual data. These storm events occurred on 6/18, 7/28, and 7/30/76 and 6/11 and 8/13/77. The first two dates show the model to overpredict while the remaining dates underpredict the measured loadings. The event which occurs on 6/8/77 represents the first nonwinter monitored event of 1977 and thus, is subject to the initial pollutant estimation of zero pounds preceeding this event after total washoff from a storm of 0.54 inches (1.3 cm) in one-half hour. The first two events of 1977 are reasonably close to the measured and reflect the accuracy of this total washoff assumption.

The suspended solids loadings of Table 27 show the total pounds discharged for monitored events to be 570 lb (259 kg) and the predicted to be 658 lb (299 kg). Suspended solids data was not collected for events that occurred on 7/30/76 and 8/13/77. Zero predicted suspended solids result when the surface total solids load is less than 6 lb (2.7 kg) as in events of 6/8 and 6/10/77.

The total phosphorus loads (TPO4) listed in Table 27 show very close correlation with the total monitored load being 1.03 lb (0.46 kg) versus a predicted load of 0.86 lb (0.39 kg). Small variations are present in the individual storms. Similar trends are found for COD, lead and iron loadings. The lead data is graphically presented in Figure 15 where those events that show the greatest variation are the result of the large differences in monitored and predicted total solids. Table 27 shows the monitored totals to be 5.17 lb (2.34 kg) and the predicted to be 4.55 lb (2.06 kg).

Milwaukee Hwy. 45

The Milwaukee Hwy. 45 monitoring data contains 18 events which will be compared to the predicted values in the following figures. A total of 39 events were simulated during 1976 and 1977 with the results of the model output presented in Appendix G (pages 155-162).

Table 28 presents data for total and suspended solids, lead, iron, COD and TPO_4, while Figure 16 and 17 present graphical comparisons of total solids and lead. The 1976 simulation period uses the K_1 value associated with nonconstruction, 172.5 lb/mi-day (48.6 kg/km-day), while the 1977 simulation period (construction) requires a K_1 of 367.7 lb/mi-day (103.6 kg/km-day) as determined in Section II. Using these K_1 values for the appropriate years, the predicted total solids for the two years was 63,478 lb (28,794 kg) while the measured values were 55,024 lb (24,981 kg). A few of the individual runoff events within the simulation period show large variations, but the overall accuracy of the model is relatively good.

Table 28. Model results for Milwaukee Hwy. 45, 1976 and 1977.

Date	Total solids, lb		Suspended solids, lb		TPO_4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
6/18/76	5886	1657	4306	856	5.67	3.41
7/28	943	2075	518	1119	0.74	4.35
7/30	2371	5995	1290	3589	1.60	13.2
8/5	470	209	127	0	0.12	0.15
8/14	2120	954	805	413	0.82	1.83
8/25	4029	3107	601	1770	0.91	6.67
8/28	2490	4188	1636	2450	2.06	9.10
9/9	3498	2384	2010	1314	1.79	5.05
9/19	1109	1104	492	507	0.60	2.16
5/4/77[a]	742	787	135	308	0.24	1.45
6/5	6149	9764	3891	5963	4.25	21.65
6/5	8670	11827	6151	7263	6.20	26.29
6/6	490	891	82	374	0.15	1.69
6/8	1123	974	428	426	0.45	1.87
6/11	3524	2876	1402	1624	1.34	6.15
6/17	4849	7407	2974	4479	3.70	16.35
6/27	3388	1833	859	967	1.94	3.81
6/30	3173	5446	1416	3243	2.18	11.93
Total	55024	63478	29123	36665	34.76	137.11

(continued)

Note: [a]Construction activity occurred during 1977
Metric units: lb x 0.454 = kg

Table 28. Model results for Milwaukee Hwy. 45, 1976 and 1977 (continued).

Date	COD, lb		Lead, lb		Iron, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
6/18/76	453	595	6.67	1.73	139.32	27.5
7/28	243	676	1.43	2.16	18.61	35.67
7/30	402	1432	2.76	6.16	50.72	112.51
8/5	50	316	0.20	0.25	3.95	0.00
8/14	377	459	2.04	1.01	22.83	13.69
8/25	207	875	1.56	3.21	20.48	55.90
8/28	455	1084	4.27	4.31	49.09	77.08
9/9	538	735	4.67	2.47	65.44	41.24
9/19	193	488	0.80	1.17	18.31	16.63
5/4/77[a]	97	427	0.40	0.84	4.00	10.43
6/5	855	2160	8.40	10.00	110.00	186.37
6/5	698	2558	7.30	12.10	188.00	226.80
6/6	37	447	0.20	0.95	4.00	12.47
6/8	176	463	0.80	1.03	17.00	14.10
6/11	332	830	1.80	2.97	42.00	51.38
6/17	534	1705	4.60	7.60	93.00	140.19
6/27	566	629	2.50	1.91	31.00	30.93
6/30	650	1326	3.20	5.60	52.00	101.75
Total	6863	17205	53.6	65.47	929.75	1155.14

Note: [a]Construction activity occurred during 1977
Metric units: lb x 0.454 = kg

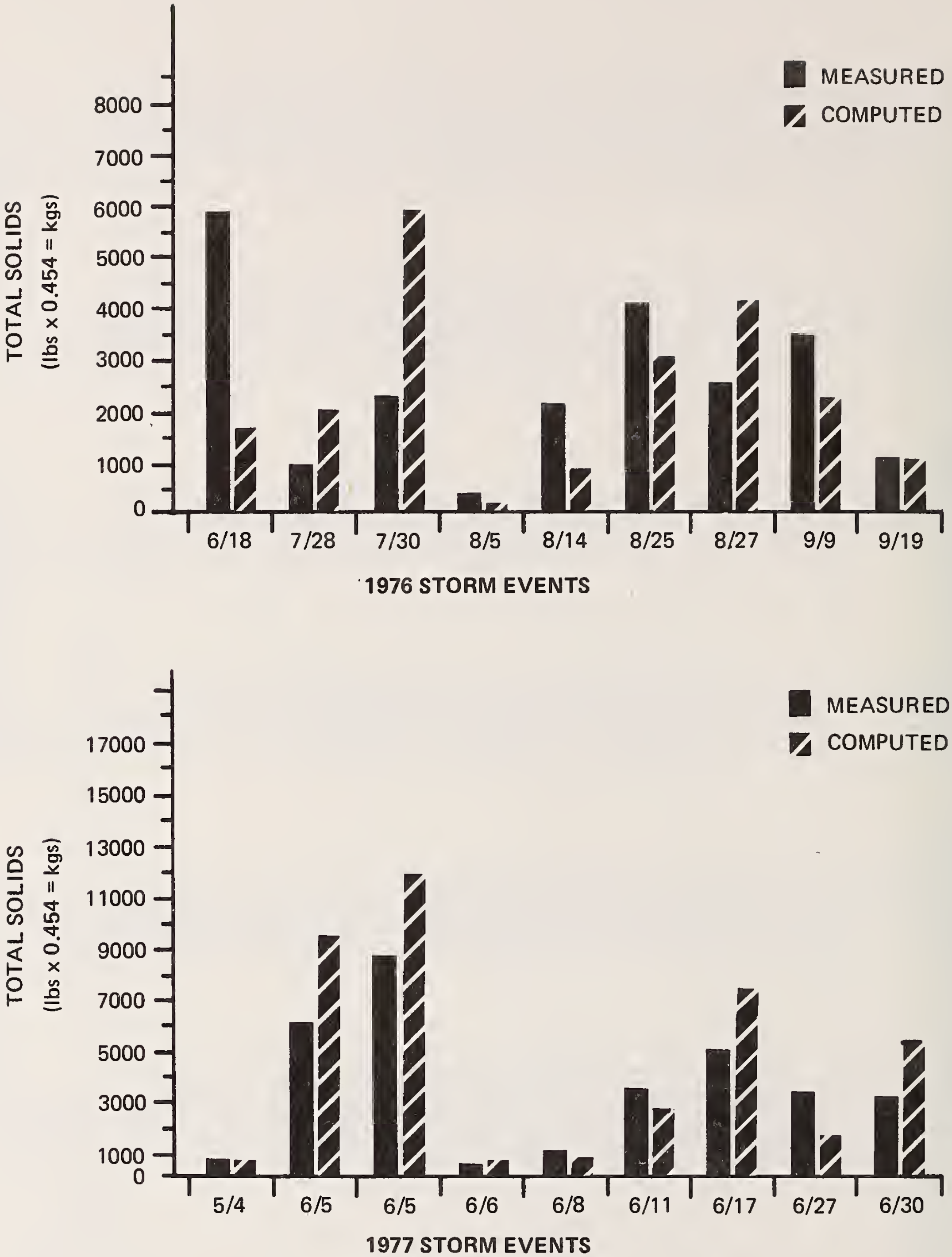


Figure 16. Measured versus computed total solids at Milwaukee Hwy. 45, 1976 and 1977.

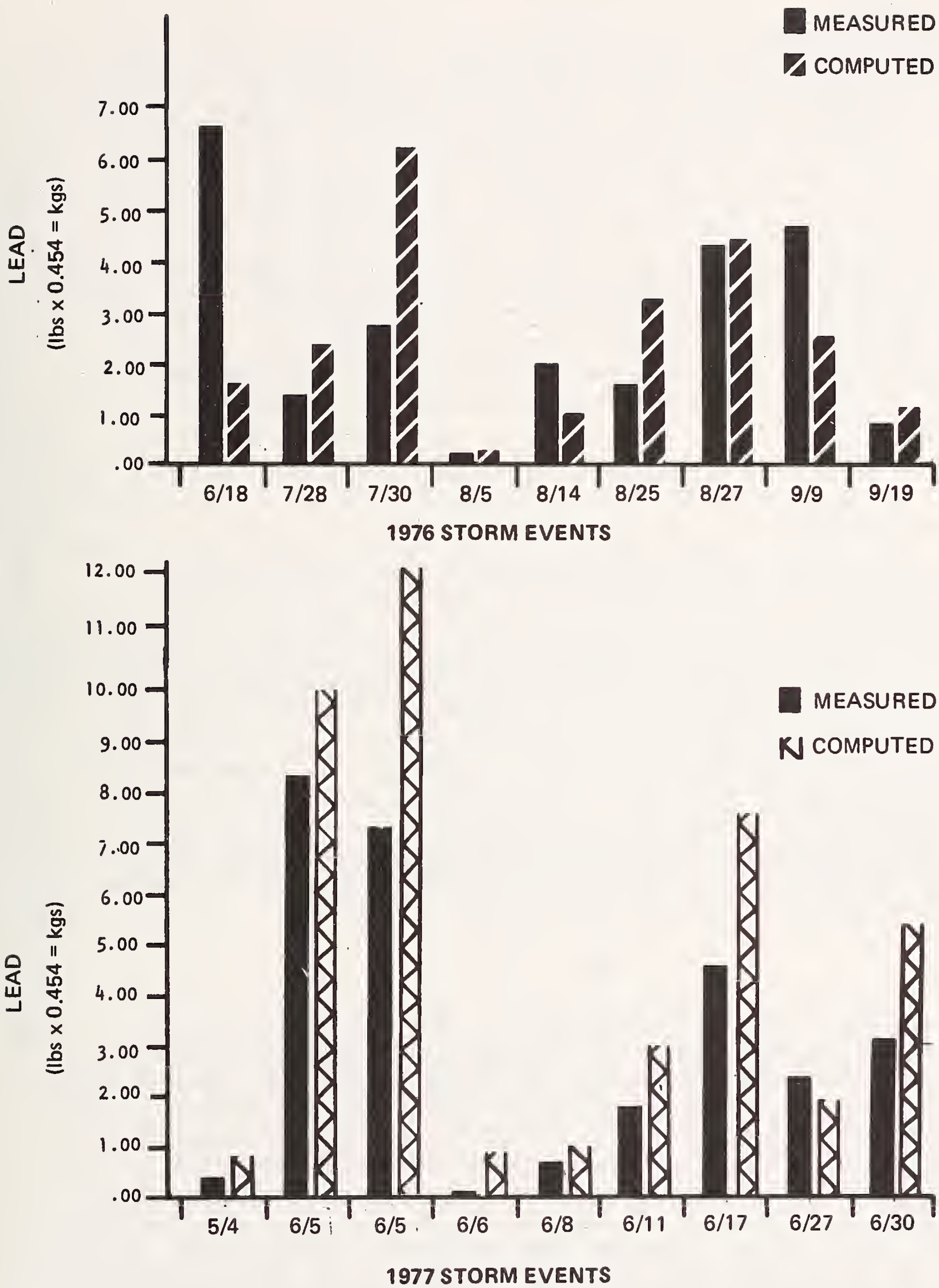


Figure 17. Measured versus computed lead at Milwaukee Hwy. 45, 1976 and 1977.

Nashville I-40

A total of 18 events at this site were used to compare the monitored and predicted quality estimates of the model. A total of 46 events were used in the analysis. The results of the model output for Nashville are presented in Appendix G (pages 163 to 169). The Nashville site was affected by construction during the entire 1977 monitoring period so the K_1 value of 347.3 lb/mi-day (37.9 kg/km-day) corresponding to this activity was applied (Section II). A simulation for 1976 was not performed because only four events were monitored that year. Table 29 lists the computed and actual values for six parameters, while Figures 18 and 19 present the total solids and lead comparisons. The total solids measured for the 18 events totalled 20,273 lb (9204 kg) while the computed values equalled 23,325 lb (10,580 kg). The TPO_4 and COD comparisons show the greatest variation in computed and actual data. The overall predictions for all parameters, however, are acceptable.

Harrisburg I-81

A total of 67 rainfall events were simulated with the predictive procedure at this site with 12 of these events having been monitored for quality parameters. The 1976 events use the K_1 value associated with the construction aspects of that year while 1977 uses the nonconstruction Type III, K_1. The model output is listed in Appendix G (pages 170 to 180) while Table 30 lists computed and measured values for total and suspended solids, lead, iron, COD and TPO_4. Figures 20 and 21 present lead and total solids values in graphical form. The monitored total solids for the period was 3655 lb (1659 kg) while the predicted load equalled 3689 lb (1673 kg). The remaining parameters are also extremely close on a total pounds basis with a few individual events showing large variations. The quality comparisons were much more accurate than anticipated, considering the complexity of the drainage configuration and base flow conditions at this site.

Denver I-25

The application of the predictive model to the Denver I-25 site is somewhat different because the arid climate and resulting long dry periods complicated the calculation of a site specific K_1 value. The model calculates a K_1 value based on the ADT data and associated site characteristics. The model output data is listed in the Appendix G and shows the calculated K_1 value to equal 378.9 lb/mi-day (106.8 kg/km-day). Table 31 lists a few selected parameters comparing the computed and actual values. Figures 22 and 23 present a graphical representation of the total solids and lead data. The accuracy of the model for this site is poor for all parameters because of the difficulties discussed in the K_1 components discussions. Except for suspended solids, the model consistently overpredicts the measured values totalled for those parameters.

Table 29. Model results for Nashville I-40, 1977.

Date	Total solids		Suspended solids, lb		TPO_4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
4/21-22/77	1559	1891	922	1003	7.40	3.93
4/22	1265	480	626	115	4.43	0.76
4/28	156	328	77	19	*	
6/13	134	214	28	0	0.25	0.16
6/14	605	292	278	0	2.28	0.34
6/19	1943	2021	1272	1085	9.57	4.13
6/22	1246	2909	555	1645	4.03	6.23
6/23	2944	1949	1630	1040	14.37	4.07
6/24	1486	856	77	349	5.40	1.60
6/25	2767	1595	1835	817	16.03	3.27
9/5	427	2477	220	1372	1.81	5.25
9/6	78	491	30	121	0.24	0.78
9/13	170	643	66	217	*	
9/13	595	1601	135	820	*	
9/14	368	965	161	420	*	
9/14	3378	2361	1504	1300	*	
9/16	597	639	249	215	*	
9/19	555	1617	327	831	*	
Total	20273	23325	10692	11369	65.81	30.62

Note: *Not monitored
Metric units: lb x 0.454 = kg

(continued)

Table 29. Model results for Nashville I-40, 1977 (continued).

Date	COD, lb		Lead, lb		Iron, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
4/21-22/77	593	640	2.23	1.97	21.83	32.06
4/22	345	368	1.27	0.53	17.08	4.42
4/28	64	339	0.22	0.38	2.16	1.43
6/13	59	316	0.11	0.26	0.54	0
6/14	179	332	0.78	0.34	8.34	0.71
6/19	651	665	4.73	2.10	33.40	34.61
6/22	293	837	1.05	3.01	7.91	52.03
6/23	715	651	4.10	2.03	44.57	33.20
6/24	315	440	1.52	0.91	17.90	11.69
6/25	451	583	4.05	1.67	46.88	26.27
9/5	210	753	0.46	2.57	5.32	43.54
9/6	34	370	0.09	0.54	0.76	4.62
9/13	*		0.19	0.70	1.59	7.60
9/13	*		0.52	1.67	4.16	26.37
9/14	*		0.42	1.02	4.03	13.91
9/14	*		1.89	2.45	36.90	41.28
9/16	*		0.33	0.69	6.27	7.53
9/19	*		0.80	1.69	8.42	26.30
Total	3909	6294	24.76	24.53	268.06	367.97

Note: *Not monitored
Metric units: lb x 0.454 = kg

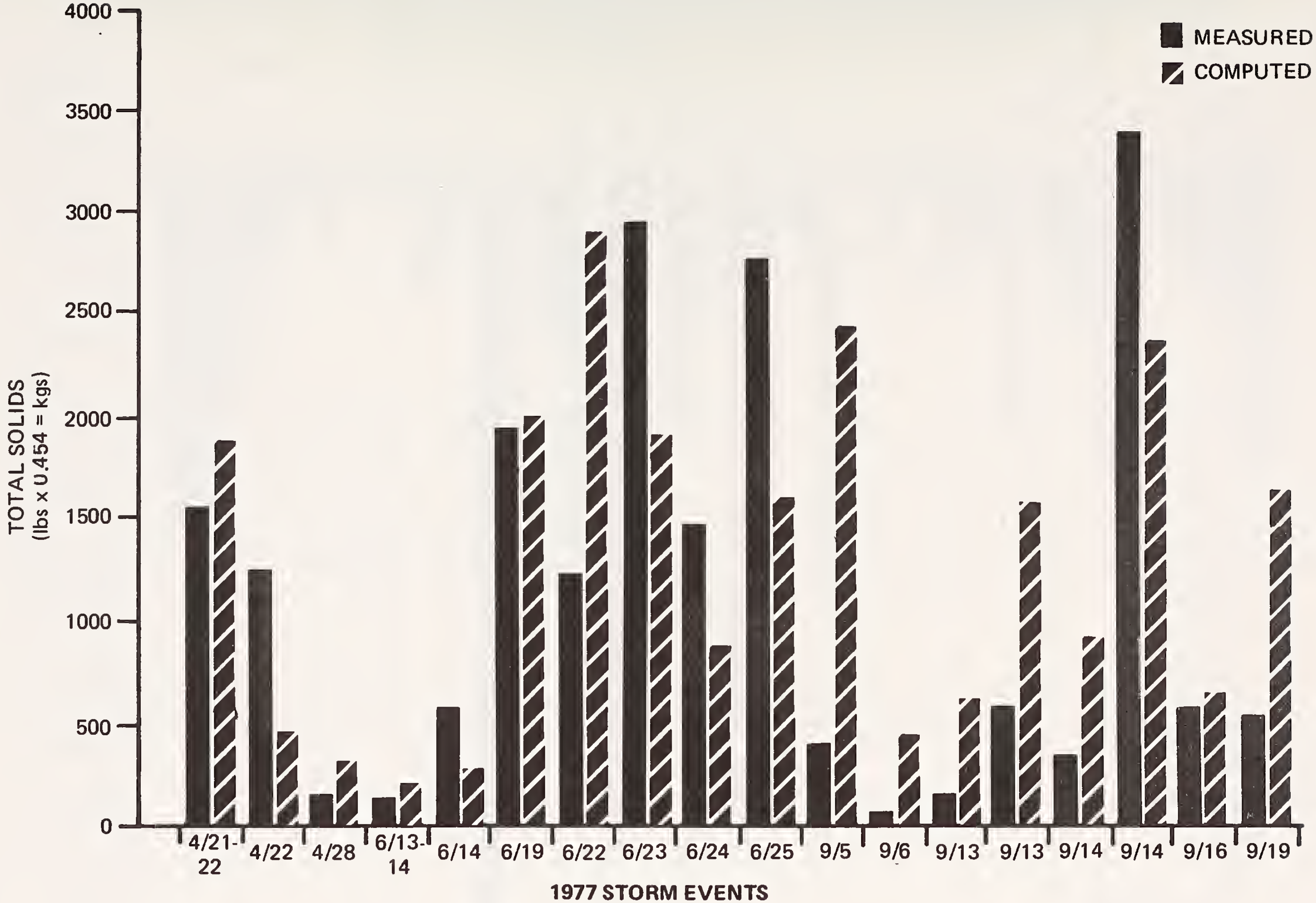


Figure 18. Measured versus computed total solids at Nashville I-40, 1977.

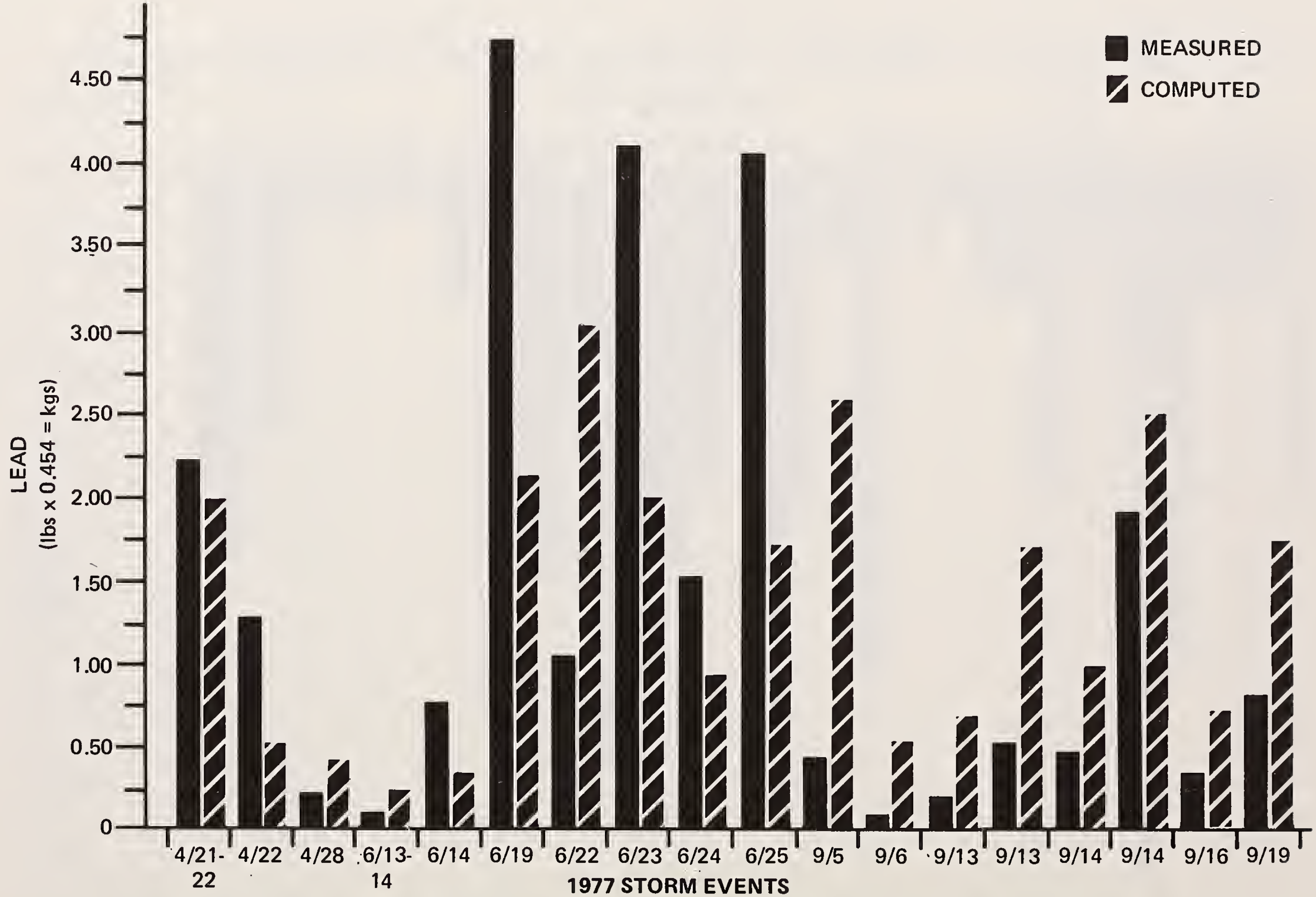


Figure 19. Measured versus computed lead at Nashville I-40, 1977.

Table 30. Model results for Harrisburg I-81, 1976 and 1977.

Date	Total solids, lb		Suspended solids, lb		TPO4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
5/16/76	189	373	20	83	0.27	0.56
7/7	227	627	86	164	0.27	1.10
7/7	1344	1427	509	420	3.13	2.87
9/10	204	287	11	55	0.19	0.37
10/20	632	312	21	63	1.97	0.43
4/24/77	337	37	56	0	0.22	0.00
6/6	30	18	0.6	0	0.01	0.00
6/9	53	38	0.4	0	0.004	0.00
6/14	275	201	8	27	0.07	0.19
6/17	105	63	5	0	0.04	0.00
6/25	92	157	19	13	0.11	0.09
6/25	167	149	31	10	0.15	0.08
Total	3655	3689	767	835	6.43	5.64
	COD, lb		Lead, lb		Iron, lb	
5/16/76	*		0.04	0.12	0.62	3.62
7/7	20	55	0.06	0.23	4.06	7.17
7/7	*	26	0.61	0.56	20.86	18.37
9/10	21	26	0.06	0.09	0.52	2.41
10/20	77	28	0.35	0.10	2.11	2.15
4/24/77	29	4	0.09	0.00	1.95	0.00
6/6	2	2	0.01	0.00	0.03	0.00
6/9	2	4	0.01	0.00	0.01	0.00
6/14	13	18	0.06	0.05	0.14	1.20
6/17	6	6	0.03	0.00	0.11	0.00
6/25	10	14	0.03	0.04	0.61	0.59
6/25	33	13	0.05	0.03	0.95	0.48
Total	212	170	1.40	1.22	31.97	36.59

Note: *Not monitored
Metric units: lb x 0.454 = kg

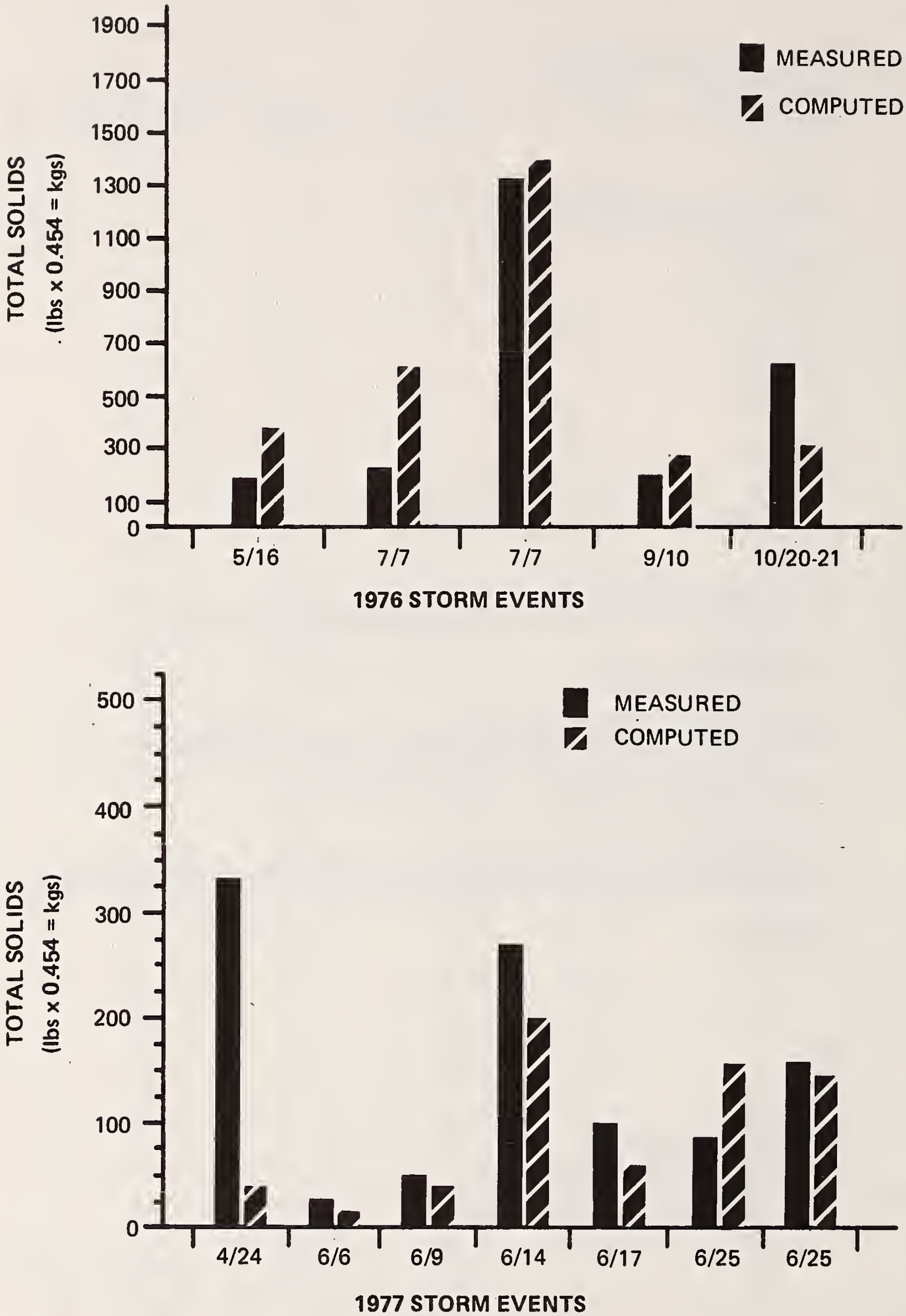
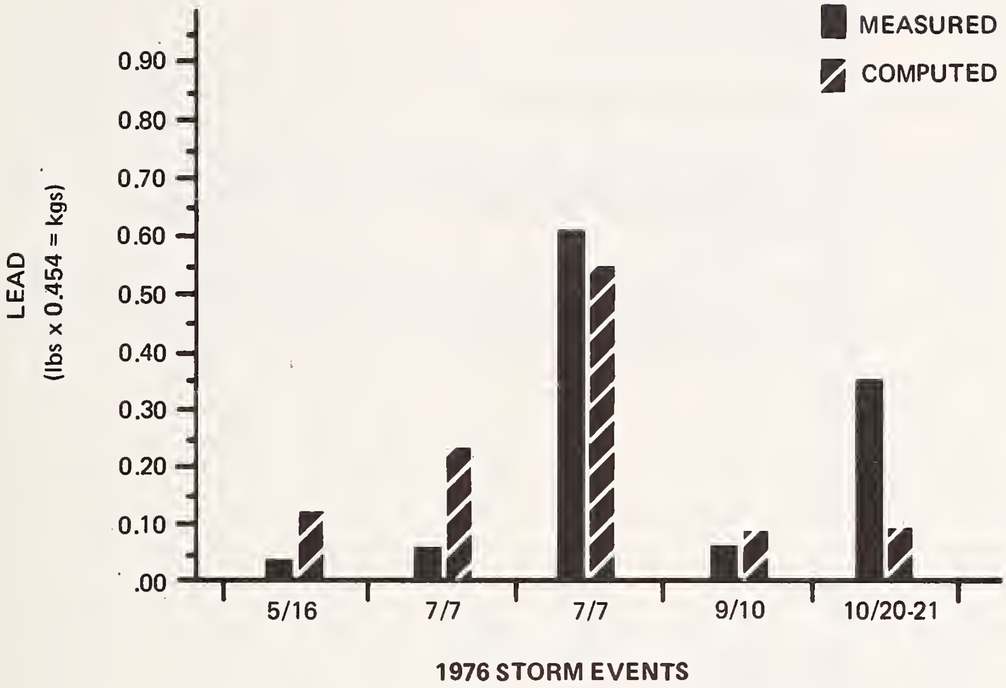


Figure 20. Measured versus computed total solids at Harrisburg I-81, 1976 and 1977.



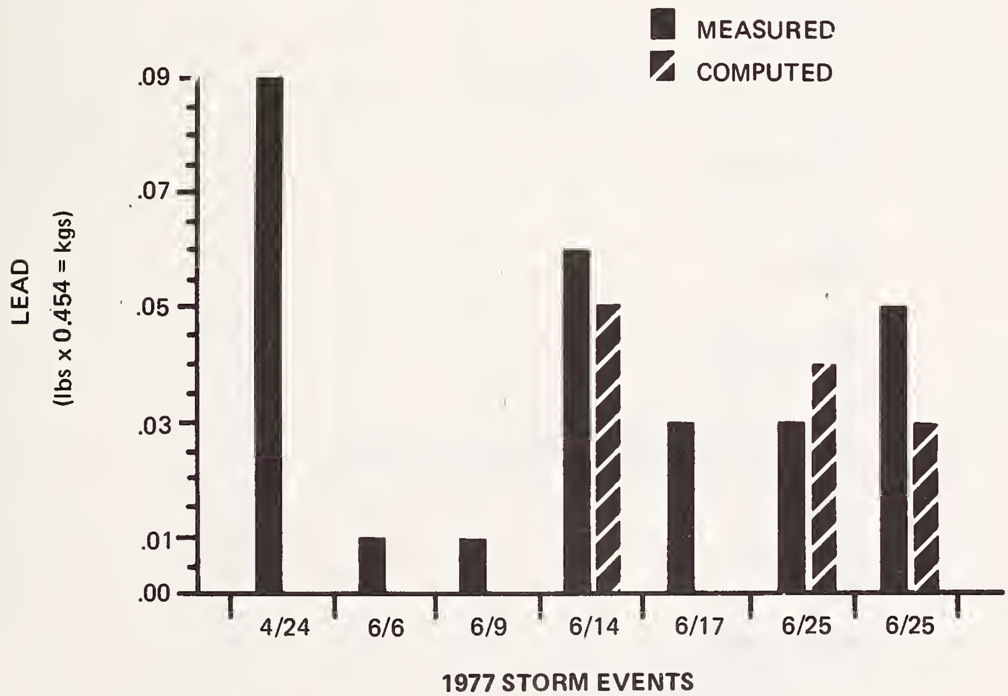


Figure 21. Measured versus computed lead at Harrisburg I-81, 1976 and 1977.

Table 31. Model results for Denver I-25, 1976 and 1977.

Date	Total solids, lb		Suspended solids, lb		TPO4, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
8/2/76	741	20	361	0	1.03	0.00
9/25	529	443	370	91	0.86	0.68
9/26	2293	1437	1652	717	3.12	2.91
4/11/77	756	211	566	0	0.68	0.15
4/12	389	65	248	0	0.43	0.00
4/15	733	286	501	0	0.77	0.32
4/19	1628	512	927	134	1.55	0.83
5/7	421	732	324	273	0.45	1.33
6/6	119	355	79	35	0.15	0.48
6/9	149	226	79	0	0.15	0.19
6/23	64	210	31	0	0.15	0.15
7/5	1823	6548	1366	3937	2.66	14.41
7/20	807	1540	445	782	0.92	3.15
7/24	235	1420	122	707	0.25	2.88
7/25	329	1113	192	513	0.49	2.19
Total	11016	15118	7263	7189	13.66	29.67
	COD, lb		Lead, lb		Iron, lb	
8/2/76	302	279	0.63	0.06	13.72	0.00
9/25	213	361	0.72	0.49	13.81	3.68
9/26	700	553	3.53	1.51	62.32	23.16
4/11/77	317	316	0.81	0.26	17.66	0.00
4/12	179	288	0.36	0.11	9.71	0.00
4/15	312	331	0.79	0.33	18.49	0.61
4/19	738	374	1.69	0.56	36.61	5.03
5/7	170	417	0.57	0.79	10.28	9.36
6/6	50	344	0.13	0.40	3.06	1.55
6/9	120	299	0.13	0.27	2.90	0.00
6/23	40	316	0.05	0.26	1.26	0.00
7/5	590	1539	1.18	6.72	38.94	123.33
7/20	387	573	0.84	1.61	14.29	25.19
7/24	108	549	0.26	1.49	3.31	22.84
7/25	112	490	0.30	1.19	6.07	16.82
Total	4338	7029	11.99	16.04	252.43	231.97

Metric units: lb x 0.454 = kg

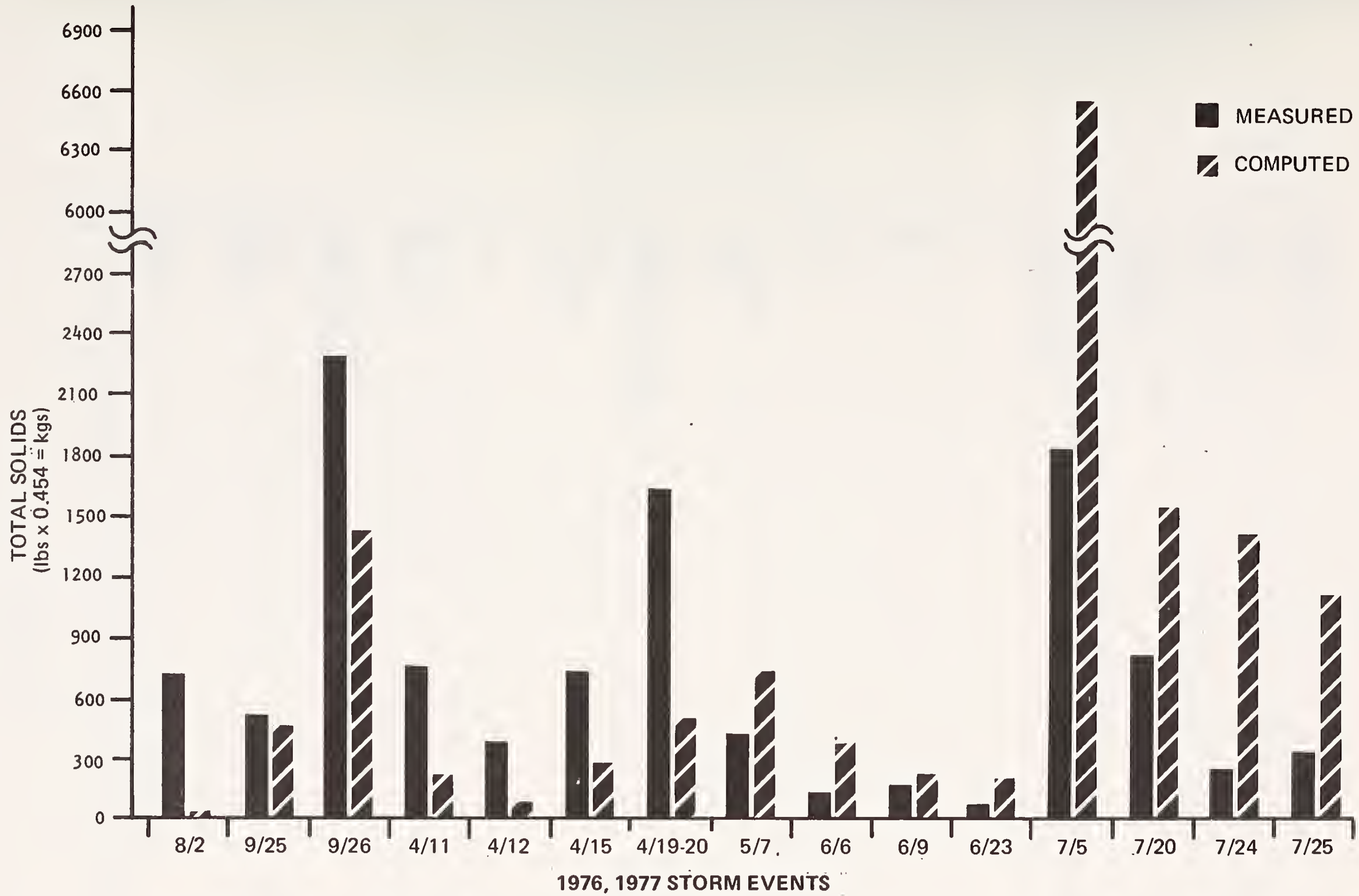


Figure 22. Measured versus computed total solids at Denver I-25, 1976 and 1977.

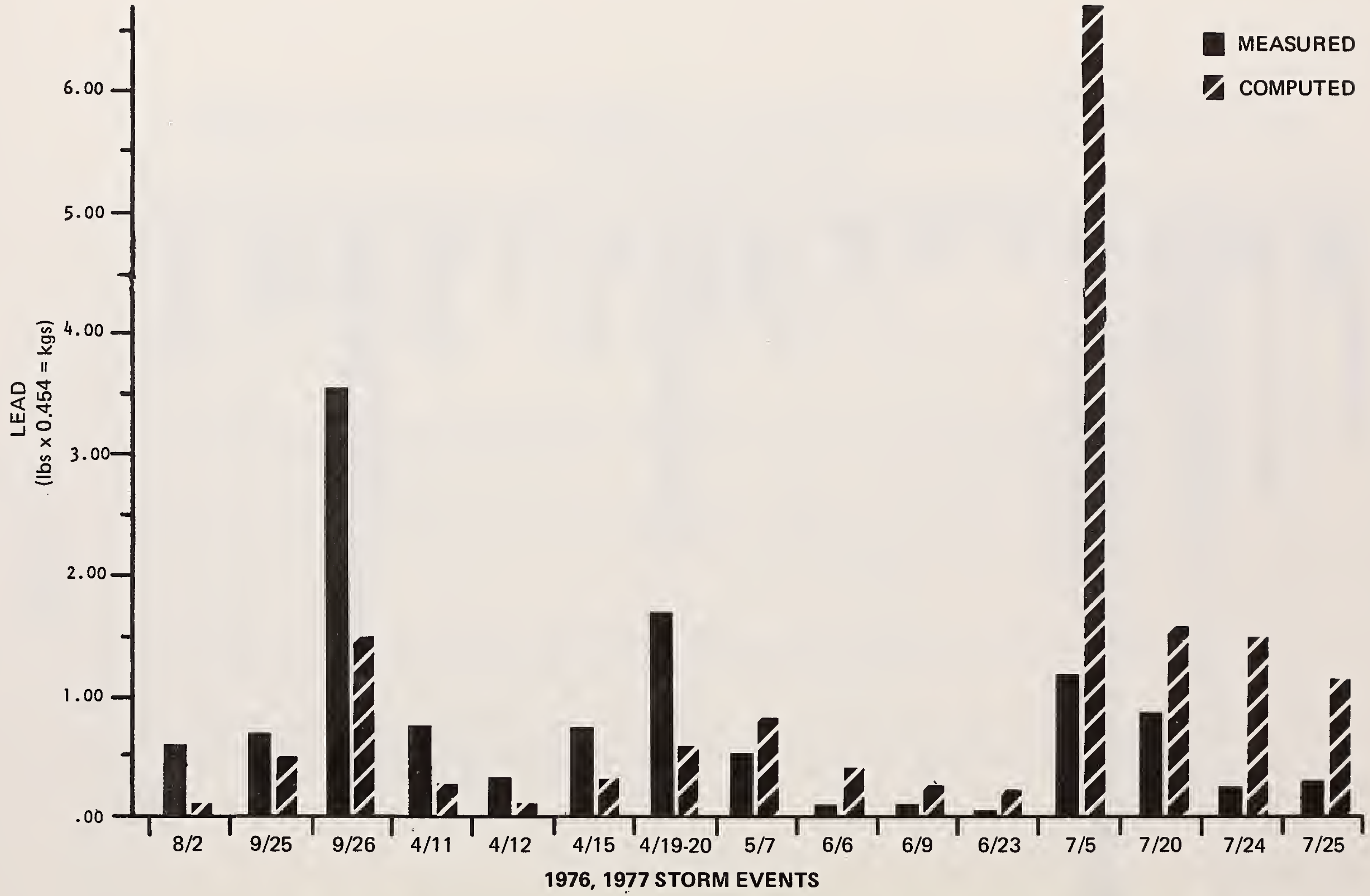


Figure 23. Measured versus computed lead at Denver I-25, 1976 and 1977.

Dallas I-45

The predictive procedure was applied to another study area independent of the subject project. The rainfall record and monitoring data were used as an indication of the models ability to predict pollutant loads from a site which was not used to develop the model parameters. This site will then serve as a verification of the model for a Type I site. The model used the ADT of 33,000 to calculate a K_1 value of 73.5 lb/mi-day (20.7 kg/km-day). The simulated rainfall record for 1977 contains 12 rainfall events with 8 events sampled for various quality parameters. Appendix G (pages 189 to 192) lists the model output for these events. Table 32 provides the monitored and predicted comparisons while Figure 24 and 25 present total solids and lead values.

The monitored total solids load equalled 468 lb (212 kg) while the predicted value was 627 lb (285 kg). All of the remaining computed parameters generally over-predicted except COD. These over-predictions are related to the methods used to determine total flow volume for this site. Because the detailed hydraulics data for this site was not available at the time, individual flow records were estimated assuming 90 percent of the rainfall resulted in runoff (Q/R = 0.9). This estimation has a significant impact on events that occurred on 7/21 and 8/28 where 90 percent of the total variation between predicted and monitored total solids occurs.

If the data as calculated by an average Q/R is used for evaluation, and two listed events are dropped, then the model can be considered verified for a Type I site. As further data becomes available, the remaining site types can be similarly verified.

MODEL LIMITATIONS

The ability of this predictive procedure to represent the runoff process from various highway systems will be determined in future applications. The predictive procedure or model is a tool for evaluating the effects of increased traffic, changes in the highway configuration or other design aspects on the loading of solids or other constituents to the receiving water.

Because of the complex interactions of rainfall, runoff and traffic on a highway, the predictive model has certain limitations which must be recognized before its use can be fully evaluated. The most obvious limitations are as follows:

1. The model assumes the highway area to be uniformly characterized by the three site types that are listed. Significant variations in a site may have widely varying results.

Table 32. Model results for Dallas I-45, 1977.

Date	Total solids, lb		Suspended solids, lb		COD, lb	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
6/15/77	56	23	10	9	39	10
6/23	23	74	2	36	27	20
7/9	55	79	19	38	27	21
7/21	172	309	112	161	157	68
7/26	62	65	26	31	38	19
7/27	49	13	24	4	20	8
8/14	25	15	7	5	21	8
8/28	26	48	4	23	16	15
Total	468	626	204	307	345	169
	Lead, lb		Iron, lb			
6/15/77	0.07	0.10	0.44	0.93		
6/23	0.10	0.39	0.30	1.70		
7/9	0.06	0.42	0.21	1.77		
7/21	0.56	1.71	2.79	5.23		
7/26	0.17	0.34	0.98	1.56		
7/27	0.13	0.05	0.61	0.78		
8/14	0.05	0.06	0.16	0.81		
8/28	0.04	0.25	0.11	1.32		
Total	1.18	3.32	5.60	14.10		

Metric units: lb x 0.454 = kg

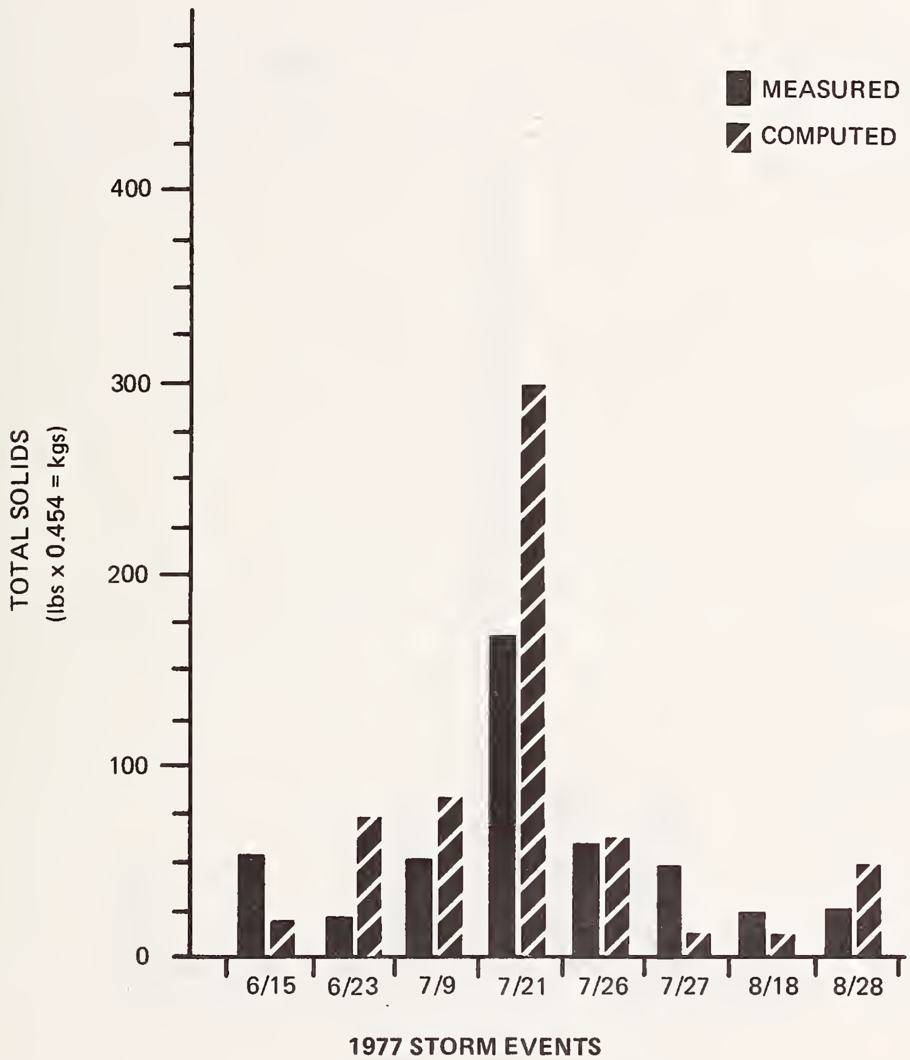


Figure 24. Measured versus computed total solids at Dallas I-45, 1977.

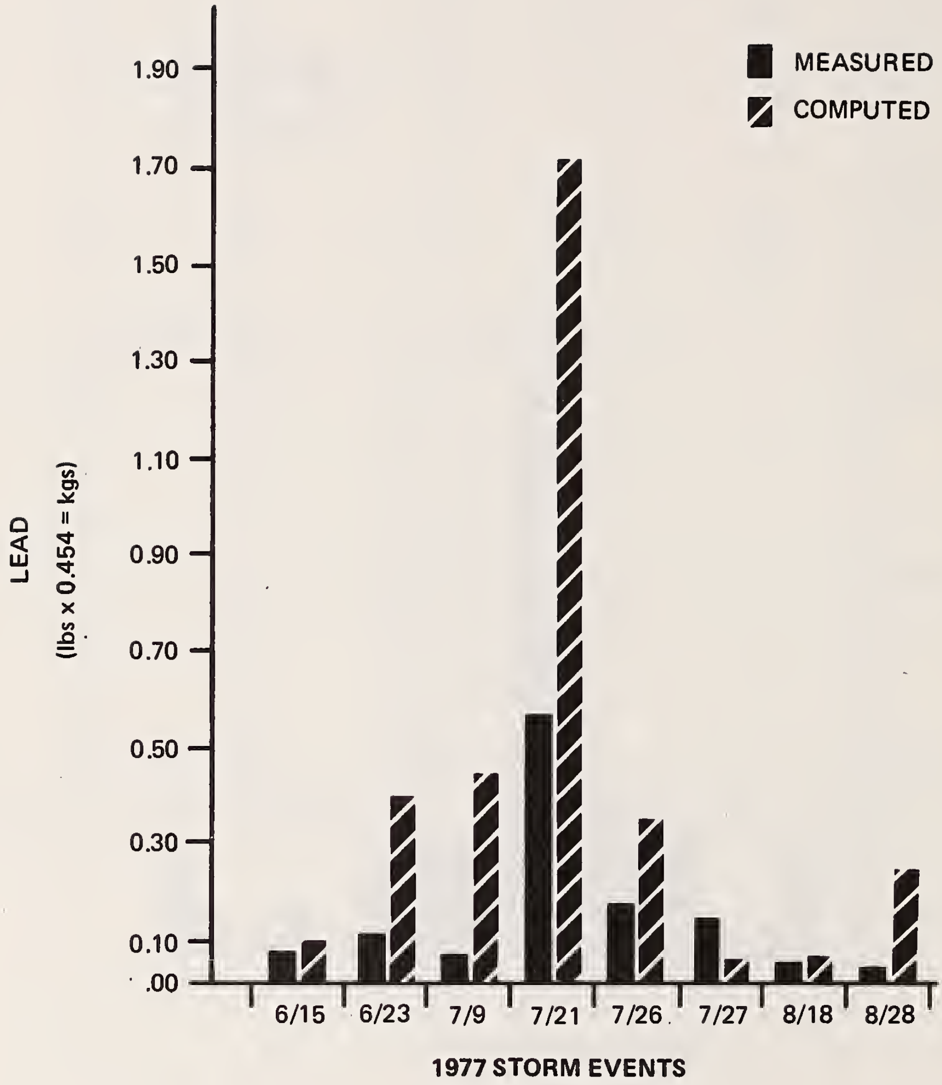


Figure 25. Measured versus computed lead at Dallas I-45, 1977.

2. The predicted pounds of total solids washed off during a rainfall event are dependent upon the model prediction of the surface load at the start of the storm. If the surface load is underestimated, the pounds discharged will be low.

3. The use of average runoff rate to remove surface pollutants is the quickest and easiest method. Peak runoff intensities during the runoff hydrograph may be more accurate, but are too complex for this procedure.

4. Long dry periods and overlapping storms present predictive problems in determining the prestorm surface load.

5. Construction activities are difficult to simulate unless monitoring data is available to determine K_1 values.

SECTION V
RECEIVING WATER IMPACT

The intended use of the predictive procedure eventually may involve the determination of the impact of highway runoff on a receiving body of water such as a lake or stream. The complex determination of the resulting water quality is beyond the scope of this analysis, however, the relative comparison of urban runoff to highway loads can be used to evaluate the anticipated impact.

ANNUAL HIGHWAY LOADS

In order to compare the impact of highway runoff with other pollutant sources, the data collected from the monitoring program at the five sites has been reduced to an average pounds (kg) of pollutant per acre (ha) of contributing area per inch (cm) of runoff. This data is summarized in Table 33 for nonwinter conditions at all sites. The unit lb/ac-in. of runoff allows the comparison of different types of drainage areas with different perviousness and runoff characteristics. Other units of this table include concentrations in mg/l and loadings in pounds per acre (kg/ha).

In order to generate an annual load for the monitoring sites, the weighted average annual rainfall volume for the sites was calculated as approximately 32.5 inches (82.5 cm), and the percent of imperviousness as a weighted average was approximately 34 percent. Using this data, approximately 12 to 14 inches (30-36 cm) of runoff will be generated during the nonwinter periods of the year over these sites on an average basis. The average drainage area size is 43.5 acres (17.6 ha). The data of Table 33 provides the lb/acre-in. (kg/ha-cm) of runoff column so that the annual load from the highway system can be expressed as a yearly load as shown in Table 34.

Table 34. Yearly highway runoff loads.

Parameter	Pollutant loading, lb/acre-in. runoff	Pollutant loading, lb/acre-yr
TS	260	3,380
SS	59	767
BOD_5	5.4	70.2
Pb	0.22	2.86
Fe	2.34	30.4
COD	33	429

metric units: lb/acre x 1.12 = kg/ha
lb/acre/in. x 0.441 = kg/ha/cm

Table 33. Summary of highway runoff quality data for all six monitoring sites - nonwinter 1976-77.

Parameter	Pollutant concentration, mg/l	Pollutant loading, lb/ac-event	Pollutant loading, lb/ac-in. runoff
TS	1,147	51.8	260
SS	261	14.0	59
VSS	77	3.7	17
TVS	242	9.4	55
BOD_5	24	0.88	5.4
TOC	41	2.1	9.3
COD	147	6.9	33
TKN	2.9	0.15	0.68
TN	1.1	0.07	0.26
TPO_4	0.8	0.05	0.18
Cl^-	386	13.0	88
Pb	0.96	0.06	0.22
Zn	0.41	0.02	0.04
Fe	10.30	0.5	2.34
Cu	0.10	.0056	0.02
Cd	0.04	.0017	0.009
Cr	0.04	.0028	0.009
Hg	3.22×10^{-3}	5.9×10^{-7}	7.3×10^{-4}
Ni	0.02	0.27	2.25

metric units: lb/ac x 1.12 = kg/ha
lb/ac-in. x 0.441 = kg/ha-cm

The yearly loads listed above are generalized for 13 inches (33 cm) of runoff per year. Similar calculations can be made for any of the parameters listed in Table 33.

IMPACT EVALUATIONS

An early task of the subject project was to sample a small receiving stream (Pine River) near the Harrisburg I-81 site prior to, during and after a rainfall event. The purpose of this effort was to quantify the effects of the highway runoff on the stream. Samples of both the instream quality and bottom sediment material were acquired upstream and downstream of the highway runoff discharge point. Analysis of the samples showed nearly uniform contamination of the bottom material for various parameters which were thought to be sensitive to highway runoff. Factors such as upstream sources of highway runoff, residual effects from construction activities and overall contamination of the stream forced curtailment of further monitoring efforts. Appendix F contains the results of this sampling effort. Future phases of Federal Highway Administration research will be directed toward the collection of such data and the quantification of receiving water impacts.

Concentrations and loadings for each parameter are provided in this section so the user of the predictive procedure can compare the magnitude of various loads to a receiving body and then evaluate the impact of the highway. Table 33 allows for a comparison of highway loading data to other pollutant sources affecting receiving water quality in a number of different ways. The most common (but least accurate) method is comparison of highway runoff concentrations with urban runoff, industrial, municipal, and nonpoint discharge concentrations.

In order to obtain a suitable average concentration which is representative of the entire country, the data listed in the "Urban Stormwater Management Technology" publication of EPA is used. This publication lists average concentrations of stormwater for 15 cities with combined sewer overflow (CSO) and 11 cities with storm sewer data. Table 35 presents an average of these values for both CSO and stormwater. These values represent the average concentrations for the 11 and 15 cities presenting data.

Comparison of this data with the highway runoff data (Table 35) show the storm sewer BOD and COD to be almost equal to highway concentrations. The CSO data are much higher in concentration as are the suspended solids data for storm sewers. A simple comparison of concentrations for these three sources to receiving water shows the highway runoff constituents to have generally lower concentrations for these parameters. Comparisons such as these are inconclusive since the sampling methods have a significant influence on the magnitude of the concentrations. The highway data is a result of flow proportioned composite samples which reflect the entire discharge period. Other

Table 35. Average concentrations for combined sewer, storm sewer and highway discharges.

Parameter	Combined sewer (15), mg/l	Storm water (15), mg/l	Highway, mg/l
BOD_5	119	27	24
COD	265	176	147
Total suspended solids	408	639	261

values may be the result of discrete samples taken during the first flush portion of the overflow which would tend to overpredict the composite concentration, or discrete samples taken late in the runoff period which would tend to underpredict the composite concentration. Many other factors enter into the comparison of concentrations. For purposes of the receiving water impact, however, the runoff concentration may not effect the receiving water. The pounds of pollutant discharged is a more significant determination. For example, if discharge A has half the concentration of discharge B, but A has twice the total flow of B, then both discharges release equal loads to the receiving body. Thus, concentration alone is meaningless unless some estimate of flow is available to determine total load and resulting concentrations in the receiving water body.

A more meaningful representation of the impact potential of various discharges can be determined by expressing the loads on an annual basis. This procedure accounts for variation in rainfall, flows and concentrations of individual events by generating the annual loading. To overcome these discrepancies the runoff or discharge data is normalized to the pounds per acre per year values presented previously in Table 34. A comparison of loads can now be made which better represents the relative impact potential of highway runoff. Data available from the literature can then be used to compare various pollutant sources.

An EPA report (16) entitled, "Nationwide Evaluation of Combined Sewer Overflows and Urban Stormwater Discharges, Volume III" presents annual loads for municipal and urban sources which are listed in Table 36. Since ultimate BOD values were not determined in this project, a comparison of BOD values between these data sources requires the transformation of BOD_5 highway data to ultimate BOD. The ultimate BOD value for highway runoff in Table 36 was obtained by assuming BOD_5 to be 70 percent of the ultimate.

Highway runoff values are significantly lower than published urban runoff values in all categories listed. Similarities exist between

Table 36. Annual loads for highway, municipal and urban runoff sources - lb/ac-yr.

	Ultimate BOD	Suspended solids	COD
Municipal effluent (16)	61	50	92
Urban runoff (16)	470	6690	938
Highway runoff	15.7	186	88

metric units: lb/ac/yr x 1.12 = kg/ha/yr

municipal effluent and highway runoff data for ultimate BOD and COD.

CONCLUSIONS

The data presented in this section has been limited to BOD, COD and suspended solids. These parameters are the only readily available data on urban runoff normally published as an annual load. For purposes of determining receiving water impacts these parameters provide an indication of the impact potential of highway runoff. Parameters such as lead or other heavy metals, which are normally not evaluated, may be more significant for highway runoff.

The brief data comparisons of this section indicate that highway runoff is similar in loading per unit area for the example parameters to storm sewer discharges but much less significant than combined sewer loads. Urban runoff loads which contain both storm and combined discharges exhibit much more impact potential for the three parameters.

SECTION VI
CONCLUSIONS AND RECOMMENDATIONS

1. Equations were developed relating runoff volume to rainfall volume for three highway site types as follows:

   Type I - urban elevated bridge decks with 100% paved areas
   $Q = 0.969\ R - 0.019$

   Type II - urban paved and nonpaved drainage areas
   $Q = 0.470\ R^{1.369}\ DD^{-0.086}$

   Type III - rural flush shouldered highways
   $Q = 0.845\ R^{1.892}\ DD^{-0.654}$

   where; Q = runoff volume (inches)
   R = rainfall volume (inches)
   DD = dry days to last storm event

2. Pollutant accumulation rates developed in this project are comparable to other highway studies.

3. Pollutant accumulation rates are related to traffic using the following equation;

   $$K_1 = 0.007\ (ADT^{0.89})$$

   where; K_1 = pollutant accumulation rate (lb/mi-day)
   ADT = average daily traffic (vehicles/day)

4. Total solids showed the highest correlation with other monitored parameters and is therefore used as the carrier pollutant in the predictive procedure to estimate 16 other parameters.

5. The wash-off coefficient (K_2) used in many surface water quality models and used in this procedure can be written as:

   $$P = P_o\ (1-e^{-K_2 r})$$

   where; P = pounds washed-off
   P_o = pounds at start of rainfall event
   K_2 = wash-off coefficient
   r = average runoff rate, in./hr

   The wash-off coefficient developed for the three highway site types used in this study are:

   K_2 = 5.0 for urban elevated bridge decks with 100 percent paved areas (Type I)
   K_2 = 6.5 for urban paved and nonpaved drainage areas (Type II)
   K_2 = 12.0 for rural flush shouldered highways (Type III)

6. The predictive model is better suited to continuous simulations using daily rainfall records covering periods of at least one month than design events, due to its inability to predict surface loads prior to individual events.

7. Highway runoff shows less impact potential than urban stormwater as measured by BOD and suspended solids.

RECOMMENDATIONS

1. Verification of the predictive procedure should be continued using data from other sites.

2. Measure the actual pollutant buildup on highway surfaces to determine the relationships between site characteristics and accumulation rates.

3. Investigate the effects of highway runoff on receiving waters in a separate, comprehensive study.

4. Investigate the pollutant characteristics of nonpaved runoff for various vegetative and side-slope configurations. Additional hydraulic information from nonpaved areas could lead to the development of a more sophisticated procedure to predict total runoff volume in which paved and nonpaved runoff are estimated separately.

SECTION VII
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SECTION VIII
GLOSSARY

Carrier pollutant
Pollutant exhibiting the highest degree of association with all other pollutants; used in the model to estimate the quantity of all other quality parameters.

CSO
Combined sewer overflow.

Dry days
The number of days in which less than 0.05 inches of rain fell prior to the event under consideration.

Highway length
The actual length of highway section in the contributing drainage area; this is in contrast to curb mile or lane mile, which is a multiple of the highway length.

K_1
The variable used to represent the rate at which surface pollutants accumulate, expressed as pounds per mile - day.

K_2
The constant used in the wash-off equation which removed the surface pollutant load; the wash-off coefficient.

Nonpaved
That portion of the highway drainage area that is partially or completely pervious.

Paved
That portion of the highway drainage area composed of concrete or asphalt traffic lanes, exit ramps or shoulder areas.

Pre-storm
That period of time prior to the rainfall event under consideration which contains the pollutant build-up period, measured in days.

Q/R
Runoff (Q) to rainfall (R) ratio; relates the total volume of runoff from both the paved and nonpaved portions of the drainage area to the amount of rain causing the runoff.

Type I
Urban highway site, elevated bridge deck, 100 percent paved with impact barriers containing each set of lanes.

Type II
Urban highway site, mountable curb with paved and nonpaved drainage area.

Type III
Rural highway site with flush shoulders, paved and nonpaved runoff through ditches.

APPENDIX A - RAINFALL - RUNOFF DATA

Table A-1. Milwaukee I-794 rainfall-runoff monitoring data, 1976 and 1977.

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
4/4/76	0.10	0.07	.70	2	1.30	2.00	1.54
4/10	0.61	0.34	.56	6	4.50	5.80	1.29
4/15	0.65	0.58	.89	5	0.50	0.70	1.40
4/17	0.36	0.31	.87	2	2.30	2.80	1.22
4/20	0.18	0.15	.83	3	2.30	2.50	1.09
4/21	0.37	0.30	.81	1	2.00	2.50	1.25
4/24	0.06	0.04	.67	3	0.80	1.20	1.50
4/24	2.27	1.92	.85	0	11.00	13.00	1.18
5/5	2.15	2.61	1.21	11	2.00	4.50	2.25
5/10	0.15	0.14b	--	5	1.00	0.75b	--
5/15	0.90	0.85b	--	5	12.00	11.50b	--
5/28	0.63a	0.60b	--	13	2.00a	2.50b	--
5/30	0.10a	0.10b	--	2	3.00a	3.50b	--
6/13	0.58a	0.55b	--	14	3.50a	4.00b	--
6/18	0.90	0.73	.81	5	2.75	3.42	1.24
6/24	0.05	0.03	.60	6	0.75	1.45	1.93
6/27	0.05	0.02	.40	3	0.17	0.75	4.41
7/28	0.33	0.27	.82	31	2.25	2.91	1.29
7/30	1.59	1.39	.87	2	4.00	4.08	1.02
8/5	0.05	0.04	.80	6	0.17	0.75	4.41
8/13	0.64	0.58	.91	8	5.25	5.41	1.03
8/25	0.14	0.12	.86	12	1.00	1.92	1.92
8/28	1.05	1.17	1.11	3	3.00	4.58	1.53

Note: -- Not calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
Metric units: in. x 2.54 = cm

(continued)

Table A-1. Milwaukee I-794 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
9/1/76	0.39	0.38	.97	4	1.75	4.17	2.38
9/9	0.85a	0.86	--	8	6.00	6.92	1.15
9/19	0.30	0.28	.93	10	4.00	8.92	2.23
10/5	1.20	1.19	.99	16	12.00	18.50	1.54
10/23	0.05	0.04	.80	18	3.30	3.50	1.06
10/24	0.05	0.04	.80	1	2.30	4.30	1.87
10/26	0.10	0.09	.90	2	1.50	3.30	2.20
10/30	0.16	0.15	.94	4	3.50	6.50	1.86
10/30	0.32	0.30	.94	0	5.50	7.50	1.36
4/2/77	0.15	0.12	.80	3	1.08	1.50	1.39
4/2	0.15	0.12	.80	0	1.08	1.80	1.67
4/4	0.19	0.18	.95	2	1.42	2.00	1.41
4/4	0.25	0.23b	--	0	2.25	2.58b	--
4/5	0.05	0.03	.60	1	0.75	0.92	1.23
4/18	0.05	0.04	.80	13	0.50	1.00	2.00
4/19	0.13	0.11	.85	1	0.75	1.33	1.77
4/21	0.10	0.09	.90	2	1.50	2.50	1.67
4/24	0.05	0.03	.60	3	0.50	0.67	1.34
5/5	0.07	0.06	.86	11	1.30	2.30	1.77
5/17	0.11	0.10	.91	12	0.75	1.33	1.77
5/21	0.05	0.04b	--	4	0.25	0.38b	--
5/31	0.17	0.16	.94	10	1.30	2.30	1.77
6/5	.52	0.46	.88	5	0.50	1.50	3.00

Note: -- Not calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
Metric units: in. x 2.54 = cm

(continued)

Table A-1. Milwaukee I-794 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
6/5/77	0.70	0.68	.97	0	4.30	5.00	1.16
6/8	0.24	0.24	1.00	3	6.49	6.83	1.06
6/10	0.05	0.04	.80	2	1.25	1.92	1.53
6/11	1.22	1.15	.94	1	4.45	4.20	0.94
6/17	0.61	0.61	1.00	6	0.33	2.17	6.57
6/28	0.10	0.10	1.00	11	0.08	0.83	10.41
6/28	0.57	0.57	1.00	0	3.21	3.67	1.14
6/30	0.79	0.76	.96	3	2.50	3.10	1.24
7/3	0.35	0.33	.94	3	2.00	2.63	1.32
7/6	0.11	0.10	.91	3	0.25	0.75	3.00
7/17	2.60	2.34b	--	11	1.67	2.58b	--
7/17	2.10	2.01b	--	0	9.00	10.44b	--
7/24	0.42	0.35	.83	7	1.00	1.25	1.25
7/29	0.05	0.01	.20	5	0.50	0.88	1.76
8/2	0.05	0.02	.40	4	0.75	0.88	1.17
8/3	0.35	0.30	.86	1	0.75	1.25	1.67
8/4	0.17	0.17	1.00	1	0.92	1.42	1.54
8/5	0.15	0.14	.93	1	0.42	0.83	1.98
8/5	0.24	0.15	.63	0	3.00	5.42	1.81
8/7	0.25	0.24b	--	2	5.25	5.72b	--
8/9	0.07	0.06b	--	2	1.25	2.50	2.00
8/13	1.28	1.04	.81	4	2.33	2.42	1.04

Note: -- Not calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
Metric units: in. x 2.54 = cm

(continued)

Table A-1. Milwaukee I-794 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
8/16/77	0.20	0.16	.80	3	2.00	2.63	1.32
8/22	0.15	0.14b	--	6	2.75	3.82b	--
8/22	0.05	0.04b	--	0	0.50	1.69b	--
8/28	1.10	0.79	.72	6	8.00	9.50	1.19
9/4	0.11	0.10b	--	7	0.25	0.85b	--
9/12	0.47	0.35	.74	8	8.00	9.00	1.13
9/16	0.12	0.05	.42	4	4.75	5.17	1.09
9/17	0.29	0.18	.62	1	1.50	2.25	1.50
9/18	0.28	0.17	.61	1	5.00	6.00	1.20
9/23	0.05	0.02	.40	5	0.08	0.17	2.13
9/23	0.13	0.12	.92	0	0.25	0.33	1.32
9/24	0.81	0.80	.99	1	2.00	2.17	1.09
9/25	0.17	0.15	.88	1	0.50	1.00	2.00
9/30	0.59	0.31	.53	5	4.80	5.00	1.04
9/30	0.17	0.12	.71	0	2.80	3.30	1.18
10/5	0.10	0.08	.80	5	1.00	1.75	1.00
10/7	0.94	0.40	.43	2	9.00	20.25	2.25
10/15	0.05	0.02	.40	8	1.00	1.13	1.13
10/18	0.06	0.05	.83	3	0.17	0.75	4.41
10/24	0.05	0.02	.40	6	0.17	0.75	4.41
10/31	0.10	0.07	.70	7	1.50	1.50	1.00
Average[c]	0.39	0.34	0.87	4.84	2.36	3.44	1.46

Note: -- Not calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
c Does not include any event with an estimated value.
Metric units: in. x 2.54 = cm.

Table A-2. Milwaukee Hwy. 45 rainfall-runoff monitoring data, 1976 and 1977.

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
4/4/76	0.06	0.01	0.17	5	1.33	2.58	1.94
4/10	0.40	0.10	0.25	6	4.58	8.00	1.75
4/17	0.09	0.05	0.56	7	1.67	5.50	3.29
4/18	0.05	0.01	0.20	1	0.08	1.33	16.63
4/20	0.15[a]	0.06	--	2	2.25[a]	5.25	--
4/21	0.45	0.10	0.22	1	4.75	8.00	1.68
4/24	1.93	1.76	0.91	3	21.25	28.0	1.32
5/5	1.36	0.85	0.63	11	4.17	7.25	1.74
5/10	0.14[a]	0.04	--	5	0.92[a]	2.50	--
5/15	1.28[a]	0.38	--	5	21.50[a]	21.50	--
5/28	0.60	0.19[b]	--	13	16.25	21.45[b]	--
5/30	0.06	0.01[b]	--	2	0.83	5.74[b]	--
6/13	0.75	0.21	0.28	14	8.25	10.25	1.24
6/18	0.66	0.27	0.41	5	4.42	10.08	2.28
6/27	0.08	0.03	0.38	9	2.00	2.50	1.25
7/28	0.33	0.06	0.18	31	1.83	4.75	2.60
7/30	1.14	0.23	0.20	2	3.67	5.75	1.57
8/5	0.05	0.01	0.25	6	0.08	0.47	5.88
8/5	0.05	0.02	0.40	0	1.75	4.00	2.29
8/14	0.31	0.08	0.26	9	3.75	8.47	2.26
8/25	0.37	0.09	0.24	11	1.08	7.47	6.92
8/28	0.92	0.29	0.31	3	3.67	11.17	3.04
9/1	0.31	0.10	0.32	4	1.75	4.50	2.57
9/9	0.80	0.32	0.40	8	7.67	10.50	1.37
9/19	0.37	0.08	0.22	10	5.07	5.92	1.17

(continued)

Note: -- Not calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
Metric units: in. x 2.54 = cm

Table A-2. Milwaukee Hwy. 45 rainfall-runoff monitoring data, 1976 and 1977 (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
10/5/76	1.40	0.49	0.35	16	26.58	30.00	1.13
10/23	0.15	0.02	0.13	18	3.25	5.75	1.77
10/24	0.05	0.01	0.20	1	2.50	3.75	1.50
10/26	0.05	0.01	0.20	2	0.75	5.25	7.00
10/30	0.46	0.14	0.30	4	14.58	20.00	1.37
4/2/77	0.62	0.25	0.40	1	6.25	18.50	2.96
4/4	0.42	0.37	0.88	2	5.75	9.00	1.57
4/20	0.19	0.07	0.37	16	2.08	6.00	2.88
4/21	0.20	0.08	0.40	1	10.00	14.75	1.48
4/24	0.15	0.02	0.13	3	4.25	5.75	1.35
4/27	0.06	0.01	0.17	3	4.50	4.75	1.06
5/4	0.18	0.03	0.17	7	3.00	3.75	1.25
5/21	0.05	0.01	0.20	17	1.25	3.00	2.40
5/31	0.07	0.01	0.14	10	4.25	5.61	1.32
6/1	0.05	0.01	0.20	1	0.17	0.22	1.29
6/5	0.83	0.23	0.28	4	3.92	6.17	1.57
6/5	0.56	0.20	0.36	0	0.33	4.50	13.64
6/16	0.10	0.01	0.10	1	0.25	2.50	10.00
6/8	0.27	0.04	0.15	2	6.50	11.67	1.80
6/11	0.61	0.15	0.25	3	6.42	8.83	1.38
6/17	0.60	0.21	0.35	6	0.50	7.00	14.00
6/27	0.40	0.21	0.53	10	9.50	13.00	1.37
6/30	0.71	0.22	0.31	3	2.42	6.00	2.49

(continued)

Metric units: in. x 2.54 = cm

Table A-2. Milwaukee Hwy. 45 rainfall-runoff monitoring data, 1976 and 1977 (continued).

Date	Total rainfall (R) inches	Runoff (Q) inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
7/3/77	0.30	0.09[b]	--	3	2.75	3.66[b]	--
7/6	0.25	0.07[b]	--	3	1.42	1.82[b]	--
7/17	2.28	0.66[b]	--	11	6.67	8.82[b]	--
7/17	1.45	0.42[b]	--	0	10.08	13.33[b]	--
Average[c]	0.43	0.17	.40	6.17	4.69	7.96	1.70

Note: -- Calculated.
a Value obtained from city raingage, not from raingage at monitoring site.
b Estimated value.
c Does not include any event with an estimated value.
Metric units: in. x 2.54 = cm

Table A-3. Nashville I-40 rainfall-runoff monitoring data, 1976 and 1977.

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
10/20/76	0.80	0.21	.26	--	5.83	9.08	1.56
10/23-24	0.58	0.11	.19	3	9.50	11.42	1.20
10/25	0.51	0.44	.86	1	9.58	15.75	1.64
10/30	1.09	0.39	.36	5	8.25	11.08	1.34
4/1/77	0.18	0.05	.28	2	1.75	3.67	2.10
4/2	1.21	0.27	.22	1	7.00	7.00	1.00
4/3-4	1.91	1.15	.60	1	9.00	16.25	1.81
4/4	0.45	0.21[a]	--	0	4.34	6.17	1.42
4/21-22	0.99	0.35	.35	17	11.50	11.92	1.04
4/22	0.41	0.25	.61	0	10.58	17.50	1.65
4/23	0.17	0.05[a]	.30	1	0.41	4.08	9.95
4/24	0.10	0.03[a]	.30	1	0.50	1.17	2.34
4/24	0.21	0.05	.47	0	1.00	3.25	3.25
4/28	0.20	0.03	.15	4	2.17	2.17	1.00
5/3	0.11	0.06	.55	5	0.08	1.83	22.88
5/5	0.06	0.05[a]	--	2	0.08	0.64[a]	--
5/6	0.12	0.10[a]	--	1	1.17	3.19[a]	--
5/7	0.12	0.07	.58	1	0.17	4.42	26.0
5/7	0.35	0.24	.69	0	0.42	5.67	13.5
6/12	0.05	0.01	.20	5	0.75	6.25	8.33
6/13-14	0.09	0.02	.22	1	1.50	5.50	3.67

(continued)

Note: -- Not calculated.
a Estimated value.
Metric units: in. x 2.54 = cm

Table A-3. Nashville I-40 rainfall-runoff monitoring data, 1976 and 1977 (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
6/14/77	0.12	0.08	.67	0	1.67	7.42	4.44
6/19	0.69	0.22	.32	5	3.41	5.34	1.57
6/22	1.21	0.42	.35	3	5.83	12.42	2.13
6/23	0.76	0.47	.62	1	2.42	4.00	1.65
6/24	0.30	0.24	.80	1	0.42	2.75	6.55
6/25	0.86	0.46	.53	1	2.00	2.75	1.38
6/26	0.05	0.04	.80	1	1.08	3.00	2.78
7/9	0.10	0.07	.70	13	1.17	2.92	2.50
7/10	0.40	0.08a	--	1	1.34	3.66a	--
7/23	0.05	0.04	.80	13	0.58	2.92	5.03
7/24	0.23	0.05a	--	1	5.17	11.01a	--
7/25	0.06	0.04	.67	1	0.75	0.83	1.11
7/28	1.04	0.22a	--	3	6.08	8.08	1.33
7/29	0.10	0.07	.70	1	0.92	2.08	2.26
8/7	0.10	0.09	.90	9	1.00	4.08	4.08
8/10	0.17	0.06	.35	3	3.75	6.17	1.65
8/13	0.13	0.09	.69	3	0.67	2.50	3.73
8/14	0.05	0.02	.40	1	0.25	1.75	7.00
8/14	0.94	0.80	.85	0	4.17	6.34	1.52
8/16	0.05	0.03	.60	2	0.42	1.67	3.98
8/16	0.54	0.33a	--	0	0.83	2.50	3.01
8/17	0.47	0.27	.57	1	1.34	2.92	2.18
8/17	0.16	0.11	.69	0	1.34	2.25	1.68
8/17	0.26	0.16	.62	0	0.92	2.34	2.54
9/4	0.16	0.11	.69	7	1.34	2.17	1.62
9/5	0.42	0.12	.29	12	1.17	4.34	3.71

Note: -- Not calculated.
a Estimated value.
Metric units: in. x 2.54 = cm

(continued)

Table A-3. Nashville I-40 rainfall-runoff monitoring data, 1976 and 1977 (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
9/6/77	0.10	0.01	.10	1	0.17	2.58	15.18
9/13	0.15	0.03	.20	7	0.92	4.00	4.35
9/13	0.53	0.21	.40	0	4.58	5.67	1.24
9/14	0.23	0.11	.49	1	1.33	2.83	2.13
9/14	0.92	0.75	.82	0	9.17	22.34	2.44
9/16	0.19	0.00	.47	2	0.75	4.83	6.44
9/19	0.60	0.16	.27	3	2.83	4.42	1.56
Average [b]	0.42	0.20	0.48	2.79	2.95	5.69	1.93

Note: a Estimated value.
b Does not include any event with an estimated value.
Metric units: in. x 2.54 = cm.

Table A-4. Denver I-25 rainfall-runoff monitoring data, 1976 and 1977.

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
8/1/76	1.03	0.70	.68	--	3.00	6.25	2.08
8/2	0.42	0.26	.62	1	7.75	9.08	1.17
9/13	0.15	0.05	.33	42	0.75	3.08	4.11
9/14	0.13	0.06	.46	1	0.42	2.92	6.95
9/15	0.12	0.02	.17	1	1.08	3.25	3.01
9/18	0.20	0.05	.25	3	0.33	1.92	6.00
9/19	0.05	0.01	.20	1	0.84	1.58	1.88
9/19	0.25	0.09	.36	0	3.50	4.92	1.41
9/25	0.23	0.06	.26	6	3.50	4.92	1.41
9/25	0.40	0.22	.55	0	6.00	14.50	2.42
9/26	0.05	0.03	.60	1	1.00	1.58	1.58
9/26	1.11	0.73	.66	0	8.00	14.67	1.84
10/7[a]	0.15	0.08	.53	11	5.75	2.50	2.30
4/11/77	0.29	0.06	.21	--	2.67	3.32	1.24
4/12	0.10	0.04	.40	1	1.67	2.25	1.35
4/15	0.46	0.17	.37	3	6.25	7.92	1.27
4/19-20	0.65	0.35	.54	4	13.25	14.75	1.11
5/7	0.20	0.04	.20	18	0.25	1.58	6.32
5/14	0.12	0.03	.25	7	0.42	1.25	2.98
5/28	0.13	0.01	.08	14	0.32	2.32	7.25
6/5	0.35	0.12	.34	8	3.75	6.45	1.72

(continued)

Note: -- Not calculated.
a Remainder of precipitation for October involved snow and snowmelt events.
Metric units: in. x 2.54 = cm.

Table A-4. Denver I-25 rainfall-runoff monitoring data, 1976 and 1977 (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
6/6/77	0.08	0.02	.25	1	0.25	1.32	5.28
6/9	0.09	0.02	.22	3	1.66	3.08	1.86
6/18	0.20	0.07	.35	9	2.84	4.42	1.56
6/23	0.05	0.01	.20	5	0.17	1.84	10.82
7/5	1.15	0.37	.32	12	2.58	6.08	2.36
7/20	0.60	0.21	.35	15	7.67	9.67	1.26
7/24	0.34	0.04	.12	4	1.17	2.00	1.71
7/25	0.30	0.09	.30	1	1.33	7.25	5.45
8/31	0.33	0.05	.15	37	1.75	4.25	2.43
Average	0.32	0.14	.42	7.46	3.00	5.03	1.68

Metric units: in. x 2.54 = cm

Table A-5. Harrisburg I-81 rainfall-runoff monitoring data, 1976 and 1977.

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
3/31-4/1/76	1.33	0.89	.67	4	15.00	46.50	3.10
4/4	0.09	0.02	.22	3	2.25	10.50	4.67
4/25	0.42	0.06	.14	21	4.92	23.50	4.78
5/1	0.45	0.05	.11	6	5.00	18.00	3.60
5/11	0.32	0.01	.03	10	1.50	6.00	4.00
5/16	0.65	0.10	.15	5	10.25	21.00	2.05
5/18	0.31	0.03	.10	2	1.25	9.50	7.60
5/20	0.11	0.01	.09	2	2.50	4.25	1.70
5/25-26	0.86	0.20	.23	5	11.15	27.00	2.42
5/29	0.83	0.45	.54	3	13.75	33.00	2.40
6/1	0.63	0.34	.54	3	2.50	12.00	4.80
6/15	0.11	0.003	.03	14	0.33	2.00	6.06
6/16	0.07	0.01	.14	1	0.33	3.00	9.09
6/17	0.10	0.03a	--	1	1.00	3.13a	--
6/19	0.63	0.14	.22	2	1.75	14.50	8.29
6/20	0.63	0.17	.27	1	3.50	10.50	3.00
6/21	0.25	0.05	.20	1	1.50	7.00	4.67
6/28-29	0.57	0.08	.14	7	3.50	15.50	4.42
7/3	1.21	0.71	.59	4	2.17	13.50	6.22
7/7	0.15	0.01	.07	4	0.75	2.00	2.67
7/7	0.49	0.15	.31	0	0.50	4.75	9.50
7/7	1.53	1.46	.95	0	2.42	18.50	7.64
7/8	0.05	0.02	.40	1	2.25	4.00	1.78

Note: -- Not calculated.
a Estimated value.
Metric units: in. x 2.54 = cm.

(continued)

Table A-5. Harrisburg I-81 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
7/10/76	0.06	0.01	.17	2	2.25	4.00	1.78
7/11	0.43	0.15	.35	1	2.75	9.00	3.27
7/15	0.29	0.05	.17	4	1.67	5.50	3.29
7/15	0.57	0.27	.47	0	0.67	11.50	17.16
7/21	0.63	0.15	.24	6	1.50	7.00	4.67
7/23	0.39	0.17	.44	2	3.00	14.50	4.83
7/23	0.26	0.15	.58	0	0.92	12.50	13.59
7/29	0.25	0.01	.04	6	2.00	6.00	3.00
8/6	0.45	0.05	.11	8	1.75	6.50	3.71
8/8	0.56	0.19	.34	2	3.25	14.00	4.31
8/9	0.23[b]	0.03	--	1	3.00[b]	11.50	--
8/13	0.84	0.37	.44	4	1.50	7.50	5.00
8/14	0.43	0.26	.61	1	2.17	9.50	4.38
8/15	0.80	0.57	.71	1	0.50	22.50	45.00
9/10	1.00	0.18	.18	16	6.00	28.50	4.75
9/15-16	1.64	0.83	.50	5	20.00	37.50	1.88
9/17	0.24	0.10	.42	1	1.00	13.50	13.50
9/20	0.10	0.002	.02	3	1.25	1.25	1.00
9/26	0.43	0.02	.05	6	3.67	33.00	8.99
9/27	0.17	0.05	.29	1	5.75	11.00	1.91
9/30	0.38	0.11	.29	3	7.75	14.00	1.81
9/30	0.25	0.22	.88	0	3.75	14.50	3.87
10/1	0.24	0.05	.21	1	8.25	12.50	1.52
10/2	0.05	0.02	.40	1	0.25	1.00	4.00

(continued)

Note: -- Not calculated.
a Estimated value.
b Value obtained from city raingage, not from raingage at monitoring site.
Metric units: in. x 2.54 = cm.

Table A-5. Harrisburg I-81 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
10/2/76	0.07	0.03	.43	0	3.25	4.00	1.23
10/3	0.89	0.83	.93	1	10.50	24.00	2.29
10/7	0.78	0.52	.67	4	14.50	20.00	1.38
10/8	3.96	4.33	1.09	1	15.75	41.00	2.60
10/20-21	1.38	0.71	.51	12	18.50	34.50	1.86
10/24	0.45	0.15	.33	3	9.00	19.00	2.11
10/25	0.59	0.42	.83	1	7.50	20.50	2.73
10/30	0.86	0.55	.64	5	9.25	21.00	2.27
4/2/77	1.42	0.85	.60	5	9.50	11.42	1.20
4/6	1.20	0.94	.78	4	6.42	30.75	4.79
4/7	0.40	0.08	.20	1	4.50	12.00	2.67
4/23	0.22	0.07a	--	16	0.34	8.12a	--
4/23	0.20	0.06a	--	0	2.84	14.29a	--
4/24	0.82	0.22	.27	1	8.25	16.83	2.04
4/25	0.23	0.05	.22	1	2.75	13.83	5.03
4/27	0.05	0.01	.20	2	0.50	2.83	5.66
4/28	0.35	0.11	.31	1	6.00	18.75	3.13
5/4	0.29	0.02	.07	6	0.23	5.50	23.87
5/16	0.10	0.03a	--	12	0.34	8.12a	--
6/6	0.45	0.02	.04	21	6.00	8.50	1.42
6/9	0.31	0.02	.07	3	6.00	11.00	1.83
6/14	0.88	0.13	.15	5	4.75	14.00	2.95
6/17	0.33	0.06	.18	3	1.25	6.84	5.47
6/20	0.32	0.05	.16	3	0.25	6.17	24.68

(continued)

Note: -- Not calculated.
a Estimated value.
b Value obtained from city raingage, not from raingage at monitoring site.
Metric units: in. x 2.54 = cm

Table A-5. Harrisburg I-81 rainfall-runoff monitoring data (continued).

Date	Total rainfall (R), inches	Runoff (Q), inches	Q/R	Dry days	Rainfall duration (RD), hours	Flow duration (FD), hours	FD/RD
6/25/77	0.64	0.11	.17	5	1.34	5.50	4.10
6/25	0.36	0.15	.42	0	0.43	17.75	41.28
Average[c]	0.58	0.28	0.49	3.97	4.66	14.25	3.06

Note: a Estimated value.
b Value obtained from city raingage, not from raingage at monitoring site.
c Does not include any event with an estimated value.
Metric units: in. x 2.54 = cm.

APPENDIX B
WASHOFF VARIABLE (K_2) SENSITIVITY

Table B-1. K_2 sensitivity I-794, 1976 and 1977.

Date	Monitored total solids, lb	Computed total solids, lb					
		$K_2 = 5$	Difference[a]	$K_2 = 6.5$	Difference[a]	$K_2 = 8$	Difference[a]
6/18/76	87	168	-81	162	-75	152	-65
7/28/76	45	173	-128	196	-151	217	-172
7/30/76	359	247	112	226	133	204	155
8/5/76	14	39	-25	36	-22	35	-21
8/13/76	94	67	27	68	26	70	24
8/25/76	29	75	-46	81	-52	87	-58
8/28/76	135	146	-11	135	0	126	9
9/9/76	98	59	39	61	37	63	35
9/19/76	28	45	-17	50	-22	54	-26
Subtotal	889	1,019	-130	1,015	-126	1,008	-119
6/8/77	35	5	30	6	29	7	28
6/10/77	12	5	7	6	6	7	5
6/11/77	173	36	137	40	133	42	131
6/17/77	119	84	35	81	38	78	41
6/28/77	12	59	-47	69	-57	78	-66
6/28/77	62	33	29	32	-30	30	32
6/30/77	84	39	45	36	48	33	51
7/3/77	27	24	3	24	3	25	2
7/17/77	115	164	-49	154	-39	148	-33
8/13/77	143	78	65	76	67	75	68
8/28/77	96	55	41	60	36	64	32
9/23/77	5	41	-36	41	-36	41	-36
9/23/77	28	53	-25	47	-19	41	-13
9/24/77	62	54	8	41	21	32	30
Subtotal	973	730	234	713	260	701	272
Total	1,862	1,749	113	1,728	134	1,709	153

Note: a. Difference = monitored - predicted
metric units: lb x 0.454 = kg

Table B-2. K_2 sensitivity Hwy. 45, 1976 and 1977.

Date	Monitored total solids, lb	Computed total solids, lb					
		$K_2 = 5$	Difference[a]	$K_2 = 6.5$	Difference[a]	$K_2 = 8$	Difference[a]
6/18/76	5,886	1,411	4,475	1,657	4,229	1,850	4,036
7/28/76	943	1,723	-780	2,075	-1,132	2,378	-1,435
7/30/76	2,371	5,320	-2,949	5,995	-3,624	6,440	-4,069
8/5/76	470	191	279	209	261	217	253
8/14/76	2,120	856	1,264	954	1,166	1,020	1,100
8/25/76	4,029	2,788	1,241	3,107	922	3,327	702
8/27/76	2,490	3,968	-1,478	4,188	-1,698	4,252	-1,762
9/9/76	3,498	2,314	1,184	2,384	1,114	2,387	1,111
9/19/76	1,109	1,049	60	1,104	5	1,133	-24
Subtotal	22,916	19,620	3,296	21,673	1,243	23,004	-88
5/4/77	742	621	121	787	-45	946	-204
6/5/77	6,149	7,937	-1,788	9,764	-3,615	11,381	-5,232
6/5/77	8,670	10,544	-1,874	11,827	-3,157	12,580	-3,910
6/6/77	490	848	-358	891	-401	888	-398
6/8/77	1,123	925	198	974	149	977	146
6/11/77	3,524	2,744	780	2,876	648	2,881	643
6/17/77	4,849	7,259	-2,410	7,408	-2,559	7,276	-2,427
6/27/77	3,388	1,752	1,636	1,833	1,555	1,870	1,518
6/30/77	3,173	5,347	-2,174	5,446	-2,273	5,417	-2,244
Subtotal	32,108	37,977	-5,869	41,806	-9,698	44,216	-12,108
Total	55,024	57,597	-2,573	63,479	-8,455	67,220	-12,196

Note: a. Difference = monitored - predicted
metric units: lb x 0.454 = kg

Table B-3. K_2 sensitivity Nashville I-81, 1977.

Date	Monitored total solids, lb	Computed total solids, lb					
		$K_2 = 5$	Difference[a]	$K_2 = 6.5$	Difference[a]	$K_2 = 8$	Difference[a]
4/21-22/77	1,559	1,509	50	1,891	-332	2,245	-686
4/22/77	1,265	404	861	480	785	541	724
4/28/77	156	282	-126	328	-172	364	-208
6/13/77	134	188	-54	214	-80	233	-99
6/14/77	605	258	347	292	313	315	290
6/19/77	1,943	1,795	148	2,021	-78	2,181	-238
6/22/77	1,246	2,724	-1,478	2,909	-1,663	2,985	-1,739
6/23/77	2,944	1,978	966	1,949	995	1,849	1,095
6/24/77	1,486	907	579	852	634	775	711
6/25/77	2,767	1,789	978	1,595	1,172	1,391	1,376
9/5/77	427	2,332	-1,905	2,477	-2,050	2,616	-2,189
9/6/77	78	475	-397	491	-413	504	-426
9/13/77	170	598	-428	643	-473	683	-513
9/13/77	595	1,527	-932	1,601	-1,006	1,662	-1,067
9/14/77	368	941	-573	965	-597	979	-611
9/14/77	3,378	2,417	961	2,361	1,017	2,286	1,092
9/16/77	597	666	-69	639	-42	610	-13
9/19/77	555	1,677	-1,122	1,617	-1,062	1,557	-1,002
Total	20,273	22,467	-2,194	23,325	-3,052	23,776	-3,503

Note: a. Difference = monitored - predicted
metric units: lb x 0.454 = kg

Table B-4. K_2 sensitivity Harrisburg I-40, 1976 and 1977.

Date	Monitored total solids, lb	Computed total solids, lb					
		$K_2 = 4$	Difference[a]	$K_2 = 12$	Difference[a]	$K_2 = 20$	Difference[a]
5/16/76	189	135	54	373	-184	576	-387
7/7/76	227	528	-301	627	-400	520	-293
7/7/76	1,344	2,005	-661	1,427	-83	758	585
5/10/76	204	213	-9	237	-83	358	-154
10/20/76	632	274	358	312	320	445	187
Subtotal	2,596	3,155	-559	3,026	-430	2,658	-62
4/24/77	337	13	324	37	300	58	279
6/6/77	30	6	24	18	12	27	3
6/9/77	53	14	39	38	15	58	-5
6/14/77	275	79	196	201	74	287	-12
6/17/77	105	27	78	63	42	84	21
6/25/77	92	71	21	157	-65	197	-105
6/25/77	167	75	92	149	18	169	-2
Subtotal	1,059	285	774	663	396	880	179
Total	3,655	3,440	215	3,689	-34	3,538	117

Note: a. Difference = monitored = predicted
metric units: lb x 0.454 = kg

APPENDIX C
MODEL LISTING

```
LEVEL 2.3.0 (JUNE 78)                    OS/360  FORTRAN H EXTENDED          DATE 80.079/13.55.51       PAGE   1

 REQUESTED OPTIONS: NOMAP

 OPTIONS IN EFFECT: NAME(MAIN) NOOPTIMIZE LINECOUNT(56) SIZE(0240K) AUTODBL(NONE)
                    SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF ALC NOANSF TERM IBM FLAG(I)

                C        DATA SET NEWQUL     AT LEVEL 061 AS OF 03/19/80
      ISN 0002        REAL LENGTH,N(,K1,KLIN,K2
      ISN 0003        INTEGER ICCUNT
                C
                C
                C
                C        PREDICTIVE MODEL FOR HIGHWAY POLLUTANTS
                C
                C
      ISN 0004        DIMENSION TITLE(20),RAIN(100),DDAYS(100),RDURAT(100),IDAY(100),
                     1          IMO(100),IYEAR(100),R(I100),CHG(100),
                     2   B2(100),ROFFIN(100),Y(100),K1(100),K2(100),POLBUP(100),
                     3          R(100),PWSHOF(100),SS(100),VSS(100),TVS(100),
                     4   TKN(100),BOD(100),TOC(100),COD(100),TN(100),TPO(100),CL(100),
                     5   PB(100),ZN(100),FE(100),NI(100),CU(100),CD(100),CR(100),
                     6   HG(100),XDY(100),PRAIN(100),    RCFFCF(100),AVEPIN(100),
                     7   BSS(100),BVSS(100),BTVS(100),BTKN(100),BBOD(100),BTOC(100),
                     8   BCOD(100),PTN(100),BTPO(100),BCL(100),BPB(100),BZN(100),
                     9   BFE(100),BNI(100),BCU(100),BCD(100),BCR(100),BHG(100),
                     1   RCMA(100),RENIT(100),XDD(100),RDUR2(100)
      ISN 0005        WRITE(6,300)
      ISN 0006    300 FORMAT(1H1,/////,20X,'DEPARTMENT OF TRANSPORTATION---PREDICTIVE PR
                     1OCEDURE'/,14X,'FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWA
                     2Y RUNOFF  *** RELEASE III ***',///,15X,'DEVELOPED BY',/,
                     3/,30X,'REXNORD,CORPORATE RESEARCH',
                     4 ' & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER',
                     5  /,30X,'5103 WEST BELOIT ROAD',
                     6  /,30X,'MILWAUKEE,WISCONSIN ,53215',
                     7//,20X,'IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT
                     8.',/,25X,'NICHOLAS KOBRIGER',
                     9     /,25X,'PHONE 1-414-643-3625',
                     1 //////////)
      ISN 0007        TOTRAN = 0.0
      ISN 0008        TRUNIN = 0.0
      ISN 0009        TRUNCF = 0.0
      ISN 0010        TRHSHF= 0.0
                C
                C
                C        READ IN TITLE
                C
                C
      ISN 0011        READ(5,900) TITLE
      ISN 0012    900 FORMAT(20A4)
      ISN 0013        WRITE(6,901)TITLE
      ISN 0014    901 FORMAT(10X,15('*'),20A4,15('*'),///)
      ISN 0015        REM = 0.0
                C
                C
                C        READ IN NUMBER OF EVENTS AND SITE TYPE
```

```
               C
               C
ISN 0016             READ(5,100) NUM,ITYPE
ISN 0017         100 FORMAT(2I10)
               C
               C
               C          READ IN SITE CHARTERISTICS
               C
               C
ISN 0018             READ(5,101) ACRES,LENGTH,ADT,PINIT,KLIN
ISN 0019         101 FORMAT(7F10.0)
ISN 0020             WRITE(6,111) ACRES,LENGTH,ADT,PINIT,KLIN
ISN 0021         111 FORMAT(42X,'SITE CHARACTERISTICS',/42X,20('-'),
                    2 /,42X,'TOTAL DRAINAGE AREA(AC)            = ',F10.2,
                    3 /,42X,'LENGTH OF HIGHWAY(MI)              = ',F10.2,
                    4 /,42X,'AVERAGE DAILY TRAFFIC              = ',F10.2,
                    5 /,42X,'INTIAL POLLUTION LEVEL(LBS)        = ',F10.2,
                    6 /,42X,'USER SUPPLIED KL FACTOR            = ',F10.2)
ISN 0022             IF(ITYPE.EQ.1) GO TO 700
ISN 0024             IF(ITYPE.EQ.2) GO TO 710
ISN 0026             IF(ITYPE.EQ.3) GO TO 720
ISN 0028             WRITE(6,625)
ISN 0029         625 FORMAT(1H1,/////,10X,'ERROR-TYPE OF SITE ON CARD TWO WAS NOT
                    1 SET TO 1,2 OR 3.')
ISN 0030             STOP
ISN 0031         701 FORMAT(//,42X,'SITE TYPE SELECTED IS AN ALL PAVED BRIDGE OR DECK')
ISN 0032         711 FORMAT(//,42X,'SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS
                    1AND INLETS ON PAVED AREA.')
ISN 0033         721 FORMAT(//,42X,'SITE TYPE SELECTED IS RURAL WITH FLUSH SHOULDERS.')
ISN 0034         700 WRITE(6,701)
ISN 0035             GO TO 730
ISN 0036         710 WRITE(6,711)
ISN 0037             GO TO 730
ISN 0038         720 WRITE(6,721)
ISN 0039             GO TO 730
ISN 0040          35 FORMAT(86X,'<TOTAL SOLIDS>',/,86X,14('-'),/,
                    1  80X,'POUNDS',/,36X,'RAIN',11X,'RUNOFF',2X,'AVE.RUNOFF',
                    1  3X,'RUNOFF',2X,'AFTER',5X,'POUNDS',4X,'POUNDS',/,5X,
                    2  'EVENT',11X,'DRY',2X,'RAINFALL',2X,'DURAT',2X,'RUNOFF',
                    3  2X,'DURAT',3X,'INTENSITY',4X,'CUBIC',3X,'PREVIOUS',2X,
                    4  'AT START',2X,'WASHED',/5X,'NUMBER',1X,'MO',1X,'DA',1X,
                    5  'YR',1X,'DAYS',1X,'INCHES',4X,'HOURS',2X,'INCHES',2X,
                    6  'HOURS',3X,'INCHES/HOUR',2X,'FEET',4X,'STORM',5X,'OF STORM',
                    7  2X,'OFF',/5X,6('-'),1X,9('-'),1X,4('-'),1X,8('-'),2X,5('-'),
                    8  2X,6('-'),2X,6('-'),2X,11('-'),2X,6('-'),2X,8('-'),
                    9  2X,8('-'),2X,6('-'))
               C
               C
               C          READ IN RAINFALL AND DRY DAYS RECORD
               C
               C
ISN 0041         730 DO 10 I=1,NUM
ISN 0042             READ(5,109) IMO(I),IDAY(I),IYEAR(I)
ISN 0043             READ(5,102) RAIN(I),DDAYS(I),RDURAT(I)
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ISN 0044       102 FORMAT(3F10.0)                                                         00001030
ISN 0045       100 FORMAT(3I5)                                                            00001040
ISN 0046        10 CONTINUE                                                               00001050
             C                                                                            00001060
             C                                                                            00001070
             C           BEGIN MAJOR LOOP OF PROGRAM                                      00001080
             C                                                                            00001090
             C                                                                            00001100
ISN 0047           DO 20 I=1,NUM                                                          00001110
ISN 0048           XOD(I) = DDAYS(I)                                                      00001120
             C     ***** FOR PURPOSES OF CALCULATING TOTAL RUNOFF, A VALUE OF*****        00001130
             C     ***** ONE IS ASSIGNED TO ANY PERIOD OF ZERO DRY DAYS. A    *****       00001140
             C     ***** ZERO VALUE FOR DRY DAYS(DDAYS) IS NOT VALID,         *****       00001150
             C     ***** BECAUSE DDAYS IS TAKEN TO A POWER WHEN CALCULATING   *****       00001160
             C     ***** TOTAL RUNOFF.                                        *****       00001170
ISN 0049           IF(XOD(I).EQ.0.0) XOD(I)=1                                             00001180
ISN 0051           IF(ITYPE.EQ.1)  GO TO 600                                              00001190
ISN 0053           IF(ITYPE.EQ.2)  GO TO 610                                              00001200
ISN 0055           IF(ITYPE.EQ.3)  GO TO 620                                              00001210
             C     ***** EQUATIONS TO CALCULATE TOTAL RUNOFF *****                        00001220
             C     ***** ROFFIN = TOTAL RUNOFF               *****                        00001230
             C     ***** RAIN = TOTAL RAIN                   *****                        00001240
             C     ***** XOD   = DRY DAYS SINCE LAST RAIN    *****                        00001250
ISN 0057       600 ROFFIN(I) = (RAIN(I)*.969) - .0187                                     00001260
ISN 0058           GO TO 630                                                              00001270
ISN 0059       610 ROFFIN(I) = ((RAIN(I)**1.369) * (XOD(I)**(-.0858))) * .470             00001280
ISN 0060           RRAIN(I)=0.91*RAIN(I)                                                  00001290
ISN 0061           IF(ROFFIN(I).GT.RRAIN(I)) ROFFIN(I)=RRAIN(I)                           00001300
ISN 0063           GO TO 630                                                              00001310
ISN 0064       620 ROFFIN(I) = ((RAIN(I)**1.892) * (XOD(I)**(-.654))) * 0.845             00001320
ISN 0065           RRAIN(I)=0.95*RAIN(I)                                                  00001330
ISN 0066           IF(ROFFIN(I).GT.RRAIN(I)) ROFFIN(I)=RRAIN(I)                           00001340
ISN 0068       630 ROFFCF(I) = ROFFIN(I)*ACRES/12. * 43560.                               00001350
             C     ***** COMPUTER DEVELOPED Y1'S (RUNOFF DURATION)       *****            00001360
ISN 0069           RDUR2(I) = RDURAT(I)                                                   00001370
             C     ***** MAXIMUM RAIN DURATION IS FIVE HOURS *****                        00001380
ISN 0070           IF(RDURAT(I).GE.5.0)  RDURAT(I) = 5.0                                  00001390
ISN 0072           IF(ITYPE.EQ.1.AND.XOD(I).GE.10.0) Y1(I) = 1.12*RDURAT(I)+0.69          00001400
ISN 0074           IF(ITYPE.EQ.2.AND.XOD(I).GE.10.0) Y1(I) = 1.06*RDURAT(I)+1.79          00001410
ISN 0076           IF(ITYPE.EQ.3.AND.XOD(I).GE.10.0) Y1(I) = 1.92*RDURAT(I)+4.18          00001420
ISN 0078           IF(ITYPE.EQ.1.AND.XOD(I).LE.9.00) Y1(I) = 1.12*RDURAT(I)+0.69          00001430
ISN 0080           IF(ITYPE.EQ.2.AND.XOD(I).LE.9.00) Y1(I) = 1.27*RDURAT(I)+2.16          00001440
ISN 0082           IF(ITYPE.EQ.3.AND.XOD(I).LE.9.00) Y1(I) = 1.49*RDURAT(I)+9.28          00001450
             C                                                                            00001460
             C                                                                            00001470
             C           POLLUTANT BUILDUP                                                00001480
             C                                                                            00001490
             C                                                                            00001500
             C          COMPUTER DEVELOPED K1'S IF NOT USER SUPPLIED                      00001510
ISN 0084           IF(K1IN.LE.0.0) K1(I) = (ADT**0.89) * 0.007                            00001520
ISN 0086           IF(K1IN.GT.0.0) K1(I) = K1IN                                           00001530
ISN 0088           IF(I.NE.1) GO TO 70                                                    00001540
ISN 0090           PENIT(I) = PINIT                                                       00001550
ISN 0091           GO TO 71                                                               00001560
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ISN 0092        70 PEN(III) = REMAI(-I)
              C      ***** POLLUTANT BUILDUP EQUATION      *****
ISN 0093        71 XDY(I)=DDAYS(I)
ISN 0094           IF(XDY(I).GT.20.) XDY(I)=20.
ISN 0096           POLBUP(I)=PENIT(I)+(K1(I)*LENGTH*XDY(I))
              C            POLLUTANT WASHOFF
              C
              C
              C            SELECTION OF K2 FACTORS
              C
ISN 0097           IF(ITYPE.EQ.1) K2(I) = 5.0
ISN 0099           IF(ITYPE.EQ.2) K2(I) = 6.5
ISN 0101           IF(ITYPE.EQ.3) K2(I) = 12.0
              C
              C            CALCULATE POLLUTANT WASHOFF
              C
              C
              C      ***** AVERAGE RUNOFF INTENSITY (R(I)) EQUATION *****
              C
ISN 0103           R(I) = ROFFIN(I)/YI(I)
              C      ***** POLLUTANT WASHOFF EQUATION      *****
ISN 0104           PWSHOF(I) = POLBUP(I) * (1.0 - (2.718**(-K2(I) * R(I))))
ISN 0105           PEMA(I) = POLBUP(I) - PWSHOF(I)
              C
              C
              C           THE NEXT THREE BLOCKS OF EQUATIONS ARE USED TO
              C           DEVELOP POUNDS OF POLLUTANTS DEPENDING UPON THE
              C           THE TYPE OF SITE
              C
              C
ISN 0106           IF(ITYPE.NE.1) GO TO 510
ISN 0108           SS(I) =(0.53000* PWSHOF(I)) - 3.2
ISN 0109           VSS(I)=(0.19100* PWSHOF(I)) + 0.2
ISN 0110           TVS(I)=(0.22100* PWSHOF(I)) + 13.3
ISN 0111           TKN(I)=(0.00330* PWSHOF(I)) + 0.16
ISN 0112           BOD(I)=(0.02300* PWSHOF(I)) + 1.50
ISN 0113           TOC(I)=(0.25700* PWSHOF(I)) + 0.80
ISN 0114           COD(I)=(0.20200* PWSHOF(I)) + 5.47
ISN 0115            TN(I)=(.00137* PWSHOF(I)) + 0.12
ISN 0116           TPO(I)=(0.00100* PWSHOF(I)) + 0.00003
ISN 0117            CL(I)=(0.03400* PWSHOF(I)) + 2.59
ISN 0118            PB(I)=(0.00560* PWSHOF(I)) - 0.024
ISN 0119            ZN(I)=(0.00084* PWSHOF(I)) + 0.014
ISN 0120            FE(I)=(0.01500* PWSHOF(I)) + 0.59
ISN 0121            CU(I)=(0.00029* PWSHOF(I)) + 0.00073
ISN 0122            CD(I)=(0.00014* PWSHOF(I)) - 0.0014
ISN 0123            CR(I)=(0.00016* PWSHOF(I)) + 0.0012
ISN 0124           GO TO 30
ISN 0125       510 IF(ITYPE.NE.2) GO TO 520
ISN 0127            SS(I) =(0.63000000* PWSHOF(I)) - 188.0
ISN 0128           VSS(I) =(0.15200000* PWSHOF(I)) +  13.5
ISN 0129           TVS(I) =(0.26300000* PWSHOF(I)) + 243.0
ISN 0130           TKN(I) =(0.00546000* PWSHOF(I)) +   1.28
ISN 0131           BOD(I) =(0.03000000* PWSHOF(I)) +  28.3
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ISN 0132          TOC(I) =(0.05600000* PWSHOF(I)) +  25.2                      00002110
ISN 0133          COD(I) =(0.19300000* PWSHOF(I)) + 275.3                      00002120
ISN 0134           TN(I) =(0.00130000* PWSHOF(I)) +   0.713                    00002130
ISN 0135          TPO(I) =(0.00225000* PWSHOF(I)) -   0.32                     00002140
ISN 0136           CL(I) =(0.04200000* PWSHOF(I)) +  87.0                      00002150
ISN 0137           PB(I) =(0.00102000* PWSHOF(I)) +   0.04                     00002160
ISN 0138           ZN(I) =(0.00059400* PWSHOF(I)) +   0.103                    00002170
ISN 0139           FE(I) =(0.01960000* PWSHOF(I)) -   5.0                      00002180
ISN 0140           CU(I) =(0.00031600* PWSHOF(I)) +   0.064                    00002190
ISN 0141           CD(I) =(0.00004160* PWSHOF(I)) +   0.021                    00002200
ISN 0142           CR(I) =(0.00004300* PWSHOF(I)) +   0.036                    00002210
ISN 0143          GO TO 30                                                      00002220
ISN 0144     520 SS(I) = (0.3200000* PWSHOF(I)) - 36.8                          00002230
ISN 0145          VSS(I)= (0.0610000*PWSHOF(I)) -  3.3                          00002240
ISN 0146          TVS(I)= (0.3210000*PWSHOF(I)) -  32.3                         00002250
ISN 0147          TKN(I)= (0.0031000*PWSHOF(I))  +  0.55                        00002260
ISN 0148          BOD(I)= (0.0300000*PWSHOF(I))  + 28.3                         00002270
ISN 0149          TOC(I)= (0.0680000*PWSHOF(I))  -  5.85                        00002280
ISN 0150          COD(I)= (0.0870000*PWSHOF(I))  +  0.65                        00002290
ISN 0151          TN(I) = (0.0019300* PWSHOF(I)) +  0.054                       00002300
ISN 0152          TPO(I)= (0.0021500*PWSHOF(I))  -  0.245                       00002310
ISN 0153          CL(I) = (0.1350000* PWSHOF(I)) +  2.6                         00002320
ISN 0154          PB(I) = (0.0004100* PWSHOF(I)) -  0.029                       00002330
ISN 0155          ZN(I) = (0.0002670* PWSHOF(I)) -  0.011                       00002340
ISN 0156          FE(I) = (0.0140000* PWSHOF(I)) -  1.61                        00002350
ISN 0157          CU(I) = (0.0000740* PWSHOF(I)) +  0.00878                     00002360
ISN 0158          CD(I) = (0.0000400* PWSHOF(I)) +  0.007                       00002370
ISN 0159          CR(I) = (0.0002300* PWSHOF(I)) -  0.028                       00002380
ISN 0160      30 CONTINUE                                                       00002390
            C          EQUATIONS TO CONVERT POUNDS TO MG/L                      00002400
ISN 0161          BSS(I) =(SS(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002410
ISN 0162          BVSS(I)=(VSS(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002420
ISN 0163          BTVS(I)=(TVS(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002430
ISN 0164          BTKN(I)=(TKN(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002440
ISN 0165          BBOD(I)=(BOD(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002450
ISN 0166          BTOC(I)=(TOC(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002460
ISN 0167          BCOD(I)=(COD(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002470
ISN 0168          BTN(I) =(TN(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002480
ISN 0169          BTPO(I)=(TPO(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)         00002490
ISN 0170          BCL(I) =(CL(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002500
ISN 0171          BPB(I) =(PB(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002510
ISN 0172          BZN(I) =(ZN(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002520
ISN 0173          BFE(I) =(FE(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002530
ISN 0174          BCU(I) =(CU(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002540
ISN 0175          BCD(I) =(CD(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002550
ISN 0176          BCR(I) =(CR(I) * 454000.)/(ROFFCF(I) * 7.48 * 3.785)          00002560
            C     *** ZERO OUT ANY NEGATIVE VALUES PREDICTED BY EQUATION ***    00002570
ISN 0177          IF(SS(I).LE.0.0) SS(I) = 0.0                                  00002580
ISN 0179          IF(PB(I).LE.0.0) PB(I) = 0.0                                  00002590
ISN 0181          IF(ZN(I).LE.0.0) ZN(I) = 0.0                                  00002600
ISN 0183          IF(FE(I).LE.0.0) FE(I) = 0.0                                  00002610
ISN 0185          IF(CR(I).LE.0.0) CR(I) = 0.0                                  00002620
ISN 0187          IF(CD(I).LE.0.0) CD(I)=0.0                                    00002630
ISN 0189          IF(VSS(I).LE.0.0) VSS(I) = 0.0                                00002640
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ISN 0191          IF(TVS(I).LE.0.0) TVS(I) = 0.0
ISN 0193          IF(TOC(I).LE.0.0) TOC(I) = 0.0
ISN 0195          IF(TPO(I).LE.0.0) TPO(I) = 0.0
ISN 0197          IF(BSS(I).LE.0.0) BSS(I) = 0.0
ISN 0199          IF(BPB(I).LE.0.0) BPB(I) = 0.0
ISN 0201          IF(BZN(I).LE.0.0) BZN(I) = 0.0
ISN 0203          IF(BFE(I).LE.0.0) BFE(I) = 0.0
ISN 0205          IF(BCP(I).LE.0.0) BCP(I) = 0.0
ISN 0207          IF(BCO(I).LE.0.0) BCO(I)=0.0
ISN 0209          IF(BVSS(I).LE.0.0) BVSS(I) = 0.0
ISN 0211          IF(BTVS(I).LE.0.0) BTVS(I) = 0.0
ISN 0213          IF(BTOC(I).LE.0.0) BTOC(I) = 0.0
ISN 0215          IF(BTPO(I).LE.0.0) BTPO(I) = 0.0
             C    *** SUM UP TOTALS FOR PRINT ***
ISN 0217          TOTRAN = TOTRAN + RAIN(I)
ISN 0218          TRUNIN = TRUNIN + ROFFIN(I)
ISN 0219          TRUNCF = TRUNCF + ROFFCF(I)
ISN 0220          TPWSHF = TPWSHF + PWSHOF(I)
ISN 0221       20 CONTINUE
             C
             C
             C         WRITE OUT APPROPRIATE DATA
             C
             C
ISN 0222          ICOUNT=10
ISN 0223          WRITE(6,350)
ISN 0224          WRITE(6,390) K1(I-1),K2(I-1)
ISN 0225      390 FORMAT(//,20X,'K1 FACTOR FOR THIS SITE  = ',F10.4,/20X,
                 1               'K2 FACTOR FOR THIS SITE  = ',F10.4,//)
ISN 0226          WRITE(6,351)
ISN 0227      350 FORMAT(1H1,//,50X,'QUANTITY RESULTS',/,50X,16('-'))
ISN 0228          DO 44 I=1,NUM
ISN 0229          IF(ICOUNT.GE.55) WRITE(6,800)
ISN 0231          IF(ICOUNT.GE.55) WRITE(6,351)
ISN 0233          IF(ICOUNT.GE.55) ICOUNT=0
ISN 0235          WRITE(6,366) I,IMO(I),IDAY(I),IYEAR(I),DDAYS(I),RAIN(I),
                 1   RDUR2(I),ROFFIN(I),Y1(I),R(I),ROFFCF(I),PEN(T(I)),
                 2   POIRUP(I),PWSHOF(I)
ISN 0236      366 FORMAT(6X,I3,3X,I2,1X,I2,1X,I2,2X,F3.0,2X,F6.2,3X,F5.2,2X,F6.3,
                 1  2X,F6.3,2X,F9.5,2X,F9.1,3(2X,F9.2))
ISN 0237          ICOUNT=ICOUNT+1
ISN 0238       44 CONTINUE
ISN 0239          IF(ICOUNT+3.GT.60) WRITE(6,800)
ISN 0241          IF(ICOUNT+3.GT.60) ICOUNT=0
ISN 0243          WRITE(6,391) TOTRAN,TRUNIN,TRUNCF,TPWSHF
ISN 0244      391 FORMAT(///,20X,
                 1   'TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES)  =',F15.2,/20X
                 2X, 'TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES)    =',F15.2,/20X
                 3X, 'TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET)=',F15.2,/20X
                 4X, 'POUNDS OF TOTAL SOLIDS DISCHARGED                 =',F(5.2)
ISN 0245          WRITE(6,367)
ISN 0246      367 FORMAT(1H1,//,50X,'QUALITY ANALYSIS',/,50X,16('-'),//)
ISN 0247          WRITE(6,368)
ISN 0248      368 FORMAT(5X,'EVENT',19X,'<SS>',18X,'<VSS>',17X,'<TVS>',17X,'<TKN>',
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                 1 /,5X,'NUMBER',2X,'MO',1X,'DA',1X,'YR',4X,'LBS ',7X,'MG/L',7X,
                 2 'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',/,
                 3 5X,6('-'),2X,8('-'),2X,18('-'),4X,18('-'),4X,18('-'),4X,
                 4 18('-'))
ISN 0249           ICOUNT=9
ISN 0250           DO 45 I=1,NUM
ISN 0251           IF(ICOUNT.GE.60) WRITE(6,800)
ISN 0253           IF(ICOUNT.GE.60) WRITE(6,368)
ISN 0255           IF(ICOUNT.GE.60) ICOUNT=3
ISN 0257           WRITE(6,369) I,IMO(I),IDAY(I),IYEAR(I),SS(I),BSS(I),VSS(I),BVSS(I)
                 1   ,TVS(I),BTVS(I),TKN(I),BTKN(I))
ISN 0258      369 FORMAT(5X,I4,4X,I2,1X,I2,1X,I2,2X,F8.3,1X,F9.4,4X,F8.3,1X,F9.4,
                 1   4X,F8.3,1X,F9.4,4X,F8.3,1X,F9.4)
ISN 0259           ICOUNT=ICOUNT+1
ISN 0260        45 CONTINUE
ISN 0261           IF(ICOUNT+3.GT.60) WRITE(6,800)
ISN 0263           IF(ICOUNT+3.GT.60) ICOUNT=0
ISN 0265           WRITE(6,370)
ISN 0266      370 FORMAT(/5X,'EVENT',19X,'<BOD5>',16X,'<TOC>',17X,'<COD>',17X,'<TN>'
                 1,/,5X,'NUMBER',2X,'MO',1X,'DA',1X,'YR',4X,'LBS ',7X,'MG/L',7X,
                 2 'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',/,
                 3 5X,6('-'),2X,8('-'),2X,18('-'),4X,18('-'),4X,18('-'),4X,
                 4 18('-'))
ISN 0267           ICOUNT=ICOUNT+3
ISN 0268           DO 46 I=1,NUM
ISN 0269           IF(ICOUNT.GE.60) WRITE(6,800)
ISN 0271           IF(ICOUNT.GE.60) WRITE(6,370)
ISN 0273           IF(ICOUNT.GE.60) ICOUNT=3
ISN 0275           WRITE(6,369) I,IMO(I),IDAY(I),IYEAR(I),BOD(I),BBOD(I),TOC(I),
                 1   BTOC(I),COD(I),BCOD(I),TN(I),BTN(I))
ISN 0276           ICOUNT=ICOUNT+1
ISN 0277        46 CONTINUE
ISN 0278           IF(ICOUNT+3.GT.60) WRITE(6,800)
ISN 0280           IF(ICOUNT+3.GT.60) ICOUNT=0
ISN 0282           WRITE(6,371)
ISN 0283      371 FORMAT(/5X,'EVENT',19X,'<TPO4>',13X,'<CHLORIDES>',13X,'<LEAD>',
                 1   16X,'<ZINC>',
                 1 /,5X,'NUMBER',2X,'MO',1X,'DA',1X,'YR',4X,'LBS ',7X,'MG/L',7X,
                 2 'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',8X,'LBS ',6X,'MG/L',/,
                 3 5X,6('-'),2X,8('-'),2X,18('-'),4X,18('-'),4X,18('-'),4X,
                 4 18('-'))
ISN 0284           ICOUNT=ICOUNT+3
ISN 0285           DO 48 I=1,NUM
ISN 0286           IF(ICOUNT.GE.60) WRITE(6,800)
ISN 0288           IF(ICOUNT.GE.60) WRITE(6,371)
ISN 0290           IF(ICOUNT.GE.60) ICOUNT=3
ISN 0292           WRITE(6,369) I,IMO(I),IDAY(I),IYEAR(I),TPO(I),BTPO(I),CL(I),
                 1   BCL(I),PB(I),BPB(I),ZN(I),BZN(I)
ISN 0293           ICOUNT=ICOUNT+1
ISN 0294        48 CONTINUE
ISN 0295           IF(ICOUNT+3.GT.60) WRITE(6,800)
ISN 0297           IF(ICOUNT+3.GT.60) ICOUNT=0
ISN 0299           WRITE(6,375)
ISN 0300           ICOUNT=ICOUNT+3
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LEVEL 2.3.0 (JUNE 78)          MAIN          OS/360  FORTRAN H EXTENDED          DATE 80.079/13.55.51          PAGE  8

  ISN 0301      375 FORMAT(/5X,'EVENT',19X,'<IRON>',14X,'<CHROMIUM>',13X,'<COPPER>',   00003730
                    1  13X,'<CADMIUM>',                                                  00003740
                    1 //5X,'NUMBER',2X,'MO',1X,'DA',1X,'YR',4X,'LBS ',7X,'MG/L',7X,      00003750
                    2 'LBS ',6X,'MG/L',8X'LBS ',6X,'MG/L',6X,'LBS ',6X,'MG/L',/,         00003760
                    3 5X,6('-'),2X,8('-'),2X,18('-'),4X,18('-'),4X,18('-'),4X,           00003770
                    4 18('-'))                                                           00003780
  ISN 0302          DO 47 I=1,NUM                                                        00003790
  ISN 0303          IF(ICOUNT.GE.60) WRITE(6,800)                                        00003800
  ISN 0305          IF(ICOUNT.GE.60) WRITE(6,375)                                        00003810
  ISN 0307          IF(ICOUNT.GE.60) ICOUNT=3                                            00003820
  ISN 0309          WRITE(6,360) I,IMO(I),IDAY(I),IYEAR(I),FE(I),BFE(I),CR(I),BCR(I),   00003830
                   1   CU(I),BCU(I),CD(I),BCD(I)                                         00003840
  ISN 0310          ICOUNT=ICOUNT+1                                                      00003850
  ISN 0311       47 CONTINUE                                                             00003860
  ISN 0312          STOP                                                                 00003870
  ISN 0313      800 FORMAT(1H1)                                                          00003880
  ISN 0314          END                                                                  00003890

*OPTIONS IN EFFECT*NAME(MAIN) NOOPTIMIZE LINECOUNT(56) SIZE(0240K) AUTODBL(NONE)

*OPTIONS IN EFFECT*SOURCE EBCDIC NOLIST NODECK OBJECT NOMAP NOFORMAT GOSTMT NOXREF ALC NOANSF TERM IBM FLAG(I)

*STATISTICS*     SOURCE STATEMENTS =     313, PROGRAM SIZE =    34760, SUBPROGRAM NAME =  MAIN

*STATISTICS*  NO  DIAGNOSTICS GENERATED

****** END OF COMPILATION ******                                          44K BYTES OF CORE NOT USED
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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF   *** RELEASE III ***

 DEVELOPED BY

              REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
              5103 WEST BELOIT ROAD
              MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625



***************                HARRISBURG - 1976                ***************


                         SITE CHARACTERISTICS
                         --------------------
                         TOTAL DRAINAGE AREA(AC)            =      18.50
                         LENGTH OF HIGHWAY(MI)              =       0.38
                         AVERAGE DAILY TRAFFIC              =   24000.00
                         INITIAL POLLUTION LEVEL(LBS)       =       0.0
                         USER SUPPLIED KI FACTOR            =     270.20

                         SITE TYPE SELECTED IS RURAL WITH FLUSH SHOULDERS.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 270.2000
K2 FACTOR FOR THIS SITE = 12.0000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE. RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	4	25	76	21.	0.42	4.92	0.022	13.626	0.00164	1501.0	0.0	2253.52	40.02
2	5	1	76	6.	0.45	5.00	0.058	15.680	0.00369	3880.6	2013.50	2629.55	113.74
3	5	11	76	10.	0.32	1.50	0.022	7.060	0.00307	1457.7	2515.91	3542.57	129.31
4	5	16	76	5.	0.65	10.25	0.131	15.680	0.00833	8766.8	3414.26	3927.64	373.40
5	5	19	76	2.	0.31	1.25	0.059	10.130	0.00578	3932.9	3554.24	3759.59	251.96
6	5	20	76	2.	0.11	2.50	0.008	11.980	0.00069	553.8	3507.63	3712.99	30.54
7	5	25	76	5.	0.36	11.15	0.222	15.680	0.01414	14899.5	3682.44	4195.92	654.77
8	5	29	76	3.	0.83	13.75	0.290	15.690	0.01847	19444.4	3541.05	3849.08	764.96
9	6	1	76	3.	0.63	2.50	0.172	11.980	0.01435	11541.2	3084.12	3392.15	536.40
10	6	15	76	14.	0.11	0.33	0.002	4.814	0.00048	155.1	2855.76	4293.22	24.65
11	6	16	76	1.	0.07	0.33	0.006	8.768	0.00063	370.6	4268.57	4371.24	32.89
12	6	17	76	1.	0.10	1.00	0.011	9.760	0.00111	727.7	4338.36	4441.04	58.77
13	6	19	76	2.	0.63	1.75	0.224	10.870	0.02061	15045.7	4382.27	4587.62	1005.15
14	6	20	76	1.	0.63	3.50	0.353	13.460	0.02619	23674.9	3582.46	3685.14	993.89
15	6	21	76	1.	0.25	1.50	0.061	10.500	0.00584	4119.4	2691.34	2794.02	190.15
16	6	28	76	7.	0.57	3.50	0.082	13.460	0.00607	5487.3	2604.87	3323.60	233.48
17	7	3	76	4.	1.21	2.17	0.489	11.492	0.04260	32871.4	3090.12	3590.82	1409.98
18	7	7	76	4.	0.15	0.75	0.009	9.390	0.00100	632.9	2099.04	2510.65	30.06
19	7	7	76	0.	0.49	0.50	0.219	9.020	0.02429	14715.9	2480.59	2480.59	627.24
20	7	7	76	0.	1.53	2.42	1.453	11.862	0.12254	97609.7	1853.36	1853.36	1427.35
21	7	8	76	1.	0.05	2.25	0.003	11.610	0.00025	196.1	426.20	528.68	1.59
22	7	10	76	2.	0.06	2.25	0.003	11.610	0.00023	175.9	527.09	732.44	1.98
23	7	11	76	1.	0.43	2.75	0.171	12.350	0.01386	11493.6	730.46	833.13	127.63
24	7	15	76	4.	0.29	1.67	0.033	10.752	0.00305	2203.2	705.50	1116.21	40.13
25	7	15	75	0.	0.57	0.67	0.292	9.272	0.03146	19590.7	1076.08	1076.08	338.37
26	7	21	76	6.	0.63	1.50	0.109	10.500	0.01040	7334.6	737.71	1353.76	158.86
27	7	23	76	2.	0.39	3.00	0.090	12.720	0.00711	6072.3	1194.02	1400.27	114.48
28	7	23	76	0.	0.26	0.92	0.066	9.642	0.00685	4436.7	1285.79	1285.79	101.49
29	7	29	76	6.	0.25	2.00	0.019	11.240	0.00169	1276.2	1184.30	1800.36	36.16
30	8	6	76	8.	0.45	1.75	0.048	10.870	0.00440	3215.1	1764.20	2585.61	133.09
31	8	8	76	2.	0.56	3.25	0.179	13.090	0.01370	12040.2	2452.51	2657.86	402.80
32	8	9	76	1.	0.23	3.00	0.052	12.720	0.00412	3518.2	2255.07	2357.74	113.69
33	8	13	76	4.	0.84	1.50	0.245	10.500	0.02337	16478.7	2244.06	2654.76	649.16
34	8	14	76	1.	0.43	2.17	0.171	11.492	0.01489	11493.6	2005.60	2108.28	345.01
35	9	15	76	1.	0.90	0.50	0.554	9.020	0.06142	37203.3	1763.27	1865.94	972.95
36	9	10	76	16.	1.00	6.00	0.138	13.780	0.01000	9256.4	893.00	2535.81	286.79
37	9	15	76	5.	1.54	20.00	0.752	15.680	0.04796	50590.2	2249.02	2762.40	1208.68
38	9	17	76	1.	0.24	1.00	0.057	9.760	0.00582	3813.2	1553.72	1656.40	111.69
39	9	20	76	3.	0.10	1.25	0.005	10.130	0.00052	354.7	1544.71	1952.74	11.56
40	9	26	76	6.	0.43	3.67	0.053	13.712	0.00387	3560.8	1841.18	2457.24	111.41
41	9	27	76	1.	0.17	5.75	0.030	15.680	0.00199	1985.8	2345.83	2448.50	54.78
42	9	30	76	3.	0.38	7.75	0.066	15.680	0.00421	4434.5	2393.72	2701.75	133.13
43	9	30	76	0.	0.25	3.75	0.061	13.830	0.00444	4119.4	2568.62	2568.62	133.13
44	10	1	76	1.	0.24	8.25	0.057	15.680	0.00362	3813.2	2435.49	2538.17	107.93
45	10	2	76	1.	0.05	0.25	0.003	8.650	0.00034	196.1	2430.24	2532.92	10.24

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
46	10	3	76	0.	0.37	3.25	0.006	13.090	0.00042	370.6	2522.68	2522.68	12.73
47	10	3	76	1.	0.89	10.50	0.678	15.680	0.04323	45517.7	2509.35	2612.63	1057.30
48	10	7	76	4.	0.78	14.50	0.213	15.680	0.01360	14322.9	1555.32	1966.03	296.06
49	10	8	76	1.	3.96	15.75	3.762	15.680	0.23992	252636.9	1669.97	1772.65	1673.02
50	10	20	76	12.	1.39	18.50	0.306	13.790	0.02221	20549.5	99.63	1331.74	311.50
51	10	24	76	3.	0.45	9.00	0.091	15.680	0.00580	6106.3	1029.24	1328.27	89.28
52	10	25	76	1.	0.59	7.50	0.311	15.680	0.01986	20911.6	1238.99	1341.67	284.46
53	10	30	76	5.	0.36	9.25	0.222	15.680	0.01414	14889.5	1057.20	1570.58	245.09

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 30.04
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 12.74
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET)= 855644.81
POUNDS OF TOTAL SOLIDS DISCHARGED = 18593.56

QUALITY ANALYSIS

EVENT NUMBER	MO DA YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4 25 76	0.0	0.0	0.0	0.0	0.0	0.0	0.674	7.2011
2	5 1 76	0.0	0.0	3.638	15.0347	4.212	17.4045	0.993	3.7298
3	5 11 76	4.250	46.9571	4.527	49.7597	8.888	97.7705	0.940	10.4258
4	5 16 76	82.697	151.2469	19.477	35.6267	87.561	160.1610	1.708	3.1233
5	5 18 76	43.827	178.6949	12.070	49.2139	49.579	109.0699	1.331	5.4272
6	5 20 76	0.0	0.0	0.0	0.0	0.0	0.0	0.645	18.6663
7	5 25 76	172.726	186.0224	36.641	39.4615	177.880	191.5741	2.590	2.7784
8	5 29 76	207.987	171.5262	43.362	35.7609	213.252	175.8682	2.921	2.4092
9	6 1 76	134.946	187.3606	29.420	40.8773	139.883	194.3583	2.213	3.0746
10	6 15 76	0.0	0.0	0.0	0.0	0.0	0.0	0.626	64.7540
11	6 16 76	0.0	0.0	0.0	0.0	0.0	0.0	0.652	28.2110
12	6 17 76	0.0	0.0	0.285	6.2769	0.0	0.0	0.732	16.1351
13	6 19 76	284.849	303.5916	58.014	61.9316	290.354	309.4587	3.666	3.9072
14	6 20 76	281.215	190.4755	57.322	38.9257	286.708	194.1965	3.631	2.4592
15	6 21 76	23.728	92.3641	8.238	32.0693	28.417	110.6176	1.136	4.4235
16	6 29 76	37.915	110.8903	10.943	31.9779	42.648	124.6332	1.274	3.7225
17	7 3 76	411.431	200.7338	82.154	40.0772	417.382	203.6124	4.893	2.3868
18	7 7 76	0.0	0.0	0.0	0.0	0.0	0.0	0.642	16.2953
19	7 7 76	163.915	178.6169	34.961	38.0570	169.043	184.2040	2.404	2.7182
20	7 7 76	419.952	68.0915	83.768	13.7618	425.880	69.9653	4.975	0.8173
21	7 8 76	0.0	0.0	0.0	0.0	0.0	0.0	0.555	45.3886
22	7 10 76	0.0	0.0	0.0	0.0	0.0	0.0	0.556	50.6931
23	7 11 76	4.042	5.6391	4.485	6.2581	9.669	12.0955	0.946	1.3104
24	7 15 76	0.0	0.0	0.0	0.0	0.0	0.0	0.674	4.9086
25	7 15 76	71.479	58.5080	17.341	14.1530	76.317	62.4684	1.595	1.3038
26	7 21 76	14.030	30.6733	6.389	13.9692	18.639	40.8590	1.042	2.2700
27	7 23 76	0.0	0.0	3.684	9.7276	4.450	11.7506	0.905	2.3897
28	7 23 76	0.0	0.0	2.891	10.4479	0.277	1.0023	0.865	3.1250
29	7 29 76	0.0	0.0	0.0	0.0	0.0	0.0	0.662	8.3191
30	8 6 76	5.790	29.8790	4.819	24.0342	10.423	51.9872	0.963	4.8011
31	8 8 76	92.095	122.6567	21.271	28.3292	96.998	129.1964	1.795	2.3956
32	8 9 76	0.0	0.0	3.635	16.5671	4.193	19.1115	0.902	4.1132
33	8 13 76	170.930	166.3350	36.299	35.3227	176.090	171.3457	2.562	2.4935
34	8 14 76	73.604	102.6914	17.746	24.7586	78.449	109.4510	1.620	2.2596
35	8 15 76	274.543	118.3363	56.050	24.1591	280.016	120.6953	3.566	1.5371
36	9 10 76	54.973	95.2351	14.194	24.5901	59.760	103.5278	1.439	2.4930
37	9 15 76	349.977	111.1309	70.429	22.3640	355.686	112.9437	4.297	1.3644
38	9 17 76	0.0	0.0	3.513	14.7723	3.551	14.9328	0.896	3.7680
39	9 20 76	0.0	0.0	0.0	0.0	0.0	0.0	0.586	26.4824
40	9 26 76	0.0	0.0	3.496	15.7442	3.463	15.5946	0.895	4.0322
41	9 27 76	0.0	0.0	0.042	0.3377	0.0	0.0	0.720	5.8126
42	9 30 76	5.802	20.9799	4.821	17.4331	10.435	37.7337	0.963	3.4912
43	9 30 76	5.801	22.5806	4.821	18.7658	10.434	40.6160	0.963	3.7475
44	10 1 76	0.0	0.0	3.283	13.8079	2.344	9.8578	0.885	3.7190
45	10 2 76	0.0	0.0	0.0	0.0	0.0	0.0	0.582	47.5807
46	10 3 76	0.0	0.0	0.0	0.0	0.0	0.0	0.589	25.5081
47	10 3 76	301.537	106.2301	61.195	21.5589	307.094	108.1879	3.829	1.3485
48	10 7 76	57.938	64.8665	14.759	16.5244	62.734	70.2361	1.468	1.6433
49	10 8 76	498.566	31.6457	98.754	6.2683	504.739	32.0375	5.736	0.3641
50	10 20 76	62.879	49.0676	15.701	12.2525	67.691	52.8222	1.516	1.1827
51	10 24 76	0.0	0.0	2.146	5.6358	0.0	0.0	0.827	2.1712

EVENT NUMBER	MO DA YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
52	10 25 76	54.228	41.5842	14.052	10.7758	59.013	45.2531	1.432	1.0980
53	10 30 76	41.630	44.8345	11.651	12.5476	46.375	49.9448	1.310	1.4106

EVENT NUMBER	MO DA YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4 25 76	29.501	315.1582	0.0	0.0	4.132	44.1417	0.127	1.3593
2	5 1 76	31.712	131.0432	1.885	7.7877	10.546	43.5776	0.262	1.0833
3	5 11 76	32.149	353.6558	2.875	31.6290	11.813	129.9487	0.289	3.1779
4	5 16 76	39.502	72.2548	19.541	35.7434	33.136	60.6098	0.737	1.3497
5	5 13 76	35.859	146.2063	11.283	46.0049	22.570	92.0261	0.515	2.1001
6	5 20 76	29.216	845.9346	0.0	0.0	3.307	95.7578	0.110	3.1913
7	5 25 76	47.943	51.6338	38.674	41.6514	57.615	62.0501	1.252	1.3486
8	5 29 76	51.249	42.2647	46.167	38.0740	67.201	55.4208	1.454	1.1990
9	6 1 76	44.392	61.6797	30.625	42.5513	47.316	65.7431	1.036	1.4399
10	6 15 76	29.039	3001.8862	0.0	0.0	2.794	288.8745	0.099	10.2451
11	6 16 76	29.296	1267.3452	0.0	0.0	3.511	151.9256	0.114	4.9409
12	6 17 76	30.063	662.5005	0.0	0.0	5.763	126.0949	0.162	3.5600
13	6 19 76	58.455	62.3008	62.500	66.6128	88.099	93.3951	1.933	2.0180
14	6 20 76	59.114	30.3624	61.728	41.8104	87.110	59.0025	1.873	1.2684
15	6 21 76	33.974	132.2524	7.012	27.2560	17.106	66.5882	0.400	1.5576
16	6 28 76	35.305	103.1722	10.027	29.3021	20.963	61.2615	0.491	1.4365
17	7 3 76	70.326	34.3075	89.410	43.6170	122.526	59.7724	2.618	1.2770
18	7 7 76	29.202	739.8494	0.0	0.0	3.265	82.7163	0.109	2.7616
19	7 7 76	47.117	51.3429	36.802	40.1028	55.220	60.1721	1.292	1.3996
20	7 7 76	71.121	11.6849	91.210	14.9843	124.830	20.5075	2.666	0.4380
21	7 8 76	28.348	2318.5776	0.0	0.0	0.780	64.4075	0.057	4.6551
22	7 10 76	28.350	2585.0105	0.0	0.0	0.822	74.9530	0.058	5.2525
23	7 11 76	32.129	44.9257	2.929	3.9468	11.754	16.3089	0.288	0.4012
24	7 15 76	29.504	214.7444	0.0	0.0	4.141	30.1414	0.127	0.9275
25	7 15 76	38.451	31.4727	17.159	14.0455	30.088	24.6284	0.673	0.5511
26	7 21 76	33.065	72.2910	4.951	10.8251	14.460	31.6345	0.345	0.7536
27	7 23 76	31.735	83.9041	1.935	5.1099	10.610	28.0192	0.264	0.6959
28	7 23 76	31.345	113.2888	1.051	3.7901	9.479	34.2613	0.240	0.8664
29	7 29 76	29.385	369.2175	0.0	0.0	3.796	47.6011	0.120	1.5099
30	9 6 76	32.203	161.0653	3.200	15.9625	12.229	60.9943	0.298	1.4941
31	8 8 76	40.304	53.7853	21.540	28.6883	35.693	47.5381	0.791	1.0536
32	8 9 76	31.711	144.5333	1.891	9.5717	10.541	49.0431	0.262	1.1944
33	8 13 76	47.775	46.4993	38.293	37.2632	57.127	55.5909	1.242	1.2086
34	8 14 76	39.650	53.0242	17.611	24.5704	30.665	42.7049	0.685	0.9562
35	8 15 76	57.488	24.7792	60.310	25.9556	85.296	36.7653	1.834	0.7907
36	9 10 76	36.904	63.9320	13.652	23.6503	25.601	44.3508	0.579	1.0028
37	9 15 76	64.560	20.5004	76.340	24.2409	105.905	33.5971	2.266	0.7195
38	9 17 76	31.651	133.0002	1.745	7.3365	10.367	43.5945	0.258	1.0866
39	9 20 76	28.647	1204.9851	0.0	0.0	1.655	74.8315	0.075	3.3971
40	9 26 76	31.642	142.4986	1.726	7.7726	10.343	46.5777	0.258	1.1613
41	9 27 76	20.944	241.7046	0.0	0.0	5.416	43.7359	0.154	1.2455
42	9 30 76	32.294	116.7780	3.203	11.5820	12.232	44.2335	0.298	1.0763
43	9 30 76	32.294	125.7102	3.203	12.4670	12.232	47.6158	0.298	1.1586
44	10 1 76	31.538	132.6249	1.489	6.2615	10.040	42.2190	0.252	1.0576
45	10 2 76	28.607	2339.7878	0.0	0.0	1.541	126.0072	0.073	5.9489
46	10 3 76	28.682	1241.1797	0.0	0.0	1.757	76.0452	0.077	3.3447
47	10 3 76	60.019	21.1445	66.047	23.2679	92.635	32.6350	1.985	0.7007
48	10 7 76	37.182	41.6281	14.282	15.9897	26.407	29.5648	0.596	0.6679
49	10 8 76	78.491	4.9821	107.915	6.9407	146.203	9.2800	3.116	0.1978
50	10 20 76	37.665	29.3760	15.332	11.9641	27.759	21.6548	0.624	0.4873
51	10 24 76	30.978	81.3526	0.221	0.5804	8.417	22.1049	0.217	0.5709
52	10 25 76	36.834	29.2455	13.404	10.3473	25.398	19.4763	0.575	0.4406

EVENT NUMBER	MO DA YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
53	10 30 76	35.653	38.3974	10.816	11.6490	21.973	23.6646	0.503	0.5412

EVENT NUMBER	MO DA YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4 25 76	0.0	0.0	9.003	95.4966	0.0	0.0	0.0	0.0
2	5 1 76	0.0	0.0	17.955	74.1564	0.018	0.0729	0.019	0.0800
3	5 11 75	0.031	0.3396	19.927	219.1502	0.024	0.2597	0.023	0.2559
4	5 16 76	0.558	1.0203	53.009	96.9605	0.124	0.2270	0.099	0.1622
5	5 18 76	0.297	1.2098	36.614	149.2876	0.074	0.3030	0.056	0.2294
6	5 20 76	0.0	0.0	6.723	194.6669	0.0	0.0	0.0	0.0
7	5 25 76	1.163	1.2523	90.994	97.9585	0.239	0.2579	0.164	0.1764
8	5 29 76	1.400	1.1543	105.869	87.3102	0.285	0.2347	0.193	0.1594
9	6 1 76	0.908	1.2620	75.013	104.2262	0.191	0.2653	0.132	0.1837
10	6 15 76	0.0	0.0	5.928	612.7585	0.0	0.0	0.0	0.0
11	6 16 76	0.0	0.0	7.039	394.6121	0.0	0.0	0.0	0.0
12	6 17 76	0.0	0.0	10.534	232.1304	0.0	0.0	0.005	0.1034
13	6 19 76	1.916	2.0422	138.206	147.3553	0.393	0.4083	0.257	0.2743
14	6 20 76	1.992	1.2813	136.762	92.6335	0.378	0.2563	0.254	0.1723
15	6 21 76	0.162	0.6293	28.135	109.5213	0.049	0.1893	0.040	0.1538
16	6 28 76	0.257	0.7510	34.120	99.7115	0.067	0.1950	0.051	0.1502
17	7 3 76	2.767	1.3498	191.719	93.5266	0.545	0.2660	0.363	0.1771
18	7 7 76	0.0	0.0	6.657	169.6720	0.0	0.0	0.0	0.0
19	7 7 76	1.104	1.2025	87.277	95.1046	0.228	0.2486	0.156	0.1705
20	7 7 76	2.924	0.4639	195.292	32.0634	0.556	0.0914	0.370	0.0609
21	7 8 76	0.0	0.0	2.815	230.2419	0.0	0.0	0.0	0.0
22	7 10 76	0.0	0.0	2.867	261.3633	0.0	0.0	0.0	0.0
23	7 11 76	0.029	0.0410	19.830	27.6667	0.023	0.0325	0.023	0.0322
24	7 15 76	0.0	0.0	8.017	58.3540	0.0	0.0	0.0	0.0
25	7 15 76	0.492	0.3949	49.260	39.5190	0.110	0.0898	0.079	0.0640
26	7 21 76	0.097	0.2110	24.044	52.5672	0.036	0.0790	0.031	0.0687
27	7 23 76	0.001	0.0030	18.055	47.6806	0.018	0.0474	0.020	0.0517
28	7 23 76	0.0	0.0	16.301	58.9157	0.013	0.0456	0.016	0.0592
29	7 29 76	0.0	0.0	7.481	93.9591	0.0	0.0	0.0	0.0
30	8 6 76	0.041	0.2053	20.568	102.5844	0.026	0.1275	0.025	0.1224
31	8 8 76	0.621	0.8271	56.978	75.8856	0.136	0.1813	0.097	0.1296
32	8 9 76	0.0	0.0	17.948	91.8029	0.018	0.0902	0.019	0.0982
33	9 13 76	1.151	1.1108	90.236	87.8103	0.237	0.2208	0.162	0.1590
34	9 14 76	0.407	0.6931	49.177	68.6106	0.112	0.1560	0.081	0.1132
35	9 15 76	1.947	0.7960	133.048	57.7356	0.370	0.1594	0.240	0.1072
36	9 10 76	0.372	0.6439	41.317	71.5770	0.099	0.1535	0.066	0.1136
37	9 15 76	2.354	0.7474	165.772	52.6287	0.467	0.1491	0.312	0.0992
38	9 17 76	0.0	0.0	17.678	74.2298	0.017	0.0706	0.019	0.0791
39	9 20 76	0.0	0.0	4.160	188.0568	0.0	0.0	0.0	0.0
40	9 26 76	0.0	0.0	17.640	79.4423	0.017	0.0751	0.019	0.0844
41	9 27 76	0.0	0.0	9.996	80.7156	0.0	0.0	0.014	0.0293
42	9 30 76	0.041	0.1491	20.573	74.3526	0.026	0.0925	0.025	0.0888
43	9 30 76	0.041	0.1605	20.572	80.0814	0.026	0.0906	0.025	0.0855
44	10 1 76	0.0	0.0	17.170	72.2044	0.015	0.0641	0.018	0.0749
45	10 2 76	0.0	0.0	3.932	325.6890	0.0	0.0	0.0	0.0
46	10 3 76	0.0	0.0	4.318	186.9667	0.0	0.0	0.0	0.0
47	10 3 76	2.028	0.7145	145.336	51.2012	0.404	0.1425	0.271	0.0956
48	10 7 76	0.392	0.4393	42.568	47.6580	0.092	0.1034	0.068	0.0762
49	10 8 76	3.352	0.2129	229.458	14.5010	0.657	0.0417	0.436	0.0277
50	10 20 76	0.425	0.3314	44.652	34.8461	0.109	0.0770	0.072	0.0563
51	10 24 76	0.0	0.0	14.653	38.4797	0.009	0.0200	0.013	0.0337
52	10 25 76	0.367	0.2911	41.033	31.4422	0.089	0.0672	0.065	0.0498
53	10 30 76	0.282	0.3037	35.688	38.4348	0.071	0.0770	0.054	0.0586

EVENT NUMBER	MO DA YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	4 25 76	0.0	0.0	0.0	0.0	0.012	0.1254	0.009	0.0919
2	5 1 76	0.0	0.0	0.0	0.0	0.017	0.0711	0.012	0.0477
3	5 11 76	0.186	2.0500	0.002	0.0166	0.018	0.2010	0.012	0.1335
4	5 16 76	3.618	6.6171	0.058	0.1059	0.036	0.0666	0.022	0.0401
5	5 18 76	1.917	7.8179	0.030	0.1221	0.027	0.1118	0.017	0.0696
6	5 20 76	0.0	0.0	0.0	0.0	0.011	0.3197	0.008	0.2381
7	5 25 76	7.557	8.1385	0.123	0.1320	0.057	0.0616	0.033	0.0357
8	5 29 76	9.099	7.5043	0.148	0.1220	0.065	0.0539	0.038	0.0310
9	6 1 76	5.990	8.1970	0.095	0.1325	0.043	0.0674	0.028	0.0395
10	6 15 76	0.0	0.0	0.0	0.0	0.011	1.0962	0.008	0.8255
11	6 16 76	0.0	0.0	0.0	0.0	0.011	0.4852	0.008	0.3598
12	6 17 76	0.0	0.0	0.0	0.0	0.013	0.2803	0.009	0.2061
13	6 19 76	12.462	13.2821	0.203	0.2166	0.083	0.0886	0.047	0.0503
14	6 20 76	12.303	8.3333	0.201	0.1359	0.082	0.0558	0.047	0.0317
15	6 21 76	1.038	4.0409	0.016	0.0604	0.023	0.0887	0.015	0.0567
16	6 29 76	1.659	4.8475	0.026	0.0751	0.026	0.0762	0.016	0.0477
17	7 3 76	18.002	8.7821	0.294	0.1435	0.112	0.0549	0.063	0.0308
18	7 7 76	0.0	0.0	0.0	0.0	0.011	0.2788	0.008	0.2078
19	7 7 76	7.171	7.8145	0.116	0.1267	0.055	0.0601	0.032	0.0350
20	7 7 76	18.373	3.0184	0.300	0.0493	0.114	0.0188	0.064	0.0105
21	7 8 76	0.0	0.0	0.0	0.0	0.009	0.7273	0.007	0.5777
22	7 10 76	0.0	0.0	0.0	0.0	0.009	0.8137	0.007	0.6453
23	7 11 76	0.177	0.2467	0.001	0.0019	0.018	0.0254	0.012	0.0169
24	7 15 76	0.0	0.0	0.0	0.0	0.012	0.0855	0.009	0.0625
25	7 15 76	3.127	2.5597	0.050	0.0408	0.034	0.0277	0.021	0.0168
26	7 21 76	0.614	1.3420	0.009	0.0197	0.021	0.0449	0.013	0.0292
27	7 23 76	0.0	0.0	0.0	0.0	0.017	0.0456	0.012	0.0306
28	7 23 76	0.0	0.0	0.0	0.0	0.016	0.0539	0.011	0.0400
29	7 29 76	0.0	0.0	0.0	0.0	0.011	0.1439	0.008	0.1061
30	8 6 76	0.253	1.2635	0.003	0.0130	0.019	0.0929	0.012	0.0615
31	8 8 76	4.029	5.3662	0.065	0.0861	0.039	0.0514	0.023	0.0308
32	8 9 76	0.0	0.0	0.0	0.0	0.017	0.0784	0.012	0.0526
33	8 13 76	7.478	7.2772	0.121	0.1180	0.057	0.0553	0.033	0.0321
34	8 14 76	3.220	4.4927	0.051	0.0716	0.034	0.0479	0.021	0.0290
35	8 15 76	12.011	5.1772	0.196	0.0844	0.081	0.0348	0.046	0.0198
36	9 10 76	2.405	4.1665	0.038	0.0658	0.030	0.0520	0.018	0.0320
37	9 15 76	15.311	4.8620	0.250	0.0794	0.098	0.0312	0.055	0.0176
38	9 17 76	0.0	0.0	0.0	0.0	0.017	0.0717	0.011	0.0432
39	9 20 76	0.0	0.0	0.0	0.0	0.010	0.4356	0.007	0.3373
40	9 26 76	0.0	0.0	0.0	0.0	0.017	0.0767	0.011	0.0516
41	9 27 76	0.0	0.0	0.0	0.0	0.013	0.1036	0.009	0.0742
42	9 30 76	0.254	0.9179	0.003	0.0095	0.019	0.0674	0.012	0.0446
43	9 30 76	0.254	0.9879	0.003	0.0102	0.019	0.0725	0.012	0.0480
44	10 1 76	0.0	0.0	0.0	0.0	0.017	0.0705	0.011	0.0476
45	10 2 76	0.0	0.0	0.0	0.0	0.010	0.7801	0.007	0.6060
46	10 3 76	0.0	0.0	0.0	0.0	0.010	0.4237	0.008	0.3249
47	10 3 76	13.192	4.6476	0.215	0.0758	0.087	0.0307	0.049	0.0174
48	10 7 76	2.535	2.8379	0.040	0.0449	0.031	0.0344	0.019	0.0211
49	10 8 76	21.812	1.3845	0.357	0.0226	0.133	0.0084	0.074	0.0047
50	10 20 76	2.751	2.1467	0.044	0.0341	0.032	0.0243	0.019	0.0152
51	10 24 76	0.0	0.0	0.0	0.0	0.015	0.0404	0.011	0.0278
52	10 25 76	2.372	1.8193	0.037	0.0287	0.030	0.0229	0.018	0.0141
53	10 30 76	1.821	1.9615	0.028	0.0306	0.027	0.0290	0.017	0.0181

APPENDIX D
MODEL INPUT FORMAT

Card number	Format	Card columns	Description	Variable name
1	20A4	1-80	Title.	TITLE
	I 10	1-10	Number of rainfall events to be run.	NUM
	I 10	11-20	Type of site. 1 - All paved bridge or deck. 2 - Paved and unpaved with curbs and inlets on paved area. 3 - Rural sites with flush shoulders.	ITYPE
3	F10.0	1-10	Area of site (acres).	ACRES
	F10.0	11-20	Length of site (miles), not curb miles or lane miles but the actual highway length.	LENGTH
	F10.0	21-30	Average daily traffic of site (vehicles per day).	ADT
	F10.0	31-40	Initial total solids load (pounds), if not known zero pounds are assumed.	PINIT
	F10.0	41-50	Total solids buildup rate (lb/mi-day) if known from sampling program. Otherwise it will be computed using average daily traffic.	KIIN
	*****************		Repeat cards 4 and 5 until I = NUM	********

continued

APPENDIX D
MODEL INPUT DATA FORMAT (continued).

Card number	Format	Card columns	Description	Variable name
4	I5	1-5	Month of rainfall event, i.e., 09	IMO(1)
	I5	6-10	Day of rainfall event, i.e., 22	IDAY(1)
	I5	11-15	Year of rainfall event, i.e., 78 These may be fictitious in the case of design storms.	IYEAR(1)
5	F10.0	1-10	Amount of rainfall per storm event (inches), i.e., 1.24 in.	RAIN(1)
	F10.0	11-20	Number of dry days since last rainfall, i.e., 7.0 days.	DDAYS(1)
	F10.0	21-30	Duration of rainfall (hours), i.e., 3.25 hr.	ROURAT(1)

APPENDIX E
MODEL VARIABLES AND DESCRIPTION

VARIABLE LIST AND DESCRIPTION	
Variable name	Description
ACRES	Area of site in acres.
ADT	Average daily traffic.
BBOD	Value for BOD_5 (mg/l)
BOD	Value for BOD_5 (pounds)
BCD	Value for Cadmium (mg/l)
BCL	Value for Chlorides (mg/l)
BCOD	Value for COD (mg/l)
BCR	Value for Chromium (mg/l)
BCU	Value for Copper (mg/l)
BFE	Value for Iron (mg/l)
BPB	Value for Lead (mg/l)
BSS	Value for Suspended Solids (mg/l)
BTKN	Value for total KJELDAHL Nitrogen (mg/l)
BTN	Value for total NO_2 + NO_3 (mg/l)
BTOC	Value for Total Organic Carbon (mg/l)
BTPO	Value for Total Phosphorus (mg/l)
BTVS	Value for Total Volatile Solids (mg/l)
BVSS	Value for Volatile Suspended Solids (mg/l)
BZN	Value for Zinc (mg/l)
CD	Value for Cadmium (pounds)
CL	Value for Chlorides (pounds)
COD	Value for COD (pounds)
CR	Value for Chromium (pounds)
CU	Value for Copper
DDAYS	Dry Days
FE	Value for Iron (pounds)
ITYPE	Type of site (Value of 1, 2 or 3)
IMO	Month of rainfall event
IDAY	Day of rainfall event
IYEAR	Year of rainfall event

continued

APPENDIX E
MODEL VARIABLES AND DESCRIPTION (continued)

VARIABLE LIST AND DESCRIPTION

Variable name	Description
KIIN	User supplied K_1 (pounds of total solids/mile-day)
K_1	Accumulation rate, (pounds of total solids/mile-day)
K_2	Washoff constant depending upon ITYPE
LENGTH	Length of site in miles
NUM	Number of rainfall events to be analyzed
PB	Value for Lead (pounds)
PENIT	Initial total solids load or remainder from previous washoff
PINIT	Initial total solids load
POLBUP	Total solids buildup from the equation $P=P_o + (K_1 \times HLxT)$
PWSHOF	Total solids washoff
R	Average runoff rate
RAIN	Rainfall in inches
RDURAT	Rainfall duration in hours
REMA	Total solids remaining (total solids buildup - total solids washoff)
ROFFCF	Runoff in cubic feet
ROFFIN	Runoff in inches
SS	Suspended solids (pounds)
TITLE	Title of simulation (user input)
TKN	Total KJELDAHL Nitrogen (pounds)
TN	Total Nitrogen (pounds)
TOC	Total Organic Carbon (pounds)
TOTRAN	Total rainfall (inches) for the entire record
TPO	Total Phosphorus (pounds)
TPWSHF	Total solids washed off (pounds) for the entire record
TRUNCF	Total runoff (cubic feet) for the entire record
TRUNIN	Total runoff (inches) for the entire record
TVS	Total Volatile Solids (pounds)

continued

APPENDIX E
MODEL VARIABLES AND DESCRIPTION (continued)

VARIABLE LIST AND DESCRIPTION	
Variable name	Description
VSS	Volatile Suspended Solids (pounds)
XDD	Dry day value used to calculate total runoff
XYD	Dry day value used to calculate pollutant build-up
Y1	Runoff Duration (hours)
ZN	Value for Zinc (pounds)

APPENDIX F
RECEIVING WATER IMPACT SAMPLING

PURPOSE

The sampling effort carried out at the Harrisburg I-81 site receiving stream (Pine River) was intended to provide a preliminary overview of the existing instream conditions before and after a runoff event. The results of this sampling effort provide direction for the receiving model and data needs for future sampling efforts.

Sampling of the receiving stream on July 1, 1976 included a prestorm and poststorm effort at the same locations to quantify changes in biological, chemical or physical stream characteristics. Locations of the sampling points are approximately 50 ft (15.2 m) upstream of where the highway runoff channel entered the stream and 150 ft (45.7 m) downstream. Runoff from the highway discharges to the stream through an unlined channel and appeared to be completely mixed by the time it reached the downstream sampling site.

Prestorm (dry weather) samples were taken approximately two hours before the start of the July 7th rainfall which produced 0.49 inches (1.24 cm) of rain in 30 minutes. Four days of dry weather preceeded this storm, insuring no highway runoff loads were contributed to the stream during the prestorm monitoring. The flow within the stream during this sampling interval was 0.2 cfs (0.006 m^3/sec) as compared to a high of 9.0 cfs (0.25 m^3/sec) during the wet weather sampling.

RESULTS

Samples of the stream and bottom materials were acquired on a grab sample basis during the prestorm period in order to determine the effects of the single discharge point of highway runoff. Sediment samples were taken at upstream and downstream locations to determine if highway runoff altered the chemical or physical properties of bottom sediments at the downstream location as compared to upstream. Table F1 presents the bulk analyses for these sediment samples. Dry weather samples show little difference between upstream and downstream locations. Wet weather samples show more significant variation between locations for certain parameters. Comparison of the analyses for the upstream site between dry and wet weather shows significant change for oils, total phosphorous and COD. Iron concentrations were high at all locations, however, iron is a regular component of surface water in that area.

The general conclusion regarding sediment analysis is: no significant impact at this sampling site can be determined. Long term build-up of metals or oils and grease on the downstream portions have not been seen nor can any impact be related to the small volume of highway runoff present.

Table F-1. Harrisburg receiving water sediment bulk analysis.

Parameter[a]	Dry weather		Wet weather	
	Upstream	Downstream	Upstream	Downstream
Total Solids	73.84%	71.47%	75.14%	74.64%
Total Volatile Solids	3.08%	3.24%	2.84%	2.76%
Oils	590	550	50	30
Total Phosphorous	198	194	164	59
COD	11,100	12,800	6,500	2,200
Iron	33,400	43,500	31,200	49,500
Zinc	138	179	191	166
Chromium	36	42	58	54
Copper	28	39	63	64
Manganese	834	952	582	974
Lead	<10	<10	<10	<10

a. Solids parameters are reported as percent, while the remaining parameters are mg/kg of dry solids.

At the same time the sediment samples were obtained, instream samples were taken to determine if immediate impacts could be quantified. Dry weather grab samples were taken to provide background concentrations. During the runoff period of the July 7th storm, grab samples were again taken at the same locations. Similar samples were also taken after the surface runoff and high in-stream flows had subsided. These samples were used to determine possible decrease of in-stream concentrations after the runoff had subsided. Table F-2 shows the analysis results for these grab samples. Again, little variation is encountered between sites or samples except for the noticeable increase in BOD after the storm. The relatively low concentrations of BOD and the increase in concentrations upstream of the discharge, however, negate further investigation as to the source or impact of this load.

Table F-3 presents the results of the in-stream samples taken during the dry and wet weather monitoring periods. Also included are composite sample results from the highway runoff on July 7th. On a simple concentration basis, the relative quality between upstream and downstream locations is consistent. Mass balance analysis of wet weather data, however, is required in order to determine the relative magnitude of the loads in the system.

Mass balance analysis using the wet weather data was calculated with stage measurements at a downstream gage and the highway runoff values. Although detailed (multiple sample) composites of the stream flow were not taken, the following mass loadings using the rough composites will provide some insight into the relative contribution of the highway runoff.

1. Highway runoff flow data	7/7/76
- duration of overflow	150 minutes
- average flow	1.13 cfs (0.032 m^3/sec)
- total flow to river	10,145 ft^3 (287.3 m^3)
2. Downstream receiving stream flow	
- duration of sampling	150 minutes
- average stage reading	2.165 feet (0.660 m)
- average flow	7.25 cfs (0.205 m^3/sec)
- total flow	65,235 ft^3 (1,847.5 m^3)

3. Upstream receiving stream flow
   - assume downstream flow - highway = upstream
   - 65,235 - 10,145 = 55,090 ft^3 (1,560.1 m^2)

Using Table F-3, the kilogram loadings of Table F-4 are, derived by multiplying total flow times composite quality (wet weather values). Columns 1, 2 and 3 of Table F-4 present the measured kilograms of each parameter from the instream and highway runoff composites. Column 4 is

Table F-2. Harrisburg receiving water.

Parameter	Units	Upstream			Downstream		
		Prestorm	Storm	Poststorm	Prestorm	Storm	Poststorm
DO	mg/l	7.4	7.6	7.6	7.8	7.7	7.8
Temperature	^{o}C	21	20	20	21	20	20
pH	--	7.6	7.3	7.6	7.4	6.8	7.5
BOD_5	mg/l	0.2	na	4.0	0.6	na	na
Chlorophyl _a_	µg/l	3.6	na	na	4.0	na	na

Note: na = no analysis performed.

Table F-3. Harrisburg instream samples.

Parameter, mg/l	Dry weather		Wet weather		
	Upstream	Downstream	Upstream	Highway	Downstream
Suspended Solids	12	28	95	136	202
Total Solids	415	431	323	358	292
Total Volatile Solids	106	115	88	97	91
Volatile Suspended Solids	4	6	14	14	23
Total Phosphorous (PO_4)	0.04	0.04	0.26	0.42	0.43
Lead	<0.1	<0.1	<0.1	0.10	0.20
Zinc	0.05	0.04	0.06	0.08	0.07
Copper	0.02	0.02	0.02	0.01	0.07
Iron	0.04	1.7	4.3	6.4	9.2
Cadmium	0.01	0.01	0.03	0.03	0.03
Chromium	0.09	0.09	0.07	0.11	0.11
Mercury[a]	<0.001	<0.001	<0.001	0.03	<0.001
TKN	0.39	1.86	1.34	1.57	1.31
NH_3-N	<0.01	0.01	0.58	0.75	0.84
NO_3-NO_2	0.69	0.64	1.06	1.17	1.44
TOC	6	4	15	16	15

a. Units are µg/l

Table F-4. Highway and receiving water wet weather loadings.

Parameter	(1) Upstream load, lb	(2) Highway load, lb	(3) Downstream load, lb	(4) Upstream(1) plus highway(2) load, lb	(5) Difference (4-3), lb	(6) Percent change
SS	327	86.1	823	413	-410	-99.3
TS	1,110	227	1,190	1,337	147	11.0
VSS	48.0	8.86	93.7	56.9	-36.8	-64.7
TPO_4	0.893	0.265	1.75	1.16	-0.59	-50.9
Fe	14.8	4.06	37.3	18.9	-18.4	-97.4
TOC	51.6	10.1	61.1	61.7	0.6	1.0

metric units: lb x 0.454 = kg

the sum of columns 1 and 2 which should be approximately equal to the downstream load of column 3 if the system is relatively free of other withdrawals or loads. Column 5 is the difference between columns 4 and 5 while column 6 is the percent change.

The results presented in Table F-4 indicate an extremely wide variation in loads. Suspended and volatile solids loads indicate either a large amount of scour within the stream or lateral inflows while total solids indicates settling or outflows between sampling points. Only TOC shows a fairly reasonable consistency. The monitoring sites were checked to insure no other in-flows or branches in the stream occurred. The only conclusion to be drawn from the data is that the upstream loads are all less than the downstream loads. However, the highway runoff contribution alone is not of sufficient magnitude to even approach a reasonable "mass balance". Other types of monitoring including benthos description were attempted but the results were also inconclusive.

APPENDIX G
MODEL RESULTS

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

             REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
             5103 WEST BELOIT ROAD
             MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625


***************          MILWAUKEE - HIGHWAY 794 - 1976          ***************

                  SITE CHARACTERISTICS
                  --------------------
                  TOTAL DRAINAGE AREA(AC)         =       2.10
                  LENGTH OF HIGHWAY(MI)           =       0.15
                  AVERAGE DAILY TRAFFIC           =   53000.00
                  INTIAL POLLUTION LEVEL(LBS)     =        0.0
                  USER SUPPLIED K1 FACTOR         =      75.60

                  SITE TYPE SELECTED IS AN ALL PAVED BRIDGE OR DECK
```

QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 75.6000
K2 FACTOR FOR THIS SITE = 5.0000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	5	10	76	5.	0.15	1.00	0.127	1.810	0.06997	965.5	0.0	56.70	16.74
2	5	15	76	5.	0.90	12.00	0.853	6.290	0.13568	6505.5	39.96	96.66	47.61
3	5	28	76	13.	0.63	2.00	0.592	2.930	0.20197	4511.1	49.05	196.47	124.90
4	5	30	76	2.	0.10	3.00	0.078	4.050	0.01931	596.1	71.58	94.26	8.67
5	6	13	76	14.	0.58	3.50	0.543	4.610	0.11786	4141.7	85.58	244.34	108.79
6	6	18	76	5.	0.90	2.75	0.853	3.770	0.22637	6505.5	135.55	192.25	130.25
7	6	24	76	6.	0.05	0.75	0.030	1.530	0.01944	226.8	62.00	130.04	12.05
8	6	27	76	3.	0.05	0.17	0.030	0.880	0.03379	226.8	117.99	152.01	23.63
9	7	28	76	31.	0.33	2.25	0.301	3.210	0.09379	2295.1	128.38	355.18	132.95
10	7	30	76	2.	1.59	4.00	1.522	5.170	0.29439	11602.3	222.23	244.91	188.70
11	8	5	76	6.	0.05	0.17	0.030	0.880	0.03379	226.8	56.21	124.25	19.31
12	8	5	76	0.	0.07	1.00	0.049	1.810	0.02714	374.5	104.94	104.94	13.32
13	8	13	76	8.	0.64	5.25	0.601	6.290	0.09562	4584.9	91.62	182.34	69.29
14	8	25	76	12.	0.14	1.00	0.117	1.810	0.06462	891.6	113.05	249.13	68.78
15	8	28	76	3.	1.05	3.00	0.999	4.050	0.24660	7613.5	180.35	214.37	151.89
16	9	1	76	4.	0.39	1.75	0.359	2.650	0.13555	2738.3	62.48	107.84	53.08
17	9	9	76	8.	0.85	6.00	0.805	6.290	0.12797	6136.1	54.76	145.48	68.75
18	9	19	76	10.	0.30	4.00	0.272	5.170	0.05261	2073.5	76.73	190.13	43.97
19	10	5	76	16.	1.20	5.00	1.144	6.290	0.18189	8721.5	146.15	327.59	195.65

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 9.97
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 9.31
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 70936.69
POUNDS OF TOTAL SOLIDS DISCHARGED = 1478.33

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	5	10	76	5.671	94.1880	3.397	56.4193	16.999	282.3440	0.215	3.5749
2	5	15	76	22.033	54.3097	9.293	22.9076	23.822	58.7192	0.317	0.7817
3	5	28	76	62.995	223.9311	24.055	85.5100	40.902	145.3966	0.572	2.0339
4	5	30	76	1.397	37.5804	1.857	49.9447	15.217	409.3376	0.189	5.0740
5	6	13	76	54.460	210.8553	20.979	81.2267	37.343	144.5832	0.519	2.0095
6	6	18	76	65.835	162.2804	25.079	61.8178	42.086	103.7409	0.590	1.4539
7	6	24	76	3.184	225.1730	2.501	176.8313	15.962	1128.6746	0.200	14.1243
8	6	27	76	9.323	659.2341	4.713	333.2571	18.522	1309.6694	0.238	16.8270
9	7	28	76	67.263	469.9744	25.593	178.8231	42.682	298.2214	0.599	4.1834
10	7	30	76	96.812	133.8062	36.242	50.0910	55.003	76.0211	0.783	1.0818
11	8	5	76	7.036	497.5166	3.889	274.9775	17.568	1242.2361	0.224	15.8201
12	8	5	76	3.858	165.1732	2.743	117.4649	16.243	695.4727	0.204	8.7323
13	8	13	76	33.525	117.2520	13.435	46.9878	28.613	100.0753	0.389	1.3593
14	8	25	76	33.252	598.0518	13.336	239.8628	28.500	512.5842	0.387	6.9598
15	8	28	76	77.304	162.8191	29.212	61.5265	46.868	98.7157	0.661	1.3927
16	9	1	76	24.932	146.0047	10.338	60.5414	25.030	146.5826	0.335	1.9628
17	9	9	76	33.239	86.8655	13.332	34.8407	28.495	74.4656	0.387	1.0111
18	9	19	76	20.105	155.4904	8.599	66.5007	23.018	178.0159	0.305	2.3597
19	10	5	76	100.492	184.7694	37.568	69.0748	56.538	103.9528	0.806	1.4813

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	5	10	76	1.885	31.3082	1.754	29.1335	8.851	147.0096	0.143	2.3740
2	5	15	76	2.595	6.3966	3.514	8.6611	15.087	37.1888	0.185	0.4566
3	5	28	76	4.373	15.5435	7.919	28.1503	30.699	109.1273	0.291	1.0348
4	5	30	76	1.699	45.7168	1.294	34.8196	7.222	194.2756	0.132	3.5477
5	6	13	76	4.002	15.4956	7.001	27.1068	27.446	106.2642	0.269	1.0417
6	6	18	76	4.496	11.0821	8.225	20.2731	31.781	78.3399	0.298	0.7357
7	6	24	76	1.777	125.6546	1.487	105.1186	7.903	558.8379	0.137	9.6520
8	6	27	76	2.043	144.4912	2.147	151.8006	10.243	724.2727	0.152	10.7740
9	7	28	76	4.558	31.8460	8.378	58.5387	32.326	225.8633	0.302	2.1111
10	7	30	76	5.840	8.0718	11.556	15.9718	43.588	60.2437	0.379	0.5232
11	8	5	76	1.944	137.4733	1.901	134.4084	9.371	662.6370	0.146	10.3560
12	8	5	76	1.806	77.3393	1.559	66.7530	8.160	349.3826	0.138	5.9192
13	8	13	76	3.094	10.8202	4.750	16.6118	19.467	68.0854	0.215	0.7517
14	8	25	76	3.082	55.4293	4.720	84.8971	19.363	348.2539	0.214	3.8530
15	8	28	76	4.994	10.5176	9.458	19.9206	36.152	76.1455	0.328	0.6910
16	9	1	76	2.721	15.9336	3.825	22.4027	16.192	94.8227	0.193	1.1286
17	9	9	76	3.081	8.0525	4.719	12.3322	19.358	50.5894	0.214	0.5598
18	9	19	76	2.511	19.4224	3.306	25.5712	14.352	110.9988	0.180	1.3940
19	10	5	76	6.000	11.0316	11.952	21.9751	44.990	82.7214	0.388	0.7135

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	5	10	76	0.017	0.2785	3.159	52.4706	0.070	1.1582	0.028	0.4661
2	5	15	76	0.048	0.1174	4.209	10.3743	0.243	0.5980	0.054	0.1331
3	5	28	76	0.125	0.4441	6.836	24.3019	0.675	2.4009	0.119	0.4227
4	5	30	76	0.009	0.2341	2.885	77.6046	0.025	0.6610	0.021	0.5726
5	6	13	76	0.109	0.4213	6.289	24.3492	0.585	2.2659	0.105	0.4080
6	6	18	76	0.130	0.3211	7.019	17.3007	0.705	1.7388	0.123	0.3042
7	6	24	76	0.012	0.8539	3.000	212.0971	0.043	3.0729	0.024	1.7054

EVENT NUMBER	MO DA YR	<TPO4> LBS	MG/L	<CHLORIDES> LBS	MG/L	<LEAD> LBS	MG/L	<ZINC> LBS	MG/L
8	6 27 76	0.024	1.6729	3.393	239.9425	0.108	7.6592	0.034	2.3934
9	7 28 76	0.133	0.9291	7.110	49.6801	0.721	5.0343	0.126	0.8781
10	7 30 76	0.189	0.2609	9.006	12.4472	1.033	1.4274	0.173	0.2384
11	8 5 76	0.019	1.3678	3.247	229.5682	0.084	5.9505	0.030	2.1371
12	8 5 76	0.013	0.5714	3.043	130.2816	0.051	2.1653	0.025	1.0784
13	8 13 76	0.069	0.2425	4.946	17.2983	0.364	1.2732	0.072	0.2525
14	8 25 76	0.069	1.2375	4.928	88.6405	0.361	6.4955	0.072	1.2909
15	8 28 76	0.152	0.3200	7.754	16.3325	0.827	1.7410	0.142	0.2982
16	9 1 76	0.053	0.3110	4.395	25.7360	0.273	1.6001	0.059	0.3431
17	9 9 76	0.069	0.1798	4.928	12.8775	0.361	0.9435	0.072	0.1875
18	9 19 76	0.044	0.3403	4.085	31.5930	0.222	1.7188	0.051	0.3939
19	10 5 76	0.196	0.3598	9.242	16.9927	1.072	1.9703	0.178	0.3279

EVENT NUMBER	MO DA YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
1	5 10 76	0.841	13.9696	0.004	0.0644	0.006	0.0927	0.001	0.0157
2	5 15 76	1.304	3.2146	0.009	0.0217	0.015	0.0358	0.005	0.0130
3	5 28 76	2.463	8.7569	0.021	0.0753	0.037	0.1313	0.016	0.0572
4	5 30 76	0.720	19.3710	0.003	0.0696	0.003	0.0873	0.0	0.0
5	6 13 76	2.222	8.6026	0.019	0.0720	0.032	0.1250	0.014	0.0535
6	6 18 76	2.544	6.2704	0.022	0.0543	0.039	0.0949	0.017	0.0415
7	6 24 76	0.771	54.4951	0.003	0.2211	0.004	0.2986	0.000	0.0203
8	6 27 76	0.944	66.7798	0.005	0.3522	0.008	0.5361	0.002	0.1349
9	7 28 76	2.584	18.0563	0.022	0.1570	0.039	0.2745	0.017	0.1203
10	7 30 76	3.421	4.7276	0.031	0.0434	0.055	0.0766	0.025	0.0346
11	8 5 76	0.880	62.2029	0.004	0.3034	0.006	0.4477	0.001	0.0922
12	8 5 76	0.790	33.8145	0.003	0.1426	0.005	0.1966	0.000	0.0199
13	8 13 76	1.629	5.6987	0.012	0.0430	0.021	0.0728	0.008	0.0290
14	8 25 76	1.622	29.1664	0.012	0.2195	0.021	0.3719	0.008	0.1480
15	8 28 76	2.868	6.0415	0.026	0.0537	0.045	0.0943	0.020	0.0418
16	9 1 76	1.386	8.1177	0.010	0.0568	0.016	0.0944	0.006	0.0353
17	9 9 76	1.621	4.2370	0.012	0.0319	0.021	0.0540	0.008	0.0215
18	9 19 76	1.250	9.6640	0.008	0.0637	0.013	0.1043	0.005	0.0368
19	10 5 76	3.525	6.4806	0.033	0.0598	0.057	0.1057	0.026	0.0478

```
     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***


 DEVELOPED BY

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      IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
           NICHOLAS KOBRIGER
           PHONE 1-414-643-3625



***************                MILWAUKEE - HIGHWAY 794 - 1977                 ***************


                               SITE CHARACTERISTICS
                               --------------------
                               TOTAL DRAINAGE AREA(AC)          =       2.10
                               LENGTH OF HIGHWAY(MI)            =       0.15
                               AVERAGE DAILY TRAFFIC            =   53000.00
                               INTIAL POLLUTION LEVEL(LBS)      =       0.0
                               USER SUPPLIED K1 FACTOR          =      75.60

                               SITE TYPE SELECTED IS AN ALL PAVED BRIDGE OR DECK
```

QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 75.6000
K2 FACTOR FOR THIS SITE = 5.0000

											<TOTAL SOLIDS>		
EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	6	8	77	3.	0.24	6.49	0.214	6.290	0.03400	1630.3	0.0	34.02	5.32
2	6	10	77	2.	0.05	1.25	0.030	2.090	0.01423	226.8	28.70	51.38	3.53
3	6	11	77	1.	1.22	4.45	1.163	5.674	0.20505	8869.2	47.85	59.19	37.96
4	6	17	77	6.	0.61	0.33	0.572	1.060	0.54019	4363.3	21.23	89.27	83.28
5	6	28	77	11.	0.10	0.08	0.078	0.780	0.10031	596.1	6.00	130.74	51.56
6	6	28	77	0.	0.57	3.21	0.534	4.285	0.12453	4067.9	79.18	79.18	36.69
7	6	30	77	3.	0.79	2.50	0.747	3.490	0.21399	5692.9	42.48	76.50	50.26
8	7	3	77	3.	0.35	2.00	0.320	2.930	0.10937	2442.8	26.25	60.27	25.38
9	7	6	77	3.	0.11	0.25	0.088	0.970	0.09061	670.0	34.88	68.90	25.10
10	7	17	77	11.	2.60	1.67	2.501	2.560	0.97668	19062.8	43.80	168.54	167.27
11	7	17	77	0.	2.10	9.00	2.016	6.290	0.32054	15369.5	1.28	1.28	1.02
12	7	24	77	7.	0.42	1.00	0.388	1.810	0.21452	2959.9	0.26	79.64	52.39
13	7	29	77	5.	0.05	0.50	0.030	1.250	0.02380	226.8	27.25	83.95	9.42
14	8	2	77	4.	0.05	0.75	0.030	1.530	0.01944	226.8	74.53	119.89	11.11
15	8	3	77	1.	0.35	0.75	0.320	1.530	0.20944	2442.8	108.78	120.12	77.97
16	8	4	77	1.	0.17	0.92	0.146	1.720	0.08488	1113.2	42.16	53.50	18.50
17	8	5	77	1.	0.15	0.42	0.127	1.160	0.10914	965.5	35.00	46.34	19.49
18	8	5	77	0.	0.24	3.00	0.214	4.050	0.05280	1630.3	26.85	26.85	6.23
19	8	7	77	2.	0.25	5.25	0.224	6.290	0.03554	1704.1	20.62	43.30	7.05
20	8	9	77	2.	0.07	1.25	0.049	2.090	0.02351	374.5	36.25	58.93	6.53
21	8	13	77	4.	1.28	2.33	1.222	3.300	0.37023	9312.4	52.40	97.76	82.40
22	8	16	77	3.	0.20	2.00	0.175	2.930	0.05976	1334.8	15.36	49.38	12.75
23	8	22	77	6.	0.15	2.75	0.127	3.770	0.03359	965.5	36.62	104.66	16.18
24	8	22	77	0.	0.05	0.50	0.030	1.250	0.02380	226.8	88.48	88.48	9.93
25	8	28	77	6.	1.10	8.00	1.047	6.290	0.16649	7982.8	78.56	146.60	82.82
26	9	4	77	7.	0.11	0.25	0.088	0.970	0.09061	670.0	63.77	143.15	52.15
27	9	12	77	8.	0.47	8.00	0.437	6.290	0.06943	3329.2	91.01	181.73	53.30
28	9	16	77	4.	0.12	4.75	0.098	6.010	0.01624	743.9	128.43	173.79	13.55
29	9	17	77	1.	0.29	1.50	0.262	2.370	0.11068	1999.6	160.24	171.58	72.92
30	9	18	77	1.	0.28	5.00	0.253	6.290	0.04016	1925.7	98.66	110.00	20.01
31	9	23	77	5.	0.05	0.08	0.030	0.780	0.03816	226.8	89.99	146.69	25.48
32	9	23	77	0.	0.13	0.25	0.107	0.970	0.11059	817.7	121.21	121.21	51.48
33	9	24	77	1.	0.81	2.00	0.766	2.930	0.26150	5840.7	69.73	81.07	59.14

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 15.53
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 14.43
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 110010.31
POUNDS OF TOTAL SOLIDS DISCHARGED = 1248.14

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	6	8	77	0.0	0.0	1.216	11.9584	14.475	142.3836	0.178	1.7464
2	6	10	77	0.0	0.0	0.874	61.8095	14.080	995.5862	0.172	12.1370
3	6	11	77	16.918	30.5875	7.450	13.4697	21.689	39.2137	0.285	0.5158
4	6	17	77	40.938	150.4512	16.106	59.1924	31.705	116.5182	0.435	1.5980
5	6	28	77	24.126	648.9919	10.048	270.2837	24.694	664.2847	0.330	8.8809
6	6	28	77	16.248	64.0497	7.209	28.4165	21.409	84.3969	0.281	1.1081
7	6	30	77	23.436	66.0149	9.799	27.6020	24.407	68.7487	0.326	0.9178
8	7	3	77	10.253	67.3082	5.048	33.1395	18.910	124.1335	0.244	1.6002
9	7	6	77	10.103	241.8049	4.994	119.5292	18.847	451.0925	0.243	5.8120
10	7	17	77	85.451	71.8817	32.148	27.0428	50.266	42.2837	0.712	0.5989
11	7	17	77	0.0	0.0	0.395	0.4119	13.525	14.1116	0.163	0.1704
12	7	24	77	24.566	133.0919	10.206	55.2946	24.878	134.7817	0.333	1.6035
13	7	29	77	1.791	126.6572	1.999	141.3285	15.381	1087.5952	0.191	13.5109
14	8	2	77	2.686	189.9478	2.321	164.1370	15.754	1113.9863	0.197	13.9050
15	8	3	77	38.122	250.2554	15.092	99.0695	30.531	200.4190	0.417	2.7393
16	8	4	77	6.605	95.1482	3.734	53.7825	17.389	250.4861	0.221	3.1843
17	8	5	77	7.128	118.3927	3.922	65.1422	17.607	292.4370	0.224	3.7256
18	8	5	77	0.102	1.0024	1.390	13.6718	14.677	144.3661	0.181	1.7760
19	8	7	77	0.536	5.0437	1.546	14.5513	14.858	139.8117	0.183	1.7245
20	8	9	77	0.263	11.2699	1.448	62.0017	14.744	631.2981	0.182	7.7740
21	8	13	77	40.473	69.6927	15.939	27.4459	31.511	54.2605	0.432	0.7438
22	8	16	77	3.559	42.7549	2.636	31.6649	16.118	193.6403	0.202	2.4278
23	8	22	77	5.376	89.2978	3.291	54.6570	16.876	280.3049	0.213	3.5445
24	8	22	77	2.061	145.7165	2.096	148.1970	15.494	1095.5425	0.193	13.6296
25	8	28	77	40.696	81.7493	16.019	32.1789	31.604	63.4852	0.433	0.8704
26	9	4	77	24.438	584.9143	10.160	243.1783	24.825	594.1628	0.332	7.9483
27	9	12	77	25.047	120.6462	10.380	49.9962	25.079	120.7965	0.336	1.6178
28	9	16	77	3.981	85.8267	2.788	60.1020	16.294	351.2705	0.205	4.4131
29	9	17	77	35.446	284.2571	14.127	113.2920	29.415	235.8900	0.401	3.2128
30	9	18	77	7.406	61.6699	4.022	33.4928	17.722	147.5771	0.226	1.8822
31	9	23	77	10.304	728.5601	5.066	358.2405	18.931	1338.5776	0.244	17.2586
32	9	23	77	24.084	472.3044	10.033	196.7448	24.677	483.9260	0.330	6.4691
33	9	24	77	28.144	77.2702	11.496	31.5617	26.370	72.3992	0.355	0.9751

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	6	8	77	1.622	15.9576	1.103	10.8507	6.544	64.3713	0.127	1.2520
2	6	10	77	1.581	111.8038	1.001	70.7927	6.183	437.1919	0.125	8.8270
3	6	11	77	2.373	4.2905	2.964	5.3583	13.137	23.7529	0.172	0.3110
4	6	17	77	3.415	12.5520	5.547	20.3855	22.292	81.9269	0.234	0.8603
5	6	28	77	2.686	72.2498	3.739	100.5752	15.885	427.3042	0.191	5.1281
6	6	28	77	2.344	9.2400	2.892	11.3987	12.882	50.7823	0.170	0.6712
7	6	30	77	2.656	7.4811	3.665	10.3225	15.622	44.0036	0.189	0.5320
8	7	3	77	2.084	13.6793	2.247	14.7496	10.598	69.5674	0.155	1.0160
9	7	6	77	2.077	49.7188	2.231	53.3900	10.540	252.2720	0.154	3.6952
10	7	17	77	5.347	4.4980	10.334	8.6931	39.258	33.0237	0.349	0.2937
11	7	17	77	1.523	1.5895	0.858	0.8953	5.676	5.9220	0.121	0.1267
12	7	24	77	2.705	14.6546	3.786	20.5124	16.053	86.9682	0.192	1.0390
13	7	29	77	1.717	121.3793	1.337	94.5235	7.372	521.2905	0.133	9.3974
14	8	2	77	1.755	124.1259	1.433	101.3303	7.713	545.4126	0.135	9.5610
15	8	3	77	3.293	21.6185	5.244	34.4250	21.219	139.2944	0.227	1.4889

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
16	8	4	77	1.926	27.7374	1.855	26.7147	9.207	132.6297	0.145	2.0937
17	8	5	77	1.948	32.3586	1.911	31.7366	9.406	156.2348	0.147	2.4366
18	8	5	77	1.643	16.1639	1.155	11.3620	6.728	66.1833	0.129	1.2643
19	8	7	77	1.662	15.6406	1.202	11.3089	6.894	64.8714	0.130	1.2201
20	8	9	77	1.650	70.6605	1.172	50.2011	6.790	290.7249	0.129	5.5213
21	8	13	77	3.395	5.8465	5.497	9.4655	22.115	38.0815	0.233	0.4010
22	8	16	77	1.793	21.5443	1.527	18.3436	8.046	96.6623	0.137	1.6515
23	8	22	77	1.872	31.0960	1.722	28.6075	8.739	145.1458	0.142	2.3614
24	8	22	77	1.728	122.2065	1.366	96.5733	7.475	528.5544	0.134	9.4466
25	8	28	77	3.405	6.8397	5.521	11.0903	22.200	44.5953	0.233	0.4690
26	9	4	77	2.699	64.6084	3.772	90.2905	16.004	383.0417	0.191	4.5821
27	9	12	77	2.726	13.1295	3.838	18.4862	16.236	78.2041	0.193	0.9297
28	9	16	77	1.812	39.0547	1.572	33.8957	8.207	176.9241	0.139	2.9871
29	9	17	77	3.177	25.4786	4.956	39.7466	20.199	161.9871	0.220	1.7635
30	9	18	77	1.960	16.3233	1.941	16.1599	9.512	79.2097	0.147	1.2275
31	9	23	77	2.086	147.4996	2.252	159.2565	10.617	750.6951	0.155	10.9532
32	9	23	77	2.684	52.6349	3.734	73.2322	15.869	311.1963	0.191	3.7363
33	9	24	77	2.860	7.8528	4.171	11.4515	17.416	47.8167	0.201	0.5519

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	6	8	77	0.005	0.0526	2.771	27.2546	0.006	0.0569	0.018	0.1616
2	6	10	77	0.004	0.2517	2.710	191.6219	0.0	0.0	0.017	1.1996
3	6	11	77	0.038	0.0687	3.881	7.0162	0.189	0.3409	0.046	0.0830
4	6	17	77	0.083	0.3062	5.421	19.9246	0.442	1.6257	0.084	0.3085
5	6	28	77	0.052	1.3877	4.343	116.8273	0.265	7.1212	0.057	1.5416
6	6	28	77	0.037	0.1448	3.838	15.1280	0.181	0.7154	0.045	0.1767
7	6	30	77	0.050	0.1416	4.299	12.1086	0.257	0.7252	0.056	0.1583
8	7	3	77	0.025	0.1668	3.453	22.6675	0.118	0.7756	0.035	0.2319
9	7	6	77	0.025	0.6015	3.443	82.4155	0.117	2.7897	0.035	0.8397
10	7	17	77	0.167	0.1407	8.277	6.9627	0.913	0.7678	0.155	0.1300
11	7	17	77	0.001	0.0011	2.625	2.7384	0.0	0.0	0.015	0.0155
12	7	24	77	0.052	0.2840	4.371	23.6821	0.269	1.4594	0.058	0.3143
13	7	29	77	0.009	0.6680	2.910	205.7772	0.029	2.0320	0.022	1.5493
14	8	2	77	0.011	0.7874	2.968	209.8374	0.038	2.7007	0.023	1.6496
15	8	3	77	0.078	0.5120	5.241	34.4038	0.413	2.7086	0.079	0.5218
16	8	4	77	0.019	0.2669	3.219	46.3705	0.080	1.1467	0.030	0.4255
17	8	5	77	0.020	0.3242	3.253	54.0233	0.085	1.4139	0.030	0.5044
18	8	5	77	0.006	0.0616	2.802	27.5596	0.011	0.1071	0.019	0.1892
19	8	7	77	0.007	0.0666	2.830	26.6270	0.015	0.1456	0.020	0.1875
20	8	9	77	0.007	0.2811	2.812	120.4086	0.013	0.5392	0.019	0.8345
21	8	13	77	0.082	0.1419	5.392	9.2843	0.437	0.7533	0.083	0.1433
22	8	16	77	0.013	0.1536	3.024	36.3244	0.047	0.5696	0.025	0.2969
23	8	22	77	0.016	0.2693	3.140	52.1569	0.067	1.1065	0.028	0.4583
24	8	22	77	0.010	0.7040	2.927	206.9998	0.032	2.2334	0.022	1.5795
25	8	28	77	0.083	0.1664	5.406	10.8594	0.440	0.8835	0.084	0.1679
26	9	4	77	0.052	1.2488	4.363	104.4263	0.268	6.4151	0.058	1.3835
27	9	12	77	0.053	0.2569	4.402	21.2036	0.274	1.3220	0.059	0.2831
28	9	16	77	0.014	0.2927	3.051	65.7657	0.052	1.1184	0.025	0.5472
29	9	17	77	0.073	0.5850	5.069	40.6522	0.384	3.0822	0.075	0.6035
30	9	18	77	0.020	0.1669	3.270	27.2328	0.088	0.7333	0.031	0.2566
31	9	23	77	0.026	1.8037	3.456	244.3898	0.119	8.3917	0.035	2.5032
32	9	23	77	0.052	1.0101	4.340	85.1152	0.264	5.1828	0.057	1.1226
33	9	24	77	0.059	0.1625	4.601	12.6315	0.307	0.8434	0.064	0.1748

EVENT NUMBER	MO	DA	YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
1	6	8	77	0.670	6.5881	0.002	0.0202	0.002	0.0224	0.0	0.0
2	6	10	77	0.643	45.4619	0.002	0.1248	0.002	0.1240	0.0	0.0
3	6	11	77	1.159	2.0962	0.007	0.0132	0.012	0.0212	0.004	0.0071
4	6	17	77	1.839	6.7592	0.015	0.0534	0.025	0.0914	0.010	0.0377
5	6	28	77	1.363	36.6751	0.009	0.2542	0.016	0.4218	0.006	0.1565
6	6	28	77	1.140	4.4956	0.007	0.0279	0.011	0.0448	0.004	0.0147
7	6	30	77	1.344	3.7854	0.009	0.0260	0.015	0.0431	0.006	0.0159
8	7	3	77	0.971	6.3725	0.005	0.0345	0.008	0.0531	0.002	0.0141
9	7	6	77	0.966	23.1325	0.005	0.1248	0.008	0.1917	0.002	0.0506
10	7	17	77	3.099	2.6069	0.028	0.0235	0.049	0.0414	0.022	0.0185
11	7	17	77	0.605	0.6315	0.001	0.0014	0.001	0.0011	0.0	0.0
12	7	24	77	1.376	7.4539	0.010	0.0519	0.016	0.0863	0.006	0.0322
13	7	29	77	0.731	51.7069	0.003	0.1914	0.003	0.2447	0.0	0.0
14	8	2	77	0.757	53.4981	0.003	0.2105	0.004	0.2794	0.000	0.0110
15	8	3	77	1.760	11.5503	0.014	0.0898	0.023	0.1532	0.010	0.0625
16	8	4	77	0.868	12.4966	0.004	0.0599	0.006	0.0878	0.001	0.0171
17	8	5	77	0.882	14.6546	0.004	0.0717	0.006	0.1060	0.001	0.0221
18	8	5	77	0.683	6.7226	0.002	0.0216	0.003	0.0250	0.0	0.0
19	8	7	77	0.696	6.5468	0.002	0.0219	0.003	0.0261	0.0	0.0
20	8	9	77	0.688	29.4588	0.002	0.0961	0.003	0.1124	0.0	0.0
21	8	13	77	1.826	3.1444	0.014	0.0248	0.025	0.0424	0.010	0.0175
22	8	16	77	0.781	9.3862	0.003	0.0389	0.004	0.0532	0.000	0.0046
23	8	22	77	0.833	13.8312	0.004	0.0629	0.005	0.0901	0.001	0.0144
24	8	22	77	0.739	52.2463	0.003	0.1971	0.004	0.2552	0.0	0.0
25	8	28	77	1.832	3.6808	0.014	0.0290	0.025	0.0497	0.010	0.0205
26	9	4	77	1.372	32.8432	0.010	0.2284	0.016	0.3794	0.006	0.1412
27	9	12	77	1.389	6.6926	0.010	0.0469	0.016	0.0780	0.006	0.0292
28	9	16	77	0.793	17.1005	0.003	0.0726	0.005	0.1004	0.000	0.0107
29	9	17	77	1.684	13.5028	0.013	0.1032	0.022	0.1754	0.009	0.0706
30	9	18	77	0.890	7.4125	0.004	0.0367	0.007	0.0544	0.001	0.0117
31	9	23	77	0.972	68.7419	0.005	0.3731	0.008	0.5741	0.002	0.1532
32	9	23	77	1.362	26.7132	0.009	0.1851	0.016	0.3071	0.006	0.1139
33	9	24	77	1.477	4.0554	0.011	0.0293	0.018	0.0491	0.007	0.0189

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELDIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625


***************               MILWAUKEE - HIGHWAY 45 - 1976               ***************

                              SITE CHARACTERISTICS
                              --------------------
                              TOTAL DRAINAGE AREA(AC)          =     106.00
                              LENGTH OF HIGHWAY(MI)            =       1.80
                              AVERAGE DAILY TRAFFIC            =   85000.00
                              INTIAL POLLUTION LEVEL(LBS)      =       0.0
                              USER SUPPLIED K1 FACTOR          =     172.50

                              SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS AND INLETS ON PAVED AREA.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 172.5000
K2 FACTOR FOR THIS SITE = 6.5000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	5	10	76	5.	0.14	0.92	0.028	3.328	0.00834	10675.5	0.0	1552.50	81.87
2	5	15	76	5.	1.28	21.50	0.574	8.510	0.06745	220855.8	1470.63	3023.13	1072.94
3	5	28	76	13.	0.60	16.25	0.187	7.090	0.02643	72114.5	1950.19	5986.69	945.03
4	5	30	76	2.	0.06	0.83	0.009	3.214	0.00293	3620.5	5041.66	5662.66	106.72
5	6	13	76	14.	0.75	8.25	0.253	7.090	0.03565	97259.2	5555.93	9902.93	2048.15
6	6	18	76	5.	0.66	4.42	0.232	7.773	0.02982	89185.4	7854.78	9407.28	1657.30
7	6	27	76	9.	0.08	2.00	0.012	4.700	0.00261	4718.1	7749.98	10544.48	177.29
8	7	28	76	31.	0.33	1.83	0.077	3.730	0.02057	29525.5	10367.20	16577.20	2074.75
9	7	30	76	2.	1.14	3.67	0.530	6.821	0.07768	203884.7	14502.44	15123.44	5995.37
10	8	5	76	6.	0.05	0.08	0.007	2.262	0.00295	2567.1	9128.07	10991.07	208.72
11	8	5	76	0.	0.05	1.75	0.008	4.383	0.00178	2993.6	10782.35	10782.35	123.69
12	8	14	76	9.	0.31	3.75	0.078	6.923	0.01131	30137.7	10658.65	13453.15	953.80
13	8	25	76	11.	0.37	1.08	0.098	2.935	0.03342	37742.1	12499.35	15914.85	3107.35
14	8	28	76	3.	0.92	3.67	0.382	6.821	0.05594	146824.6	12807.50	13739.00	4187.98
15	9	1	76	4.	0.31	1.75	0.084	4.383	0.01916	32309.3	9551.02	10793.02	1263.70
16	9	9	76	8.	0.80	7.67	0.290	8.510	0.03404	111469.2	9529.31	12013.31	2384.44
17	9	19	76	10.	0.37	5.07	0.099	7.090	0.01395	38052.1	9628.87	12733.87	1103.60
18	10	5	76	16.	1.40	26.58	0.587	7.090	0.08283	225967.3	11630.27	16598.27	6909.57

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 9.62
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 3.53
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 1359901.00
POUNDS OF TOTAL SOLIDS DISCHARGED = 34402.25

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	5	10	76	0.0	0.0	25.944	38.9712	264.532	397.3555	1.727	2.5942
2	5	15	76	487.949	35.4286	176.586	12.8214	525.182	38.1320	7.138	0.5183
3	5	28	76	407.370	90.5847	157.145	34.9435	491.543	109.3019	6.440	1.4320
4	5	30	76	0.0	0.0	29.722	131.6426	271.068	1200.5955	1.863	8.2502
5	6	13	76	1102.332	181.7480	324.818	53.5547	781.662	128.8773	12.463	2.0548
6	6	18	76	856.098	153.9281	265.409	47.7211	678.869	122.0621	10.329	1.8571
7	6	27	76	0.0	0.0	40.447	137.4716	289.626	984.3740	2.248	7.6404
8	7	28	76	1119.095	607.7966	328.863	178.6101	788.660	428.3328	12.608	6.8477
9	7	30	76	3589.086	282.2849	924.797	72.7361	1819.784	143.1277	34.015	2.6753
10	8	5	76	0.0	0.0	45.225	282.5090	297.892	1860.8596	2.420	15.1146
11	8	5	76	0.0	0.0	32.301	173.0247	275.531	1475.9082	1.955	10.4741
12	8	14	76	412.893	219.6925	158.477	84.3228	493.849	262.7678	6.488	3.4520
13	8	25	76	1769.633	751.8738	485.818	206.4122	1060.234	450.4673	18.246	7.7523
14	8	28	76	2450.427	267.6282	650.073	70.9989	1344.439	146.8355	24.146	2.6372
15	9	1	76	608.132	301.8271	205.583	102.0345	575.354	285.5586	8.180	4.0598
16	9	9	76	1314.196	189.0573	375.935	54.0811	870.107	125.1716	14.299	2.0570
17	9	19	76	507.268	213.7703	181.247	76.3803	533.247	224.7183	7.306	3.0787
18	10	5	76	4165.023	295.5698	1063.754	75.4891	2060.216	146.2027	39.006	2.7681

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	5	10	76	30.756	46.1990	29.785	44.7399	291.101	437.2651	0.819	1.2309
2	5	15	76	60.488	4.3919	85.264	6.1923	482.376	35.0240	2.108	0.1530
3	5	28	76	56.651	12.5972	78.122	17.3715	457.691	101.7744	1.942	0.4317
4	5	30	76	31.502	139.5250	31.177	138.0847	295.898	1310.5679	0.852	3.7725
5	6	13	76	89.744	14.7967	139.896	23.0655	670.592	110.5645	3.376	0.5566
6	6	18	76	78.019	14.0280	118.009	21.2182	595.159	107.0107	2.867	0.5156
7	6	27	76	33.619	114.2620	35.128	119.3922	309.516	1051.9763	0.943	3.2066
8	7	28	76	90.543	49.1750	141.386	76.7889	675.728	366.9973	3.410	1.8521
9	7	30	76	208.161	16.3721	360.941	28.3883	1432.407	112.6602	8.507	0.6691
10	8	5	76	34.562	215.8972	36.888	230.4311	315.582	1971.3645	0.984	6.1489
11	8	5	76	32.011	171.4688	32.127	172.0900	299.173	1602.5466	0.874	4.6806
12	8	14	76	56.914	30.2829	78.613	41.8283	459.383	244.4292	1.953	1.0391
13	8	25	76	121.521	51.6311	199.212	84.6402	875.019	371.7742	4.753	2.0192
14	8	28	76	153.939	16.8128	259.727	28.3666	1083.580	118.3453	6.157	0.6725
15	9	1	76	66.211	32.8618	95.967	47.6303	519.194	257.6855	2.356	1.1692
16	9	9	76	99.833	14.3618	158.729	22.8343	735.497	105.8069	3.813	0.5485
17	9	19	76	61.408	25.8783	87.002	36.6638	488.295	205.7748	2.148	0.9051
18	10	5	76	235.587	16.7184	412.135	29.2471	1608.846	114.1714	9.695	0.6880

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	5	10	76	0.0	0.0	90.439	135.8484	0.124	0.1855	0.151	0.2265
2	5	15	76	2.094	0.1520	132.063	9.5887	1.134	0.0824	0.730	0.0530
3	5	28	76	1.806	0.4017	126.691	28.1717	1.004	0.2232	0.655	0.1456
4	5	30	76	0.0	0.0	91.482	405.1868	0.149	0.6593	0.165	0.7323
5	6	13	76	4.288	0.7070	173.022	28.5272	2.129	0.3510	1.299	0.2142
6	6	18	76	3.409	0.6129	156.607	28.1582	1.730	0.3111	1.071	0.1925
7	6	27	76	0.079	0.2681	94.446	321.0007	0.221	0.7506	0.207	0.7020
8	7	28	76	4.348	2.3616	174.140	94.5778	2.156	1.1711	1.315	0.7140
9	7	30	76	13.170	1.0358	338.806	26.6474	6.155	0.4841	3.604	0.2835

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
10	8	5	76	0.150	0.9346	95.766	598.2271	0.253	1.5797	0.225	1.4048
11	8	5	76	0.0	0.0	92.195	493.8516	0.166	0.8901	0.175	0.9387
12	8	14	76	1.826	0.9716	127.060	67.6060	1.013	0.5389	0.660	0.3512
13	8	25	76	6.672	2.8346	217.509	92.4142	3.210	1.3636	1.918	0.8148
14	8	28	76	9.103	0.9942	262.895	28.7126	4.312	0.4709	2.549	0.2784
15	9	1	76	2.523	1.2524	140.075	69.5220	1.329	0.6596	0.841	0.4174
16	9	9	76	5.045	0.7258	187.146	26.9225	2.472	0.3556	1.496	0.2151
17	9	19	76	2.163	0.9116	133.351	56.1962	1.166	0.4912	0.748	0.3150
18	10	5	76	15.227	1.0805	377.202	26.7680	7.088	0.5030	4.138	0.2937

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	5	10	76	0.0	0.0	0.040	0.0594	0.090	0.1350	0.024	0.0367
2	5	15	76	16.030	1.1639	0.082	0.0060	0.403	0.0293	0.066	0.0048
3	5	28	76	13.523	3.0070	0.077	0.0170	0.363	0.0806	0.060	0.0134
4	5	30	76	0.0	0.0	0.041	0.1798	0.098	0.4328	0.025	0.1127
5	6	13	76	35.144	5.7943	0.124	0.0205	0.711	0.1173	0.106	0.0175
6	6	18	76	27.483	4.9415	0.107	0.0193	0.588	0.1057	0.090	0.0162
7	6	27	76	0.0	0.0	0.044	0.1483	0.120	0.4079	0.028	0.0964
8	7	28	76	35.665	19.3703	0.125	0.0680	0.720	0.3908	0.107	0.0583
9	7	30	76	112.509	8.8490	0.294	0.0231	1.959	0.1540	0.270	0.0213
10	8	5	76	0.0	0.0	0.045	0.2809	0.130	0.8118	0.030	0.1854
11	8	5	76	0.0	0.0	0.041	0.2213	0.103	0.5522	0.026	0.1401
12	8	14	76	13.694	7.2866	0.077	0.0410	0.365	0.1944	0.061	0.0323
13	8	25	76	55.904	23.7523	0.170	0.0721	1.046	0.4444	0.150	0.0638
14	8	28	76	77.084	8.4189	0.216	0.0236	1.387	0.1515	0.195	0.0213
15	9	1	76	19.769	9.8115	0.090	0.0448	0.463	0.2300	0.074	0.0365
16	9	9	76	41.735	6.0039	0.139	0.0199	0.817	0.1176	0.120	0.0173
17	9	19	76	16.631	7.0084	0.083	0.0352	0.413	0.1739	0.067	0.0282
18	10	5	76	130.427	9.2558	0.333	0.0236	2.247	0.1595	0.308	0.0219

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELOIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625


***************               MILWAUKEE - HIGHWAY 45 - 1977                    ***************

                              SITE CHARACTERISTICS
                              --------------------
                              TOTAL DRAINAGE AREA(AC)          =     106.00
                              LENGTH OF HIGHWAY(MI)            =       1.80
                              AVERAGE DAILY TRAFFIC            =   85000.00
                              INTIAL POLLUTION LEVEL(LBS)      =       0.0
                              USER SUPPLIED K1 FACTOR          =     367.70

                              SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS AND INLETS ON PAVED AREA.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 367.7000
K2 FACTOR FOR THIS SITE = 6.5000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	4	4	77	2.	0.42	5.75	0.135	8.510	0.01587	51964.9	0.0	1323.72	129.73
2	4	20	77	16.	0.19	2.08	0.038	3.995	0.00955	14676.1	1193.99	11783.75	709.00
3	4	21	77	1.	0.20	10.00	0.052	8.510	0.00610	19971.9	11074.74	11736.60	456.15
4	4	24	77	3.	0.15	4.25	0.032	7.558	0.00422	12258.6	11280.45	13266.03	358.53
5	4	27	77	3.	0.06	4.50	0.009	7.875	0.00115	3496.7	12907.50	14893.07	111.28
6	5	4	77	7.	0.18	3.00	0.038	5.970	0.00637	14630.8	14781.79	19414.80	787.27
7	5	21	77	17.	0.05	1.25	0.006	3.115	0.00196	2347.6	18627.53	29879.15	377.95
6	5	31	77	10.	0.07	4.25	0.010	6.295	0.00161	3894.5	29501.20	36119.80	375.46
9	6	1	77	1.	0.05	0.17	0.008	2.376	0.00327	2993.6	35744.32	36406.18	766.64
10	6	5	77	4.	0.83	3.92	0.323	7.138	0.04530	124414.5	35639.54	38286.98	9763.78
11	6	5	77	0.	0.56	0.33	0.213	2.579	0.08239	81767.2	28523.20	28523.20	11826.54
12	6	6	77	1.	0.10	0.25	0.020	2.477	0.00811	7732.3	16696.65	17358.51	891.39
13	6	8	77	2.	0.27	6.50	0.074	8.510	0.00867	28380.4	16467.12	17790.84	974.47
14	6	11	77	3.	0.61	6.42	0.217	8.510	0.02555	83654.5	16816.37	18801.95	2876.49
15	6	17	77	6.	0.60	0.50	0.200	2.795	0.07165	77060.8	15925.46	19896.62	7407.62
16	6	27	77	10.	0.40	9.50	0.110	7.090	0.01552	42338.0	12489.00	19107.60	1833.27
17	6	30	77	3.	0.71	2.42	0.268	5.233	0.05114	102978.2	17274.32	19259.90	5446.23
18	7	3	77	3.	0.30	2.75	0.082	5.653	0.01456	31663.0	13813.67	15799.25	1426.33
19	7	6	77	3.	0.25	1.42	0.064	3.963	0.01618	24669.1	14372.92	16358.50	1632.51
20	7	17	77	11.	2.28	6.67	1.182	7.090	0.16677	454957.8	14725.99	22006.45	14562.07
21	7	17	77	0.	1.45	10.08	0.782	8.510	0.09185	300762.0	7444.37	7444.37	3346.40

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 9.73
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 3.86
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 1486612.00
POUNDS OF TOTAL SOLIDS DISCHARGED = 66059.06

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4	4	77	0.0	0.0	33.218	10.2508	277.118	85.5152	1.988	0.6136
2	4	20	77	258.673	282.6370	121.269	132.5034	429.468	469.2554	5.151	5.6284
3	4	21	77	99.375	79.7898	82.835	66.5093	362.968	291.4314	3.771	3.0275
4	4	24	77	37.873	49.5426	67.996	88.9472	337.293	441.2183	3.238	4.2351
5	4	27	77	0.0	0.0	30.415	139.4799	272.267	1248.5942	1.888	8.6564
6	5	4	77	307.982	337.5554	133.166	145.9525	450.053	493.2681	5.579	6.1142
7	5	21	77	50.107	342.2649	70.948	484.6208	342.400	2338.8127	3.344	22.8389
8	5	31	77	48.552	199.9172	70.573	290.5881	341.751	1407.1807	3.330	13.7120
9	6	1	77	294.980	1580.0896	130.029	696.5105	444.625	2381.6765	5.466	29.2782
10	6	5	77	5963.180	768.5911	1497.595	193.0242	2810.875	362.2920	54.590	7.0361
11	6	5	77	7262.719	1424.3225	1811.135	355.1890	3353.381	657.6458	65.853	12.9147
12	6	6	77	373.576	774.7419	148.991	308.9861	477.436	990.1316	6.147	12.7480
13	6	8	77	425.914	240.6528	161.619	91.3190	499.285	282.1091	6.601	3.7295
14	6	11	77	1624.186	311.3398	450.726	86.3995	999.515	191.5970	16.986	3.2560
15	6	17	77	4478.797	932.0010	1139.458	237.1118	2191.203	455.9714	41.726	8.6827
16	6	27	77	966.962	366.2415	292.157	110.6560	725.151	274.6543	11.290	4.2760
17	6	30	77	3243.127	505.0178	841.328	131.0110	1675.360	260.8860	31.016	4.8299
18	7	3	77	710.586	359.8762	230.302	116.6363	618.124	313.0486	9.068	4.5924
19	7	6	77	840.478	546.3381	261.641	170.0750	672.349	437.0486	10.193	6.6261
20	7	17	77	8986.105	316.7295	2226.935	78.4919	4072.826	143.5533	80.789	2.8475
21	7	17	77	1920.230	102.3808	522.152	27.8396	1123.102	59.8804	19.551	1.0424

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4	4	77	32.192	9.9340	32.465	10.0182	300.337	92.6803	0.882	0.2721
2	4	20	77	49.570	54.1624	64.904	70.9172	412.138	450.3196	1.635	1.7861
3	4	21	77	41.985	33.7099	50.744	40.7434	363.337	291.7278	1.306	1.0486
4	4	24	77	39.056	51.0896	45.278	59.2284	344.496	450.6409	1.179	1.5424
5	4	27	77	31.638	145.0914	31.432	144.1436	296.777	1360.9978	0.858	3.9332
6	5	4	77	51.918	56.9035	69.287	75.9404	427.244	468.2686	1.736	1.9032
7	5	21	77	39.638	270.7556	46.365	316.7029	348.244	2378.7273	1.204	8.2264
8	5	31	77	39.564	162.9086	46.227	190.3418	347.768	1431.9534	1.201	4.9457
9	6	1	77	51.299	274.7881	68.132	364.9531	423.260	2267.2354	1.710	9.1578
10	6	5	77	321.213	41.4010	571.972	73.7211	2159.710	278.3638	13.406	1.7279
11	6	5	77	383.096	75.1306	687.486	134.8259	2557.823	501.6255	16.087	3.1550
12	6	6	77	55.042	114.1484	75.118	155.7835	447.338	927.7144	1.872	3.8819
13	6	8	77	57.534	32.5083	79.770	45.0723	463.372	261.8176	1.980	1.1186
14	6	11	77	114.595	21.9666	186.283	35.7086	830.462	159.1910	4.452	0.8535
15	6	17	77	250.529	52.1329	440.026	91.5659	1704.970	354.7903	10.343	2.1523
16	6	27	77	83.298	31.5496	127.863	48.4288	629.122	238.2828	3.096	1.1727
17	6	30	77	191.687	29.8494	330.189	51.4168	1326.423	206.5499	7.793	1.2135
18	7	3	77	71.090	36.0034	105.074	53.2149	550.581	278.8416	2.567	1.3002
19	7	6	77	77.275	50.2314	116.620	75.8070	590.374	383.7622	2.835	1.8430
20	7	17	77	465.162	16.3954	840.676	29.6310	3085.781	108.7633	19.644	0.6924
21	7	17	77	128.692	6.8615	212.598	11.3351	921.155	49.1132	5.063	0.2700

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4	4	77	0.0	0.0	92.448	28.5284	0.172	0.0532	0.179	0.0552
2	4	20	77	1.275	1.3934	116.778	127.5969	0.763	0.8339	0.517	0.5650
3	4	21	77	0.706	0.5671	106.158	85.2359	0.505	0.4057	0.369	0.2966

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	MG/L	<CHLORIDES> LBS	MG/L	<LEAD> LBS	MG/L	<ZINC> LBS	MG/L
4	4	24	77	0.487	0.6366	102.058	133.5040	0.406	0.5307	0.312	0.4086
5	4	27	77	0.0	0.0	91.674	420.4087	0.154	0.7040	0.168	0.7704
6	5	4	77	1.451	1.5907	120.065	131.5945	0.843	0.9240	0.563	0.6168
7	5	21	77	0.530	3.6229	102.874	702.6934	0.426	2.9065	0.324	2.2112
8	5	31	77	0.525	2.1610	102.770	423.1621	0.423	1.7417	0.322	1.3270
9	6	1	77	1.405	7.5256	119.199	638.4990	0.822	4.4030	0.551	2.9500
10	6	5	77	21.648	2.7903	497.079	64.0682	9.999	1.2888	5.805	0.7482
11	6	5	77	26.290	5.1558	583.715	114.4747	12.103	2.3736	7.010	1.3747
12	6	6	77	1.686	3.4957	124.438	258.0669	0.949	1.9685	0.624	1.2932
13	6	8	77	1.873	1.0580	127.928	72.2825	1.034	0.5842	0.672	0.3797
14	6	11	77	6.152	1.1793	207.812	39.8355	2.974	0.5701	1.783	0.3418
15	6	17	77	16.347	3.4017	398.120	82.8455	7.596	1.5806	4.429	0.9216
16	6	27	77	3.805	1.4411	163.997	62.1148	1.910	0.7234	1.174	0.4445
17	6	30	77	11.934	1.8584	315.742	49.1671	5.595	0.8713	3.284	0.5113
18	7	3	77	2.889	1.4633	146.906	74.4004	1.495	0.7571	0.936	0.4740
19	7	6	77	3.353	2.1796	155.565	101.1225	1.705	1.1084	1.056	0.6867
20	7	17	77	32.445	1.1436	698.607	24.6235	14.893	0.5249	8.607	0.3034
21	7	17	77	7.209	0.3844	227.549	12.1327	3.453	0.1841	2.057	0.1097

EVENT NUMBER	MO	DA	YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
1	4	4	77	0.0	0.0	0.042	0.0128	0.105	0.0324	0.026	0.0081
2	4	20	77	8.896	9.7207	0.066	0.0726	0.288	0.3147	0.050	0.0552
3	4	21	77	3.941	3.1639	0.056	0.0447	0.208	0.1671	0.040	0.0321
4	4	24	77	2.027	2.6518	0.051	0.0673	0.177	0.2319	0.036	0.0470
5	4	27	77	0.0	0.0	0.041	0.1870	0.099	0.4548	0.026	0.1175
6	5	4	77	10.431	11.4321	0.070	0.0766	0.313	0.3428	0.054	0.0589
7	5	21	77	2.408	16.4467	0.052	0.3569	0.183	1.2530	0.037	0.2508
8	5	31	77	2.359	9.7150	0.052	0.2147	0.183	0.7521	0.037	0.1508
9	6	1	77	10.026	53.7055	0.069	0.3694	0.306	1.6405	0.053	0.2833
10	6	5	77	186.370	24.0211	0.456	0.0588	3.149	0.4059	0.427	0.0551
11	6	5	77	226.800	44.4787	0.545	0.1068	3.801	0.7455	0.513	0.1006
12	6	6	77	12.471	25.8635	0.074	0.1541	0.346	0.7169	0.058	0.1205
13	6	8	77	14.100	7.9666	0.078	0.0440	0.372	0.2102	0.062	0.0348
14	6	11	77	51.379	9.8489	0.160	0.0306	0.973	0.1865	0.141	0.0270
15	6	17	77	140.189	29.1722	0.355	0.0738	2.405	0.5004	0.329	0.0685
16	6	27	77	30.932	11.7157	0.115	0.0435	0.643	0.2437	0.097	0.0368
17	6	30	77	101.746	15.8439	0.270	0.0421	1.785	0.2780	0.248	0.0386
18	7	3	77	22.956	11.6261	0.097	0.0493	0.515	0.2607	0.080	0.0407
19	7	6	77	26.997	17.5490	0.106	0.0690	0.580	0.3769	0.089	0.0578
20	7	17	77	280.417	9.8837	0.662	0.0233	4.666	0.1644	0.627	0.0221
21	7	17	77	60.589	3.2304	0.180	0.0096	1.121	0.0598	0.160	0.0085

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELOIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT:
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625


***************                  NASHVILLE - 1977                                     ***************

                            SITE CHARACTERISTICS
                            --------------------
                            TOTAL DRAINAGE AREA(AC)          =      55.60
                            LENGTH OF HIGHWAY(MI)            =       1.13
                            AVERAGE DAILY TRAFFIC            =   38000.00
                            INTIAL POLLUTION LEVEL(LBS)      =       0.0
                            USER SUPPLIED K1 FACTOR          =     347.30

                            SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS AND INLETS ON PAVED AREA.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 347.3000
K2 FACTOR FOR THIS SITE = 6.5000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	4	21	77	17.	0.99	11.50	0.364	7.090	0.05127	73372.1	0.0	6671.63	1890.81
2	4	22	77	0.	0.41	10.58	0.139	8.510	0.01630	27988.6	4780.82	4780.82	480.45
3	4	23	77	1.	0.17	0.42	0.042	2.693	0.01543	8386.2	4300.37	4692.82	447.71
4	4	24	77	1.	0.10	0.50	0.020	2.795	0.00719	4055.8	4245.11	4637.55	211.72
5	4	24	77	0.	0.21	1.00	0.055	3.430	0.01618	11199.5	4425.83	4425.83	441.73
6	4	28	77	4.	0.20	2.17	0.046	4.916	0.00937	9301.1	3984.11	5553.90	328.28
7	5	3	77	5.	0.11	0.08	0.020	2.262	0.00882	4025.1	5225.61	7187.86	400.37
8	5	5	77	2.	0.06	0.08	0.009	2.262	0.00416	1899.1	6787.48	7572.38	202.02
9	5	6	77	1.	0.12	1.17	0.026	3.646	0.00707	5205.7	7370.36	7762.81	348.85
10	5	7	77	1.	0.12	0.17	0.026	2.376	0.01086	5205.7	7413.96	7806.41	531.81
11	5	7	77	0.	0.35	0.42	0.112	2.693	0.04146	22537.6	7274.59	7274.59	1718.32
12	6	12	77	5.	0.05	0.75	0.007	3.113	0.00218	1367.7	5556.27	7518.52	105.64
13	6	13	77	1.	0.09	1.50	0.017	4.065	0.00428	3511.0	7412.87	7805.32	214.11
14	6	14	77	0.	0.12	1.67	0.026	4.281	0.00603	5205.7	7591.21	7591.21	291.52
15	6	19	77	5.	0.69	3.42	0.246	6.503	0.03788	49715.5	7299.69	9261.93	2021.07
16	6	22	77	3.	1.21	5.83	0.555	8.510	0.06525	112066.3	7240.87	8418.21	2909.49
17	6	23	77	1.	0.76	2.42	0.323	5.233	0.06168	65149.8	5508.72	5901.16	1948.98
18	6	24	77	1.	0.30	0.42	0.090	2.693	0.03357	18249.8	3952.18	4344.63	651.68
19	6	25	77	1.	0.86	2.00	0.382	4.700	0.08134	77162.7	3492.95	3885.40	1595.42
20	6	26	77	1.	0.05	1.08	0.008	3.532	0.00220	1570.2	2289.97	2682.42	38.13
21	7	9	77	13.	0.10	1.17	0.016	3.030	0.00532	3254.6	2644.29	7746.12	263.34
22	7	10	77	1.	0.40	1.33	0.134	3.849	0.03483	27058.2	7482.79	7875.23	1595.37
23	7	23	77	13.	0.05	0.58	0.006	2.405	0.00260	1260.1	6279.86	11381.70	190.44
24	7	24	77	1.	0.23	5.17	0.063	8.510	0.00739	12684.8	11191.26	11583.71	542.89
25	7	25	77	1.	0.06	0.75	0.010	3.113	0.00321	2015.4	11040.82	11433.27	235.94
26	7	28	77	3.	1.04	6.08	0.451	8.510	0.05303	91087.9	11197.33	12374.67	3607.89
27	7	29	77	1.	0.10	0.92	0.020	3.328	0.00604	4055.8	8766.79	9159.23	352.45
28	8	7	77	9.	0.10	1.00	0.017	3.430	0.00485	3359.0	8806.78	12338.82	383.04
29	8	10	77	3.	0.17	3.75	0.038	6.923	0.00546	7631.8	11955.78	13133.12	458.07
30	8	13	77	3.	0.13	0.67	0.026	3.011	0.00870	5286.0	12675.05	13852.40	761.43
31	8	14	77	1.	0.05	0.25	0.008	2.477	0.00314	1570.2	13090.97	13483.41	272.41
32	8	14	77	0.	0.94	4.17	0.432	7.456	0.05792	87154.7	13211.01	13211.01	4144.15
33	8	16	77	2.	0.05	0.42	0.007	2.693	0.00272	1479.6	9066.86	9851.75	172.74
34	8	16	77	0.	0.54	0.83	0.202	3.214	0.06291	40806.2	9679.01	9679.01	3248.08
35	8	17	77	1.	0.47	1.33	0.167	3.849	0.04344	33742.8	6430.93	6823.37	1678.22
36	8	17	77	0.	0.16	1.33	0.038	3.849	0.00994	7718.3	5145.15	5145.15	321.74
37	8	17	77	0.	0.26	0.92	0.074	3.328	0.02233	15003.0	4823.41	4823.41	651.70
38	8	24	77	7.	0.16	1.33	0.032	3.849	0.00841	6531.5	4171.71	6918.86	367.93
39	9	5	77	12.	0.42	1.17	0.116	3.030	0.03822	23373.0	6550.93	11260.31	2476.62
40	9	6	77	1.	0.10	0.17	0.020	2.376	0.00846	4055.8	8783.69	9176.14	490.81
41	9	13	77	7.	0.15	0.92	0.030	3.328	0.00890	5979.1	8685.32	11432.46	642.58
42	9	13	77	0.	0.53	4.58	0.197	7.977	0.02471	39775.2	10789.87	10789.87	1600.65
43	9	14	77	1.	0.23	1.33	0.063	3.849	0.01633	12684.8	9189.23	9581.67	964.75
44	9	14	77	0.	0.92	9.17	0.419	8.510	0.04927	84626.2	8616.93	8616.93	2361.19
45	9	16	77	2.	0.19	0.75	0.046	3.113	0.01465	9201.6	6255.73	7040.62	639.36

										<TOTAL SOLIDS>	
EVENT NUMBER	MO DA YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
46	9 19 77	3.	0.60	2.83	0.213	5.754	0.03694	42897.4	6401.27	7578.61	1617.49

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES)	=	15.12
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES)	=	5.36
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET)	=	1081467.00
POUNDS OF TOTAL SOLIDS DISCHARGED	=	47019.24

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4	21	77	1003.208	219.2545	300.902	65.7633	740.282	161.7912	11.604	2.5361
2	4	22	77	114.681	65.7052	86.528	49.5751	369.357	211.6189	3.903	2.2363
3	4	23	77	94.054	179.8474	81.551	155.9392	360.746	689.8057	3.724	7.1218
4	4	24	77	0.0	0.0	45.682	180.6141	298.683	1180.9172	2.436	9.6313
5	4	24	77	90.287	129.2757	80.642	115.4660	359.174	514.2756	3.692	5.2861
6	4	28	77	18.819	32.4460	63.399	109.3051	329.339	567.8049	3.072	5.2971
7	5	3	77	64.232	255.8960	74.356	296.2305	348.297	1387.5984	3.466	13.8084
8	5	5	77	0.0	0.0	44.206	373.2786	296.130	2500.5227	2.383	20.1221
9	5	6	77	31.773	97.8735	66.525	204.9235	334.746	1031.1597	3.185	9.8102
10	5	7	77	147.041	452.9473	94.335	290.5920	382.866	1179.3889	4.184	12.8875
11	5	7	77	894.541	636.4731	274.684	195.4402	694.918	494.4397	10.662	7.5861
12	6	12	77	0.0	0.0	29.558	346.5461	270.784	3174.7854	1.857	21.7700
13	6	13	77	0.0	0.0	46.044	210.2930	299.310	1367.0120	2.449	11.1852
14	6	14	77	0.0	0.0	57.811	178.0813	319.669	984.7156	2.872	8.8460
15	6	19	77	1085.271	350.0540	320.702	103.4424	774.540	249.8278	12.315	3.9722
16	6	22	77	1644.979	235.3822	455.742	65.2128	1008.196	144.2641	17.166	2.4563
17	6	23	77	1039.858	255.9466	309.745	76.2394	755.582	185.9760	11.921	2.9343
18	6	24	77	348.560	306.2722	142.956	125.6123	466.992	410.3367	5.930	5.2107
19	6	25	77	817.115	169.8105	256.004	53.2020	662.596	137.6987	9.991	2.0763
20	6	26	77	0.0	0.0	19.296	197.0577	253.029	2583.9861	1.488	15.1979
21	7	9	77	0.0	0.0	53.527	263.7312	312.258	1538.5046	2.718	13.3908
22	7	10	77	817.081	484.2324	255.996	151.7127	662.581	392.6704	9.991	5.9209
23	7	23	77	0.0	0.0	42.446	540.1753	293.084	3729.8279	2.320	29.5218
24	7	24	77	154.018	194.7038	96.019	121.3834	385.779	487.6885	4.244	5.3653
25	7	25	77	0.0	0.0	49.362	392.7505	305.051	2427.1304	2.568	20.4339
26	7	28	77	2084.968	367.0515	561.899	98.9204	1191.874	209.8255	20.979	3.6933
27	7	29	77	34.043	134.5975	67.072	265.1868	335.694	1327.2502	3.204	12.6693
28	8	7	77	53.314	254.5193	71.722	342.3999	343.739	1641.0122	3.371	16.0950
29	8	10	77	100.584	211.3445	83.127	174.6635	363.472	763.7183	3.781	7.9447
30	8	13	77	291.698	884.8953	129.237	392.0522	443.255	1344.6572	5.437	16.4948
31	8	14	77	0.0	0.0	54.906	560.7085	314.643	3213.1963	2.767	28.2606
32	8	14	77	2422.813	445.7766	643.410	118.3819	1332.911	245.2441	23.907	4.3987
33	8	16	77	0.0	0.0	39.757	430.8865	288.432	3126.0144	2.223	24.0948
34	8	16	77	1858.289	730.2571	507.208	199.3189	1097.244	431.1870	19.014	7.4722
35	8	17	77	869.278	413.1101	268.589	127.6427	684.372	325.2363	10.443	4.9629
36	8	17	77	14.693	30.5272	62.404	129.6521	327.616	680.6663	3.037	6.3091
37	8	17	77	222.568	237.8887	112.558	120.3057	414.396	442.9209	4.838	5.1713
38	8	24	77	43.793	107.5195	69.425	170.4484	339.764	834.1736	3.289	8.0747
39	9	5	77	1372.270	941.4863	389.946	267.5339	894.351	613.5957	14.802	10.1556
40	9	6	77	121.212	479.2415	88.104	348.3391	372.084	1471.1260	3.960	15.6562
41	9	13	77	216.827	581.5178	111.173	298.1587	411.999	1104.9597	4.789	12.8425
42	9	13	77	820.408	330.7542	256.798	103.5304	663.970	267.6851	10.020	4.0395
43	9	14	77	419.790	530.6836	160.141	202.4452	496.728	627.9465	6.548	8.2771
44	9	14	77	1299.551	246.2504	372.401	70.5659	863.994	163.7171	14.172	2.6855
45	9	16	77	214.795	374.3250	110.682	192.8869	411.151	716.5156	4.771	8.3143
46	9	19	77	831.019	310.6475	259.358	96.9522	668.400	249.8581	10.111	3.7798

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4	21	77	85.024	18.5823	131.085	28.6491	640.226	139.9236	3.171	0.6930
2	4	22	77	42.713	24.4721	52.105	29.8529	368.026	210.8563	1.338	0.7664

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
3	4	23	77	41.731	79.7967	50.271	96.1272	361.707	691.6428	1.295	2.4763
4	4	24	77	34.652	137.0040	37.056	146.5118	316.162	1250.0269	0.988	3.9072
5	4	24	77	41.552	59.4950	49.937	71.5007	360.553	516.2505	1.287	1.8431
6	4	28	77	38.149	65.7709	43.584	75.1420	338.659	583.8735	1.140	1.9650
7	5	3	77	40.311	160.5973	47.621	189.7182	352.571	1404.6267	1.233	4.9141
8	5	5	77	34.360	290.1399	36.513	308.3147	314.289	2653.8591	0.976	8.2381
9	5	6	77	38.765	119.4136	44.735	137.8036	342.627	1055.4360	1.166	3.5933
10	5	7	77	44.254	136.3219	54.981	169.3658	377.939	1164.2124	1.404	4.3260
11	5	7	77	79.850	56.8136	121.426	86.3955	606.936	431.8396	2.947	2.0967
12	6	12	77	31.469	368.9590	31.116	364.8167	295.689	3466.7825	0.850	9.9697
13	6	13	77	34.723	158.5882	37.190	169.8543	316.622	1446.0830	0.991	4.5277
14	6	14	77	37.046	114.1157	41.525	127.9145	331.563	1021.3535	1.092	3.3637
15	6	19	77	88.932	28.6850	138.380	44.6343	665.366	214.6136	3.340	1.0774
16	6	22	77	115.585	16.5392	188.131	26.9200	836.832	119.7433	4.495	0.6432
17	6	23	77	86.769	21.3571	134.343	33.0666	651.453	160.3461	3.247	0.7991
18	6	24	77	53.850	47.3173	72.894	64.0506	439.675	386.3330	1.820	1.5994
19	6	25	77	76.163	15.8279	114.544	23.8041	583.216	121.2023	2.787	0.5792
20	6	26	77	29.444	300.6882	27.335	279.1553	282.660	2886.5801	0.763	7.7876
21	7	9	77	36.200	178.3593	39.947	196.8198	326.124	1606.8252	1.055	5.1997
22	7	10	77	76.161	45.1359	114.541	67.8810	583.206	345.6296	2.787	1.6517
23	7	23	77	34.013	432.8542	35.864	456.4143	312.054	3971.2358	0.961	12.2243
24	7	24	77	44.587	56.3648	55.602	70.2896	380.077	480.4802	1.419	1.7935
25	7	25	77	35.378	281.4846	38.412	305.6272	320.836	2552.7185	1.020	8.1134
26	7	28	77	136.537	24.0368	227.242	40.0051	971.622	171.0509	5.403	0.9512
27	7	29	77	38.873	153.6959	44.937	177.6702	343.323	1357.4124	1.171	4.6306
28	8	7	77	39.791	189.9632	46.650	222.7079	349.226	1667.2085	1.211	5.7811
29	8	10	77	42.042	88.3377	50.852	106.8487	363.708	764.2129	1.308	2.7494
30	8	13	77	51.143	155.1466	67.840	205.7988	422.255	1280.9524	1.703	5.1698
31	8	14	77	36.472	372.4614	40.455	413.1318	327.874	3348.3210	1.067	10.8977
32	8	14	77	152.624	28.0816	257.272	47.3359	1075.121	197.8129	6.100	1.1224
33	8	16	77	33.482	362.8806	34.874	377.9600	308.640	3345.0286	0.938	10.1613
34	8	16	77	125.742	49.4133	207.092	81.3817	902.179	354.5315	4.936	1.9395
35	8	17	77	78.647	37.3755	119.180	56.6385	599.196	284.7581	2.895	1.3757
36	8	17	77	37.952	78.8504	43.217	89.7894	337.395	700.9827	1.131	2.3503
37	8	17	77	47.851	51.1447	61.695	65.9417	401.077	428.6853	1.560	1.6676
38	8	24	77	39.338	96.5802	45.804	112.4555	346.310	850.2432	1.191	2.9248
39	9	5	77	102.599	70.3908	163.891	112.4420	753.287	516.8149	3.933	2.6981
40	9	6	77	43.024	170.1075	52.686	208.3053	370.027	1462.9937	1.351	5.3417
41	9	13	77	47.577	127.6002	61.185	164.0938	399.318	1070.9502	1.548	4.1526
42	9	13	77	76.319	30.7688	114.836	46.2972	584.225	235.5353	2.794	1.1264
43	9	14	77	57.242	72.3638	79.226	100.1545	461.496	583.4072	1.967	2.4868
44	9	14	77	99.136	18.7851	157.427	29.8306	731.010	138.5182	3.783	0.7168
45	9	16	77	47.481	82.7450	61.004	106.3121	398.696	694.8101	1.544	2.6910
46	9	19	77	76.825	28.7183	115.779	43.2801	587.476	219.6074	2.816	1.0526

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4	21	77	3.934	0.8599	166.414	36.3703	1.969	0.4302	1.207	0.2638
2	4	22	77	0.761	0.4360	107.179	61.4068	0.530	0.3037	0.384	0.2198
3	4	23	77	0.687	1.3143	105.804	202.3137	0.497	0.9497	0.364	0.6969
4	4	24	77	0.156	0.6183	95.892	379.1340	0.256	1.0120	0.227	0.8961
5	4	24	77	0.674	0.9649	105.552	151.1332	0.491	0.7024	0.361	0.5168
6	4	28	77	0.419	0.7218	100.788	173.7661	0.375	0.6463	0.295	0.5081
7	5	3	77	0.581	2.3140	103.815	413.5959	0.448	1.7863	0.337	1.3419
8	5	5	77	0.135	1.1360	95.485	806.2727	0.246	2.0777	0.221	1.8659
9	5	6	77	0.465	1.4321	101.652	313.1294	0.396	1.2193	0.307	0.9448
10	5	7	77	0.877	2.7002	109.336	336.8010	0.582	1.7942	0.414	1.2740

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	MG/L	<CHLORIDES> LBS	MG/L	<LEAD> LBS	MG/L	<ZINC> LBS	MG/L
11	5	7	77	3.546	2.5232	159.169	113.2504	1.793	1.2755	1.106	0.7873
12	6	12	77	0.0	0.0	91.437	1072.0452	0.148	1.7323	0.165	1.9310
13	6	13	77	0.162	0.7387	95.992	438.4180	0.258	1.1801	0.228	1.0415
14	6	14	77	0.336	1.0348	99.244	305.7124	0.337	1.0392	0.273	0.8417
15	6	19	77	4.227	1.3635	171.885	55.4414	2.101	0.6778	1.283	0.4139
16	6	22	77	6.226	0.8909	209.199	29.9345	3.008	0.4304	1.802	0.2579
17	6	23	77	4.065	1.0006	168.857	41.5619	2.028	0.4992	1.241	0.3055
18	6	24	77	1.596	1.4026	122.771	107.8761	0.909	0.7985	0.600	0.5275
19	6	25	77	3.270	0.6795	154.008	32.0054	1.667	0.3465	1.035	0.2150
20	6	26	77	0.0	0.0	88.602	904.8179	0.079	0.8057	0.125	1.2793
21	7	9	77	0.273	1.3427	98.060	483.1458	0.309	1.5205	0.257	1.2652
22	7	10	77	3.270	1.9377	154.005	91.2694	1.667	0.9881	1.035	0.6132
23	7	23	77	0.108	1.3805	94.998	1208.9595	0.234	2.9810	0.214	2.7261
24	7	24	77	0.901	1.1396	109.801	138.8069	0.594	0.7506	0.420	0.5310
25	7	25	77	0.211	1.6777	96.909	771.0557	0.281	2.2330	0.241	1.9158
26	7	28	77	7.798	1.3728	238.531	41.9926	3.720	0.6549	2.210	0.3891
27	7	29	77	0.473	1.8702	101.803	402.5029	0.399	1.5795	0.309	1.2210
28	8	7	77	0.542	2.5867	103.088	492.1409	0.431	2.0562	0.327	1.5596
29	8	10	77	0.711	1.4932	106.239	223.2265	0.507	1.0658	0.371	0.7785
30	8	13	77	1.393	4.2264	118.980	360.9370	0.817	2.4774	0.548	1.6614
31	8	14	77	0.293	2.9913	98.441	1005.3003	0.318	3.2460	0.262	2.6765
32	8	14	77	9.004	1.6567	261.054	48.0317	4.267	0.7851	2.523	0.4642
33	8	16	77	0.069	0.7443	94.255	1021.5356	0.216	2.3432	0.204	2.2097
34	8	16	77	6.988	2.7462	223.419	87.7977	3.353	1.3177	2.000	0.7859
35	8	17	77	3.456	1.6424	157.485	74.8423	1.752	0.8325	1.083	0.5147
36	8	17	77	0.404	0.8392	100.513	208.8289	0.368	0.7649	0.291	0.6044
37	8	17	77	1.146	1.2252	114.371	122.2440	0.705	0.7532	0.484	0.5169
38	8	24	77	0.508	1.2468	102.453	251.5375	0.415	1.0196	0.318	0.7804
39	9	5	77	5.252	3.6036	191.018	131.0535	2.566	1.7606	1.549	1.0630
40	9	6	77	0.784	3.1010	107.614	425.4792	0.541	2.1375	0.390	1.5405
41	9	13	77	1.126	3.0194	113.988	305.7107	0.695	1.8651	0.478	1.2827
42	9	13	77	3.281	1.3229	154.227	62.1780	1.673	0.6743	1.038	0.4184
43	9	14	77	1.851	2.3396	127.519	161.2056	1.024	1.2946	0.666	0.8425
44	9	14	77	4.993	0.9461	186.170	35.2771	2.448	0.4639	1.482	0.2808
45	9	16	77	1.119	1.9493	113.853	198.4124	0.692	1.2062	0.476	0.8302
46	9	19	77	3.319	1.2408	154.935	57.9169	1.690	0.6317	1.048	0.3916

EVENT NUMBER	MO	DA	YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
1	4	21	77	32.060	7.0068	0.117	0.0256	0.661	0.1446	0.100	0.0218
2	4	22	77	4.417	2.5305	0.057	0.0325	0.216	0.1237	0.041	0.0235
3	4	23	77	3.775	7.2185	0.055	0.1056	0.205	0.3929	0.040	0.0758
4	4	24	77	0.0	0.0	0.045	0.1783	0.131	0.5176	0.030	0.1179
5	4	24	77	3.658	5.2374	0.055	0.0787	0.204	0.2915	0.039	0.0564
6	4	28	77	1.434	2.4730	0.050	0.0864	0.168	0.2892	0.035	0.0598
7	5	3	77	2.847	11.3431	0.053	0.2120	0.191	0.7590	0.038	0.1500
8	5	5	77	0.0	0.0	0.045	0.3773	0.128	1.0795	0.029	0.2483
9	5	6	77	1.837	5.6599	0.051	0.1571	0.174	0.5367	0.036	0.1094
10	5	7	77	5.423	16.7066	0.059	0.1813	0.232	0.7148	0.043	0.1328
11	5	7	77	28.679	20.4054	0.110	0.0782	0.607	0.4319	0.092	0.0658
12	6	12	77	0.0	0.0	0.041	0.4753	0.097	1.1418	0.025	0.2977
13	6	13	77	0.0	0.0	0.045	0.2065	0.132	0.6013	0.030	0.1366
14	6	14	77	0.714	2.1987	0.049	0.1495	0.156	0.4809	0.033	0.1020
15	6	19	77	34.613	11.1644	0.123	0.0396	0.703	0.2266	0.105	0.0339
16	6	22	77	52.026	7.4445	0.161	0.0231	0.983	0.1407	0.142	0.0203
17	6	23	77	33.200	8.1717	0.120	0.0295	0.680	0.1673	0.102	0.0251
18	6	24	77	11.693	10.2744	0.073	0.0638	0.333	0.2927	0.056	0.0496

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
19	6	25	77	26.270	5.4594	0.105	0.0217	0.568	0.1181	0.087	0.0182
20	6	26	77	0.0	0.0	0.038	0.3844	0.076	0.7766	0.023	0.2307
21	7	9	77	0.161	0.7954	0.047	0.2332	0.147	0.7253	0.032	0.1574
22	7	10	77	26.269	15.5681	0.105	0.0620	0.568	0.3367	0.087	0.0518
23	7	23	77	0.0	0.0	0.044	0.5624	0.124	1.5803	0.029	0.3681
24	7	24	77	5.641	7.1306	0.059	0.0750	0.236	0.2978	0.044	0.0551
25	7	25	77	0.0	0.0	0.046	0.3672	0.139	1.1024	0.031	0.2452
26	7	28	77	65.715	11.5688	0.191	0.0336	1.204	0.2120	0.171	0.0301
27	7	29	77	1.908	7.5438	0.051	0.2023	0.175	0.6934	0.036	0.1410
28	8	7	77	2.508	11.9710	0.052	0.2505	0.185	0.8834	0.037	0.1763
29	8	10	77	3.978	8.3588	0.056	0.1170	0.209	0.4386	0.040	0.0842
30	8	13	77	9.924	30.1053	0.069	0.2085	0.305	0.9241	0.053	0.1598
31	8	14	77	0.339	3.4635	0.048	0.4873	0.150	1.5327	0.032	0.3302
32	8	14	77	76.225	14.0248	0.214	0.0394	1.374	0.2527	0.193	0.0356
33	8	16	77	0.0	0.0	0.043	0.4707	0.119	1.2852	0.028	0.3055
34	8	16	77	58.662	23.0527	0.176	0.0690	1.090	0.4285	0.156	0.0614
35	8	17	77	27.893	13.2557	0.108	0.0514	0.594	0.2824	0.091	0.0432
36	8	17	77	1.306	2.7134	0.050	0.1035	0.166	0.3442	0.034	0.0714
37	8	17	77	7.773	8.3083	0.064	0.0684	0.270	0.2885	0.048	0.0514
38	8	24	77	2.211	5.4292	0.052	0.1272	0.180	0.4426	0.036	0.0891
39	9	5	77	43.542	29.8731	0.142	0.0978	0.847	0.5808	0.124	0.0851
40	9	6	77	4.620	18.2660	0.057	0.2258	0.219	0.8663	0.041	0.1638
41	9	13	77	7.595	20.3684	0.064	0.1707	0.267	0.7162	0.048	0.1280
42	9	13	77	26.373	10.6324	0.105	0.0423	0.570	0.2297	0.088	0.0353
43	9	14	77	13.909	17.5833	0.077	0.0980	0.369	0.4663	0.061	0.0773
44	9	14	77	41.279	7.8220	0.138	0.0261	0.810	0.1535	0.119	0.0226
45	9	16	77	7.531	13.1250	0.063	0.1106	0.266	0.4636	0.048	0.0829
46	9	19	77	26.703	9.9819	0.106	0.0395	0.575	0.2150	0.088	0.0330

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

             REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
              5103 WEST BELOIT ROAD
              MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625



***************                HARRISBURG - 1976                ***************


                         SITE CHARACTERISTICS
                         --------------------
                         TOTAL DRAINAGE AREA(AC)          =      18.50
                         LENGTH OF HIGHWAY(MI)            =       0.38
                         AVERAGE DAILY TRAFFIC            =   24000.00
                         INTIAL POLLUTION LEVEL(LBS)      =       0.0
                         USER SUPPLIED KI FACTOR          =     270.20

                         SITE TYPE SELECTED IS RURAL WITH FLUSH SHOULDERS.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 270.2000
K2 FACTOR FOR THIS SITE = 12.0000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	4	25	76	21.	0.42	4.92	0.022	13.626	0.00164	1501.0	0.0	2053.52	40.02
2	5	1	76	6.	0.45	5.00	0.058	15.680	0.00369	3880.6	2013.50	2629.55	113.74
3	5	11	76	10.	0.32	1.50	0.022	7.060	0.00307	1457.7	2515.81	3542.57	128.31
4	5	16	76	5.	0.65	10.25	0.131	15.680	0.00833	8766.8	3414.26	3927.64	373.40
5	5	18	76	2.	0.31	1.25	0.059	10.130	0.00578	3932.9	3554.24	3759.59	251.96
6	5	20	76	2.	0.11	2.50	0.008	11.980	0.00069	553.8	3507.63	3712.98	30.54
7	5	25	76	5.	0.86	11.15	0.222	15.680	0.01414	14989.5	3682.44	4195.82	654.77
8	5	29	76	3.	0.83	13.75	0.290	15.680	0.01847	19444.4	3541.05	3849.08	764.96
9	6	1	76	3.	0.63	2.50	0.172	11.980	0.01435	11541.2	3084.12	3392.15	536.40
10	6	15	76	14.	0.11	0.33	0.002	4.814	0.00048	155.1	2855.76	4293.22	24.65
11	6	16	76	1.	0.07	0.33	0.006	8.768	0.00063	370.6	4268.57	4371.24	32.88
12	6	17	76	1.	0.10	1.00	0.011	9.760	0.00111	727.7	4338.36	4441.04	58.77
13	6	19	76	2.	0.63	1.75	0.224	10.870	0.02061	15045.7	4382.27	4587.62	1005.15
14	6	20	76	1.	0.63	3.50	0.353	13.460	0.02619	23674.8	3582.46	3685.14	993.80
15	6	21	76	1.	0.25	1.50	0.061	10.500	0.00584	4119.4	2691.34	2794.02	189.15
16	6	28	76	7.	0.57	3.50	0.082	13.460	0.00607	5487.3	2604.87	3323.60	233.48
17	7	3	76	4.	1.21	2.17	0.489	11.492	0.04260	32871.4	3090.12	3500.82	1400.88
18	7	7	76	4.	0.15	0.75	0.009	9.390	0.00100	632.9	2099.94	2510.65	30.06
19	7	7	76	0.	0.49	0.50	0.219	9.020	0.02429	14715.9	2480.59	2480.59	627.24
20	7	7	76	0.	1.53	2.42	1.453	11.862	0.12254	97609.7	1853.36	1853.36	1427.35
21	7	8	76	1.	0.05	2.25	0.003	11.610	0.00025	196.1	426.00	528.68	1.59
22	7	10	76	2.	0.06	2.25	0.003	11.610	0.00023	175.9	527.09	732.44	1.98
23	7	11	76	1.	0.43	2.75	0.171	12.350	0.01386	11493.6	730.46	833.13	127.63
24	7	15	76	4.	0.29	1.67	0.033	10.752	0.00305	2203.2	705.50	1116.21	40.13
25	7	15	76	0.	0.57	0.67	0.292	9.272	0.03146	19590.7	1076.08	1076.08	338.37
26	7	21	76	6.	0.63	1.50	0.109	10.500	0.01040	7334.6	737.71	1353.76	158.84
27	7	23	76	2.	0.39	3.00	0.090	12.720	0.00711	6072.3	1194.92	1400.27	114.48
28	7	23	76	0.	0.26	0.92	0.066	9.642	0.00685	4436.7	1285.79	1285.79	101.49
29	7	29	76	6.	0.25	2.00	0.019	11.240	0.00169	1276.2	1184.30	1800.36	36.16
30	8	6	76	8.	0.45	1.75	0.048	10.870	0.00440	3215.1	1764.20	2585.61	133.09
31	8	8	76	2.	0.56	3.25	0.179	13.090	0.01370	12040.2	2452.51	2657.86	402.80
32	8	9	76	1.	0.23	3.00	0.052	12.720	0.00412	3518.2	2255.07	2357.74	113.69
33	8	13	76	4.	0.84	1.50	0.245	10.500	0.02337	16478.7	2244.06	2654.76	649.16
34	8	14	76	1.	0.43	2.17	0.171	11.492	0.01489	11493.6	2005.60	2108.28	345.01
35	8	15	76	1.	0.80	0.50	0.554	9.020	0.06142	37203.3	1763.27	1865.94	972.95
36	9	10	76	16.	1.00	6.00	0.138	13.780	0.01000	9256.4	893.00	2535.81	286.79
37	9	15	76	5.	1.64	20.00	0.752	15.680	0.04796	50500.2	2249.02	2762.40	1208.68
38	9	17	76	1.	0.24	1.00	0.057	9.760	0.00582	3813.2	1553.72	1656.40	111.69
39	9	20	76	3.	0.10	1.25	0.005	10.130	0.00052	354.7	1544.71	1852.74	11.56
40	9	26	76	6.	0.43	3.67	0.053	13.712	0.00387	3560.8	1841.18	2457.24	111.41
41	9	27	76	1.	0.17	5.75	0.030	15.680	0.00189	1985.8	2345.83	2448.50	54.78
42	9	30	76	3.	0.38	7.75	0.066	15.680	0.00421	4434.5	2393.72	2701.75	133.13
43	9	30	76	0.	0.25	3.75	0.061	13.830	0.00444	4119.4	2568.62	2568.62	133.13
44	10	1	76	1.	0.24	8.25	0.057	15.680	0.00362	3813.2	2435.49	2538.17	107.93
45	10	2	76	1.	0.05	0.25	0.003	8.650	0.00034	196.1	2430.24	2532.92	10.24

EVENT NUMBER	MO	OA	YR	ORY OAYS	RAINFALL INCHES	RAIN OURAT HOURS	RUNOFF INCHES	RUNOFF OURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIOS> POUNOS AFTER PREVIOUS STORH	POUNOS AT START OF STORH	POUNOS WASHEO OFF
46	10	3	76	0.	0.07	3.25	0.006	13.090	0.00042	370.6	2522.68	2522.68	12.73
47	10	3	76	1.	0.89	10.50	0.678	15.680	0.04323	45517.7	2509.95	2612.63	1057.30
48	10	7	76	4.	0.78	14.50	0.213	15.680	0.01360	14322.9	1555.32	1966.03	296.06
49	10	8	76	1.	3.96	15.75	3.762	15.680	0.23992	252636.9	1669.97	1772.65	1673.02
50	10	20	76	12.	1.38	18.50	0.306	13.780	0.02221	20549.5	99.63	1331.74	311.50
51	10	24	76	3.	0.45	9.00	0.091	15.680	0.00580	6106.3	1020.24	1328.27	89.28
52	10	25	76	1.	0.59	7.50	0.311	15.680	0.01986	20911.6	1238.99	1341.67	284.46
53	10	30	76	5.	0.86	9.25	0.222	15.680	0.01414	14889.5	1057.20	1570.58	245.09

TOTAL RAINFALL OURING SIMULATION PERIOO (INCHES) = 30.04
TOTAL RUNOFF OURING SIMULATION PERIOO (INCHES) = 12.74
TOTAL RUNOFF OURING SIMULATION PERIOO (CUBIC FEET)= 855444.81
POUNOS OF TOTAL SOLIOS OISCHARGEO = 18593.56

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4	25	76	0.0	0.0	0.0	0.0	0.0	0.0	0.674	7.2011
2	5	1	76	0.0	0.0	3.638	15.0347	4.212	17.4045	0.903	3.7298
3	5	11	76	4.260	46.8571	4.527	49.7987	8.888	97.7705	0.948	10.4258
4	5	16	76	82.687	151.2469	19.477	35.6267	87.561	160.1610	1.708	3.1233
5	5	18	76	43.827	178.6949	12.070	49.2108	48.579	198.0698	1.331	5.4272
6	5	20	76	0.0	0.0	0.0	0.0	0.0	0.0	0.645	18.6663
7	5	25	76	172.726	186.0224	36.641	39.4615	177.880	191.5741	2.580	2.7784
8	5	29	76	207.987	171.5262	43.362	35.7609	213.252	175.8682	2.921	2.4092
9	6	1	76	134.846	187.3606	29.420	40.8773	139.883	194.3583	2.213	3.0746
10	6	15	76	0.0	0.0	0.0	0.0	0.0	0.0	0.626	64.7540
11	6	16	76	0.0	0.0	0.0	0.0	0.0	0.0	0.652	28.2119
12	6	17	76	0.0	0.0	0.285	6.2768	0.0	0.0	0.732	16.1351
13	6	19	76	284.849	303.5916	58.014	61.8316	290.354	309.4587	3.666	3.9072
14	6	20	76	281.215	190.4755	57.322	38.8257	286.708	194.1965	3.631	2.4592
15	6	21	76	23.728	92.3641	8.238	32.0683	28.417	110.6176	1.136	4.4235
16	6	28	76	37.915	110.8003	10.943	31.9778	42.648	124.6332	1.274	3.7225
17	7	3	76	411.481	200.7338	82.154	40.0772	417.382	203.6124	4.893	2.3868
18	7	7	76	0.0	0.0	0.0	0.0	0.0	0.0	0.643	16.2953
19	7	7	76	163.915	178.6169	34.961	38.0970	169.043	184.2040	2.494	2.7182
20	7	7	76	419.952	68.9915	83.768	13.7618	425.880	69.9653	4.975	0.8173
21	7	8	76	0.0	0.0	0.0	0.0	0.0	0.0	0.555	45.3886
22	7	10	76	0.0	0.0	0.0	0.0	0.0	0.0	0.556	50.6931
23	7	11	76	4.042	5.6391	4.485	6.2581	8.669	12.0955	0.946	1.3194
24	7	15	76	0.0	0.0	0.0	0.0	0.0	0.0	0.674	4.9086
25	7	15	76	71.479	58.5080	17.341	14.1939	76.317	62.4684	1.599	1.3088
26	7	21	76	14.030	30.6733	6.389	13.9692	18.689	40.8590	1.042	2.2790
27	7	23	76	0.0	0.0	3.684	9.7276	4.450	11.7506	0.905	2.3897
28	7	23	76	0.0	0.0	2.891	10.4479	0.277	1.0023	0.865	3.1250
29	7	29	76	0.0	0.0	0.0	0.0	0.0	0.0	0.662	8.3191
30	8	6	76	5.790	28.8790	4.819	24.0342	10.423	51.9872	0.963	4.8011
31	8	8	76	92.095	122.6567	21.271	28.3292	96.998	129.1864	1.799	2.3956
32	8	9	76	0.0	0.0	3.635	16.5671	4.193	19.1115	0.902	4.1132
33	8	13	76	170.930	166.3350	36.299	35.3227	176.080	171.3457	2.562	2.4935
34	8	14	76	73.604	102.6914	17.746	24.7586	78.449	109.4510	1.620	2.2596
35	8	15	76	274.543	118.3363	56.050	24.1591	280.016	120.6953	3.566	1.5371
36	9	10	76	54.973	95.2351	14.194	24.5901	59.760	103.5278	1.439	2.4930
37	9	15	76	349.977	111.1309	70.429	22.3640	355.686	112.9437	4.297	1.3644
38	9	17	76	0.0	0.0	3.513	14.7723	3.551	14.9328	0.896	3.7689
39	9	20	76	0.0	0.0	0.0	0.0	0.0	0.0	0.586	26.4824
40	9	26	76	0.0	0.0	3.496	15.7442	3.463	15.5946	0.895	4.0322
41	9	27	76	0.0	0.0	0.042	0.3377	0.0	0.0	0.720	5.8126
42	9	30	76	5.802	20.9799	4.821	17.4331	10.435	37.7337	0.963	3.4812
43	9	30	76	5.801	22.5806	4.821	18.7658	10.434	40.6160	0.963	3.7475
44	10	1	76	0.0	0.0	3.283	13.8079	2.344	9.8578	0.885	3.7199
45	10	2	76	0.0	0.0	0.0	0.0	0.0	0.0	0.582	47.5803
46	10	3	76	0.0	0.0	0.0	0.0	0.0	0.0	0.589	25.5081
47	10	3	76	301.537	106.2301	61.195	21.5589	307.094	108.1879	3.828	1.3485
48	10	7	76	57.938	64.8665	14.759	16.5244	62.734	70.2361	1.468	1.6433
49	10	8	76	498.566	31.6457	98.754	6.2683	504.739	32.0375	5.736	0.3641
50	10	20	76	62.879	49.0676	15.701	12.2525	67.691	52.8222	1.516	1.1827
51	10	24	76	0.0	0.0	2.146	5.6358	0.0	0.0	0.827	2.1712

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
52	10	25	76	54.228	41.5842	14.052	10.7758	59.013	45.2531	1.432	1.0980
53	10	30	76	41.630	44.8345	11.651	12.5476	46.375	49.9448	1.310	1.4106

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4	25	76	29.501	315.1582	0.0	0.0	4.132	44.1417	0.127	1.3593
2	5	1	76	31.712	131.0432	1.885	7.7877	10.546	43.5776	0.262	1.0633
3	5	11	76	32.149	353.6558	2.875	31.6280	11.813	129.9487	0.289	3.1770
4	5	16	76	39.502	72.2548	19.541	35.7434	33.136	60.6098	0.737	1.3487
5	5	18	76	35.859	146.2063	11.283	46.0049	22.570	92.0261	0.515	2.1001
6	5	20	76	29.216	845.9346	0.0	0.0	3.307	95.7578	0.110	3.1819
7	5	25	76	47.943	51.6338	38.674	41.6514	57.615	62.0501	1.252	1.3486
8	5	29	76	51.249	42.2647	46.167	38.0740	67.201	55.4208	1.454	1.1990
9	6	1	76	44.392	61.6797	30.625	42.5513	47.316	65.7431	1.036	1.4389
10	6	15	76	29.039	3001.8862	0.0	0.0	2.794	288.8745	0.099	10.2451
11	6	16	76	29.286	1267.3452	0.0	0.0	3.511	151.9256	0.114	4.9408
12	6	17	76	30.063	662.5005	0.0	0.0	5.763	126.9949	0.162	3.5600
13	6	19	76	58.455	62.3008	62.500	66.6128	88.098	93.8951	1.893	2.0180
14	6	20	76	58.114	39.3624	61.728	41.8104	87.110	59.0025	1.873	1.2684
15	6	21	76	33.974	132.2524	7.012	27.2960	17.106	66.5882	0.400	1.5576
16	6	28	76	35.305	103.1722	10.027	29.3021	20.963	61.2615	0.481	1.4065
17	7	3	76	70.326	34.3075	89.410	43.6170	122.526	59.7724	2.618	1.2770
18	7	7	76	29.202	739.8494	0.0	0.0	3.265	82.7163	0.109	2.7616
19	7	7	76	47.117	51.3429	36.802	40.1028	55.220	60.1721	1.202	1.3096
20	7	7	76	71.121	11.6840	91.210	14.9843	124.830	20.5075	2.666	0.4380
21	7	8	76	28.348	2318.5776	0.0	0.0	0.789	64.4975	0.057	4.6551
22	7	10	76	28.359	2585.0105	0.0	0.0	0.822	74.9530	0.058	5.2525
23	7	11	76	32.129	44.8257	2.829	3.9468	11.754	16.3988	0.288	0.4012
24	7	15	76	29.504	214.7444	0.0	0.0	4.141	30.1414	0.127	0.9275
25	7	15	76	38.451	31.4737	17.159	14.0455	30.088	24.6284	0.673	0.5511
26	7	21	76	33.065	72.2910	4.951	10.8251	14.469	31.6345	0.345	0.7536
27	7	23	76	31.735	83.8041	1.935	5.1099	10.610	28.0192	0.264	0.6959
28	7	23	76	31.345	113.2888	1.051	3.7991	9.479	34.2613	0.240	0.8664
29	7	29	76	29.385	369.2175	0.0	0.0	3.796	47.6911	0.120	1.5099
30	8	6	76	32.293	161.0653	3.200	15.9625	12.229	60.9949	0.298	1.4841
31	8	8	76	40.384	53.7853	21.540	28.6883	35.693	47.5381	0.791	1.0536
32	8	9	76	31.711	144.5333	1.881	8.5717	10.541	48.0431	0.262	1.1944
33	8	13	76	47.775	46.4903	38.293	37.2632	57.127	55.5909	1.242	1.2086
34	8	14	76	38.650	53.9243	17.611	24.5704	30.666	42.7849	0.685	0.9562
35	8	15	76	57.488	24.7792	60.310	25.9956	85.296	36.7653	1.834	0.7907
36	9	10	76	36.904	63.9320	13.652	23.6503	25.601	44.3508	0.579	1.0028
37	9	15	76	64.560	20.5004	76.340	24.2409	105.805	33.5971	2.266	0.7195
38	9	17	76	31.651	133.0992	1.745	7.3365	10.367	43.5945	0.258	1.0866
39	9	20	76	28.647	1294.9851	0.0	0.0	1.655	74.8315	0.075	3.3971
40	9	26	76	31.642	142.4986	1.726	7.7726	10.343	46.5777	0.258	1.1613
41	9	27	76	29.944	241.7946	0.0	0.0	5.416	43.7359	0.154	1.2456
42	9	30	76	32.294	116.7780	3.203	11.5820	12.232	44.2335	0.298	1.0763
43	9	30	76	32.294	125.7102	3.203	12.4670	12.232	47.6158	0.298	1.1586
44	10	1	76	31.538	132.6249	1.489	6.2615	10.040	42.2190	0.252	1.0576
45	10	2	76	28.607	2339.7878	0.0	0.0	1.541	126.0072	0.073	5.9489
46	10	3	76	28.682	1241.1797	0.0	0.0	1.757	76.0452	0.077	3.3447
47	10	3	76	60.019	21.1445	66.047	23.2679	92.635	32.6350	1.989	0.7007
48	10	7	76	37.182	41.6281	14.282	15.9897	26.407	29.5648	0.596	0.6670
49	10	8	76	78.491	4.9821	107.915	6.8497	146.203	9.2800	3.116	0.1978
50	10	20	76	37.645	29.3760	15.332	11.9641	27.750	21.6548	0.624	0.4870
51	10	24	76	30.978	81.3526	0.221	0.5804	8.417	22.1048	0.217	0.5709
52	10	25	76	36.834	28.2455	13.494	10.3473	25.398	19.4763	0.575	0.4406

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
53	10	30	76	35.653	38.3974	10.816	11.6490	21.973	23.6646	0.503	0.5412

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4	25	76	0.0	0.0	8.003	85.4966	0.0	0.0	0.0	0.0
2	5	1	76	0.0	0.0	17.955	74.1964	0.018	0.0729	0.019	0.0800
3	5	11	76	0.031	0.3396	19.922	219.1502	0.024	0.2597	0.023	0.2559
4	5	16	76	0.558	1.0203	53.009	96.9605	0.124	0.2270	0.089	0.1622
5	5	18	76	0.297	1.2098	36.614	149.2876	0.074	0.3030	0.056	0.2294
6	5	20	76	0.0	0.0	6.723	194.6668	0.0	0.0	0.0	0.0
7	5	25	76	1.163	1.2523	90.994	97.9985	0.239	0.2579	0.164	0.1764
8	5	29	76	1.400	1.1543	105.869	87.3102	0.285	0.2347	0.193	0.1594
9	6	1	76	0.908	1.2620	75.013	104.2262	0.191	0.2653	0.132	0.1837
10	6	15	76	0.0	0.0	5.928	612.7585	0.0	0.0	0.0	0.0
11	6	16	76	0.0	0.0	7.039	304.6121	0.0	0.0	0.0	0.0
12	6	17	76	0.0	0.0	10.534	232.1304	0.0	0.0	0.005	0.1034
13	6	19	76	1.916	2.0422	138.296	147.3953	0.383	0.4083	0.257	0.2743
14	6	20	76	1.892	1.2813	136.762	92.6335	0.378	0.2563	0.254	0.1723
15	6	21	76	0.162	0.6293	28.135	109.5213	0.049	0.1890	0.040	0.1538
16	6	28	76	0.257	0.7510	34.120	99.7115	0.067	0.1950	0.051	0.1500
17	7	3	76	2.767	1.3498	191.719	93.5266	0.545	0.2660	0.363	0.1771
18	7	7	76	0.0	0.0	6.657	168.6720	0.0	0.0	0.0	0.0
19	7	7	76	1.104	1.2025	87.277	95.1046	0.228	0.2486	0.156	0.1705
20	7	7	76	2.824	0.4639	195.292	32.0834	0.556	0.0914	0.370	0.0608
21	7	8	76	0.0	0.0	2.815	230.2419	0.0	0.0	0.0	0.0
22	7	10	76	0.0	0.0	2.867	261.3633	0.0	0.0	0.0	0.0
23	7	11	76	0.029	0.0410	19.830	27.6667	0.023	0.0325	0.023	0.0322
24	7	15	76	0.0	0.0	8.017	58.3540	0.0	0.0	0.0	0.0
25	7	15	76	0.482	0.3949	48.280	39.5190	0.110	0.0898	0.079	0.0649
26	7	21	76	0.097	0.2110	24.044	52.5672	0.036	0.0790	0.031	0.0687
27	7	23	76	0.001	0.0030	18.055	47.6806	0.018	0.0474	0.020	0.0517
28	7	23	76	0.0	0.0	16.301	58.9157	0.013	0.0456	0.016	0.0582
29	7	29	76	0.0	0.0	7.481	93.9991	0.0	0.0	0.0	0.0
30	8	6	76	0.041	0.2053	20.568	102.5844	0.026	0.1275	0.025	0.1224
31	8	8	76	0.621	0.8271	56.978	75.8856	0.136	0.1813	0.097	0.1286
32	8	9	76	0.0	0.0	17.948	81.8029	0.018	0.0803	0.019	0.0882
33	8	13	76	1.151	1.1198	90.236	87.8103	0.237	0.2308	0.162	0.1580
34	8	14	76	0.497	0.6931	49.177	68.6106	0.112	0.1569	0.081	0.1132
35	8	15	76	1.847	0.7960	133.948	57.7356	0.370	0.1594	0.249	0.1072
36	9	10	76	0.372	0.6438	41.317	71.5770	0.089	0.1535	0.066	0.1136
37	9	15	76	2.354	0.7474	165.772	52.6387	0.467	0.1481	0.312	0.0990
38	9	17	76	0.0	0.0	17.678	74.3388	0.017	0.0706	0.019	0.0791
39	9	20	76	0.0	0.0	4.160	188.0568	0.0	0.0	0.0	0.0
40	9	26	76	0.0	0.0	17.640	79.4423	0.017	0.0751	0.019	0.0844
41	9	27	76	0.0	0.0	9.996	80.7166	0.0	0.0	0.004	0.0293
42	9	30	76	0.041	0.1491	20.573	74.3926	0.026	0.0925	0.025	0.0888
43	9	30	76	0.041	0.1605	20.572	80.0814	0.026	0.0996	0.025	0.0955
44	10	1	76	0.0	0.0	17.170	72.2044	0.015	0.0641	0.018	0.0749
45	10	2	76	0.0	0.0	3.982	325.6880	0.0	0.0	0.0	0.0
46	10	3	76	0.0	0.0	4.318	186.8667	0.0	0.0	0.0	0.0
47	10	3	76	2.028	0.7145	145.336	51.2012	0.404	0.1425	0.271	0.0956
48	10	7	76	0.392	0.4383	42.568	47.6580	0.092	0.1034	0.068	0.0762
49	10	8	76	3.352	0.2128	228.458	14.5010	0.657	0.0417	0.436	0.0277
50	10	20	76	0.425	0.3314	44.652	34.8441	0.099	0.0770	0.072	0.0563
51	10	24	76	0.0	0.0	14.653	38.4797	0.008	0.0200	0.013	0.0337
52	10	25	76	0.367	0.2811	41.003	31.4422	0.088	0.0672	0.065	0.0498
53	10	30	76	0.282	0.3037	35.688	38.4348	0.071	0.0770	0.054	0.0586

EVENT NUMBER	MO	DA	YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
1	4	25	76	0.0	0.0	0.0	0.0	0.012	0.1254	0.009	0.0919
2	5	1	76	0.0	0.0	0.0	0.0	0.017	0.0711	0.012	0.0477
3	5	11	76	0.186	2.0500	0.002	0.0166	0.018	0.2010	0.012	0.1335
4	5	16	76	3.618	6.6171	0.058	0.1059	0.036	0.0666	0.022	0.0401
5	5	18	76	1.917	7.8179	0.030	0.1221	0.027	0.1118	0.017	0.0696
6	5	20	76	0.0	0.0	0.0	0.0	0.011	0.3197	0.008	0.2381
7	5	25	76	7.557	8.1385	0.123	0.1320	0.057	0.0616	0.033	0.0357
8	5	29	76	9.099	7.5043	0.148	0.1220	0.065	0.0539	0.038	0.0310
9	6	1	76	5.900	8.1970	0.095	0.1325	0.048	0.0674	0.028	0.0395
10	6	15	76	0.0	0.0	0.0	0.0	0.011	1.0962	0.008	0.8255
11	6	16	76	0.0	0.0	0.0	0.0	0.011	0.4852	0.008	0.3598
12	6	17	76	0.0	0.0	0.0	0.0	0.013	0.2893	0.009	0.2061
13	6	19	76	12.462	13.2821	0.203	0.2166	0.083	0.0886	0.047	0.0503
14	6	20	76	12.303	8.3333	0.201	0.1359	0.082	0.0558	0.047	0.0317
15	6	21	76	1.038	4.0409	0.016	0.0604	0.023	0.0887	0.015	0.0567
16	6	28	76	1.659	4.8475	0.026	0.0751	0.026	0.0762	0.016	0.0477
17	7	3	76	18.002	8.7821	0.294	0.1435	0.112	0.0549	0.063	0.0308
18	7	7	76	0.0	0.0	0.0	0.0	0.011	0.2788	0.008	0.2078
19	7	7	76	7.171	7.8145	0.116	0.1267	0.055	0.0601	0.032	0.0350
20	7	7	76	18.373	3.0184	0.300	0.0493	0.114	0.0188	0.064	0.0105
21	7	8	76	0.0	0.0	0.0	0.0	0.009	0.7278	0.007	0.5777
22	7	10	76	0.0	0.0	0.0	0.0	0.009	0.8137	0.007	0.6453
23	7	11	76	0.177	0.2467	0.001	0.0019	0.018	0.0254	0.012	0.0169
24	7	15	76	0.0	0.0	0.0	0.0	0.012	0.0855	0.009	0.0626
25	7	15	76	3.127	2.5597	0.050	0.0408	0.034	0.0277	0.021	0.0168
26	7	21	76	0.614	1.3420	0.009	0.0187	0.021	0.0449	0.013	0.0292
27	7	23	76	0.0	0.0	0.0	0.0	0.017	0.0456	0.012	0.0306
28	7	23	76	0.0	0.0	0.0	0.0	0.016	0.0589	0.011	0.0400
29	7	29	76	0.0	0.0	0.0	0.0	0.011	0.1439	0.008	0.1061
30	8	6	76	0.253	1.2635	0.003	0.0130	0.019	0.0929	0.012	0.0615
31	8	8	76	4.029	5.3662	0.065	0.0861	0.039	0.0514	0.023	0.0308
32	8	9	76	0.0	0.0	0.0	0.0	0.017	0.0784	0.012	0.0526
33	8	13	76	7.478	7.2772	0.121	0.1180	0.057	0.0553	0.033	0.0321
34	8	14	76	3.220	4.4927	0.051	0.0716	0.034	0.0479	0.021	0.0290
35	8	15	76	12.011	5.1772	0.196	0.0844	0.081	0.0348	0.046	0.0198
36	9	10	76	2.405	4.1665	0.038	0.0658	0.030	0.0520	0.018	0.0320
37	9	15	76	15.311	4.8620	0.250	0.0794	0.098	0.0312	0.055	0.0176
38	9	17	76	0.0	0.0	0.0	0.0	0.017	0.0717	0.011	0.0482
39	9	20	76	0.0	0.0	0.0	0.0	0.010	0.4356	0.007	0.3373
40	9	26	76	0.0	0.0	0.0	0.0	0.017	0.0767	0.011	0.0516
41	9	27	76	0.0	0.0	0.0	0.0	0.013	0.1036	0.009	0.0742
42	9	30	76	0.254	0.9179	0.003	0.0095	0.019	0.0674	0.012	0.0446
43	9	30	76	0.254	0.9879	0.003	0.0102	0.019	0.0725	0.012	0.0480
44	10	1	76	0.0	0.0	0.0	0.0	0.017	0.0705	0.011	0.0476
45	10	2	76	0.0	0.0	0.0	0.0	0.010	0.7801	0.007	0.6060
46	10	3	76	0.0	0.0	0.0	0.0	0.010	0.4207	0.008	0.3249
47	10	3	76	13.192	4.6476	0.215	0.0758	0.087	0.0307	0.049	0.0174
48	10	7	76	2.535	2.8379	0.040	0.0449	0.031	0.0344	0.019	0.0211
49	10	8	76	21.812	1.3845	0.357	0.0226	0.133	0.0084	0.074	0.0047
50	10	20	76	2.751	2.1467	0.044	0.0341	0.032	0.0248	0.019	0.0152
51	10	24	76	0.0	0.0	0.0	0.0	0.015	0.0404	0.011	0.0278
52	10	25	76	2.372	1.8193	0.037	0.0287	0.030	0.0229	0.018	0.0141
53	10	30	76	1.821	1.9615	0.028	0.0306	0.027	0.0290	0.017	0.0181

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELOIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625


***************                  HARRISBURG - 1977                     ***************

                             SITE CHARACTERISTICS
                             --------------------
                             TOTAL DRAINAGE AREA(AC)          =      18.50
                             LENGTH OF HIGHWAY(MI)            =       0.38
                             AVERAGE DAILY TRAFFIC            =   24000.00
                             INTIAL POLLUTION LEVEL(LBS)      =       0.0
                             USER SUPPLIED K1 FACTOR          =      62.80

                             SITE TYPE SELECTED IS RURAL WITH FLUSH SHOULDERS.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 62.8000
K2 FACTOR FOR THIS SITE = 12.0000

EVENT NUMBER	MO	OA	YR	ORY DAYS	RAINFALL INCHES	RAIN OURAT HOURS	RUNOFF INCHES	RUNOFF OURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNOS WASHEO OFF
1	4	6	77	4.	1.20	6.42	0.482	15.680	0.03073	32359.3	0.0	95.46	29.44
2	4	7	77	1.	0.40	4.50	0.149	14.940	0.00999	10023.8	66.02	89.88	10.15
3	4	24	77	17.	0.82	8.25	0.091	13.780	0.00660	6111.6	79.73	485.42	36.98
4	4	25	77	1.	0.23	2.75	0.052	12.350	0.00424	3518.2	448.43	472.30	23.44
5	4	27	77	2.	0.05	0.50	0.002	9.020	0.00021	124.6	448.86	496.59	1.22
6	4	28	77	1.	0.35	6.00	0.116	15.680	0.00739	7786.0	495.36	519.23	44.08
7	5	4	77	6.	0.29	0.23	0.025	8.620	0.00292	1690.0	475.15	618.33	21.28
8	6	6	77	33.	0.45	6.00	0.019	13.780	0.00138	1272.6	597.05	1074.32	17.58
9	6	9	77	3.	0.31	6.00	0.045	15.680	0.00287	3016.9	1056.74	1128.33	38.13
10	6	14	77	5.	0.88	4.75	0.232	15.310	0.01513	15551.4	1090.20	1209.52	200.75
11	6	17	77	3.	0.33	1.25	0.051	10.130	0.00499	3395.7	1008.78	1080.37	62.81
12	6	20	77	3.	0.32	0.25	0.048	8.650	0.00552	3203.6	1017.56	1089.15	69.74
13	6	25	77	5.	0.64	1.34	0.127	10.263	0.01235	8513.4	1019.41	1138.73	156.86
14	6	25	77	0.	0.36	0.42	0.122	8.902	0.01374	8212.2	981.87	981.87	149.21

TOTAL RAINFALL OURING SIMULATION PERIOO (INCHES) = 6.63
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 1.56
TOTAL RUNOFF DURING SIMULATION PERIOO (CUBIC FEET)= 104779.06
POUNDS OF TOTAL SOLIOS OISCHARGED = 861.68

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4	6	77	0.0	0.0	0.0	0.0	0.0	0.0	0.641	0.3178
2	4	7	77	0.0	0.0	0.0	0.0	0.0	0.0	0.581	0.9302
3	4	24	77	0.0	0.0	0.0	0.0	0.0	0.0	0.665	1.7439
4	4	25	77	0.0	0.0	0.0	0.0	0.0	0.0	0.623	2.8380
5	4	27	77	0.0	0.0	0.0	0.0	0.0	0.0	0.554	71.2730
6	4	28	77	0.0	0.0	0.0	0.0	0.0	0.0	0.687	1.4142
7	5	4	77	0.0	0.0	0.0	0.0	0.0	0.0	0.616	5.8448
8	6	6	77	0.0	0.0	0.0	0.0	0.0	0.0	0.605	7.6170
9	6	9	77	0.0	0.0	0.0	0.0	0.0	0.0	0.668	3.5517
10	6	14	77	27.440	28.2941	8.946	9.2243	32.140	33.1413	1.172	1.2088
11	6	17	77	0.0	0.0	0.531	2.5085	0.0	0.0	0.745	3.5166
12	6	20	77	0.0	0.0	0.954	4.7760	0.0	0.0	0.766	3.8352
13	6	25	77	13.395	25.2310	6.268	11.8072	18.052	34.0027	1.036	1.9519
14	6	25	77	10.948	21.3772	5.802	11.3292	15.597	30.4555	1.013	1.9772

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4	6	77	29.183	14.4618	0.0	0.0	3.211	1.5913	0.108	0.0535
2	4	7	77	28.605	45.7607	0.0	0.0	1.533	2.4531	0.073	0.1161
3	4	24	77	29.409	77.1646	0.0	0.0	3.867	10.1473	0.122	0.3193
4	4	25	77	29.003	132.1932	0.0	0.0	2.689	12.2568	0.097	0.4416
5	4	27	77	28.337	3646.9138	0.0	0.0	0.756	97.3608	0.056	7.2381
6	4	28	77	29.622	61.0095	0.0	0.0	4.485	9.2374	0.135	0.2774
7	5	4	77	28.939	274.5889	0.0	0.0	2.502	23.7377	0.093	0.8820
8	6	6	77	28.827	363.2366	0.0	0.0	2.180	27.4643	0.086	1.0858
9	6	9	77	29.444	156.5054	0.0	0.0	3.967	21.0875	0.124	0.6579
10	6	14	77	34.322	35.3914	7.801	8.0439	18.115	18.6793	0.421	0.4345
11	6	17	77	30.184	142.5417	0.0	0.0	6.114	28.8736	0.169	0.7978
12	6	20	77	30.392	152.1279	0.0	0.0	6.717	33.6238	0.182	0.9091
13	6	25	77	33.006	62.1696	4.816	9.0723	14.297	26.9294	0.341	0.6424
14	6	25	77	32.776	64.0014	4.296	8.3894	13.631	26.6176	0.327	0.6386

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4	6	77	0.0	0.0	6.574	3.2578	0.0	0.0	0.0	0.0
2	4	7	77	0.0	0.0	3.971	6.3524	0.0	0.0	0.0	0.0
3	4	24	77	0.0	0.0	7.593	19.9213	0.0	0.0	0.0	0.0
4	4	25	77	0.0	0.0	5.764	26.2724	0.0	0.0	0.0	0.0
5	4	27	77	0.0	0.0	2.765	355.8862	0.0	0.0	0.0	0.0
6	4	28	77	0.0	0.0	8.551	17.6114	0.0	0.0	0.001	0.0016
7	5	4	77	0.0	0.0	5.473	51.9345	0.0	0.0	0.0	0.0
8	6	6	77	0.0	0.0	4.974	62.6689	0.0	0.0	0.0	0.0
9	6	9	77	0.0	0.0	7.747	41.1808	0.0	0.0	0.0	0.0
10	6	14	77	0.187	0.1924	29.701	30.6260	0.053	0.0550	0.043	0.0439
11	6	17	77	0.0	0.0	11.079	52.3189	0.0	0.0	0.006	0.0272
12	6	20	77	0.0	0.0	12.015	60.1405	0.0	0.0	0.008	0.0381
13	6	25	77	0.092	0.1738	23.776	44.7845	0.035	0.0665	0.031	0.0582
14	6	25	77	0.076	0.1480	22.744	44.4106	0.032	0.0628	0.029	0.0563

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	4	6	77	0.0	0.0	0.0	0.0	0.011	0.0054	0.008	0.0041
2	4	7	77	0.0	0.0	0.0	0.0	0.010	0.0152	0.007	0.0118
3	4	24	77	0.0	0.0	0.0	0.0	0.012	0.0302	0.008	0.0222
4	4	25	77	0.0	0.0	0.0	0.0	0.011	0.0479	0.008	0.0362
5	4	27	77	0.0	0.0	0.0	0.0	0.009	1.1416	0.007	0.9072
6	4	28	77	0.0	0.0	0.0	0.0	0.012	0.0248	0.009	0.0180
7	5	4	77	0.0	0.0	0.0	0.0	0.010	0.0983	0.008	0.0745
8	6	6	77	0.0	0.0	0.0	0.0	0.010	0.1270	0.008	0.0971
9	6	9	77	0.0	0.0	0.0	0.0	0.012	0.0617	0.009	0.0453
10	6	14	77	1.200	1.2379	0.018	0.0187	0.024	0.0244	0.015	0.0155
11	6	17	77	0.0	0.0	0.0	0.0	0.013	0.0634	0.010	0.0449
12	6	20	77	0.0	0.0	0.0	0.0	0.014	0.0698	0.010	0.0490
13	6	25	77	0.586	1.1039	0.008	0.0152	0.020	0.0384	0.013	0.0250
14	6	25	77	0.479	0.9352	0.006	0.0123	0.020	0.0387	0.013	0.0253

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***


 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELOIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625




***************                DENVER - 1976                                     ***************


                      SITE CHARACTERISTICS
                      --------------------
                      TOTAL DRAINAGE AREA(AC)            =      35.30
                      LENGTH OF HIGHWAY(MI)              =       0.68
                      AVERAGE DAILY TRAFFIC              =  149000.00
                      INTIAL POLLUTION LEVEL(LBS)        =       0.0
                      USER SUPPLIED K1 FACTOR            =       0.0

                      SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS AND INLETS ON PAVED AREA.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 281.3416
K2 FACTOR FOR THIS SITE = 6.5000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	8	2	76	1.	0.42	7.75	0.143	8.510	0.01684	18365.7	0.0	191.31	19.84
2	9	13	76	42.	0.15	0.75	0.025	2.585	0.00983	3255.2	171.48	3997.72	247.35
3	9	14	76	1.	0.13	0.42	0.029	2.693	0.01069	3687.8	3750.37	3941.68	264.45
4	9	15	76	1.	0.12	1.08	0.026	3.532	0.00730	3305.1	3677.23	3868.54	179.34
5	9	18	76	3.	0.20	0.33	0.047	2.579	0.01831	6052.7	3689.21	4263.14	478.42
6	9	19	76	1.	0.05	0.84	0.008	3.227	0.00241	996.9	3784.72	3976.03	61.82
7	9	19	76	0.	0.25	3.50	0.070	6.605	0.01067	9027.3	3914.21	3914.21	262.15
8	9	25	76	6.	0.23	3.50	0.054	6.605	0.00816	6905.9	3652.06	4799.93	247.92
9	9	25	76	0.	0.40	6.00	0.134	8.510	0.01575	17179.1	4552.02	4552.02	443.01
10	9	26	76	1.	0.05	1.00	0.008	3.430	0.00227	996.9	4109.00	4300.31	62.93
11	9	26	76	0.	1.11	8.00	0.542	8.510	0.06371	69474.6	4237.37	4237.37	1436.69
12	10	7	76	11.	0.15	5.75	0.028	7.090	0.00402	3651.7	2800.69	4905.12	126.48

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 3.26
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 1.12
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 142898.81
POUNDS OF TOTAL SOLIDS DISCHARGED = 3830.39

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	8	2	76	0.0	0.0	16.515	14.4199	248.217	216.7267	1.388	1.2122
2	9	13	76	0.0	0.0	51.098	251.7187	308.054	1517.5449	2.631	12.9587
3	9	14	76	0.0	0.0	53.696	233.4879	312.550	1359.0649	2.724	11.8443
4	9	15	76	0.0	0.0	40.760	197.7603	290.166	1407.8511	2.259	10.9613
5	9	18	76	113.404	300.4448	86.220	228.4248	368.824	977.1382	3.892	10.3117
6	9	19	76	0.0	0.0	22.897	368.2930	259.259	4170.1641	1.618	26.0181
7	9	19	76	0.0	0.0	53.347	94.7629	311.945	554.1255	2.711	4.8163
8	9	25	76	0.0	0.0	51.183	118.8493	308.202	715.6562	2.634	6.1154
9	9	25	76	91.098	85.0350	80.838	75.4579	359.512	335.5852	3.699	3.4527
10	9	26	76	0.0	0.0	23.065	371.0071	259.551	4174.8633	1.624	26.1156
11	9	26	76	717.113	165.5198	231.876	53.5204	620.849	143.3007	9.124	2.1060
12	10	7	76	0.0	0.0	32.725	143.7056	276.264	1213.1567	1.971	8.6534

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	8	2	76	28.895	25.2293	26.311	22.9729	279.128	243.7164	0.739	0.6451
2	9	13	76	35.721	175.9680	39.052	192.3780	323.039	1591.3662	1.035	5.0965
3	9	14	76	36.233	157.5545	40.009	173.9721	326.339	1419.0229	1.057	4.5952
4	9	15	76	33.680	163.4122	35.243	170.9948	309.912	1503.6580	0.946	4.5906
5	9	18	76	42.653	113.0008	51.991	137.7427	367.635	973.9868	1.335	3.5367
6	9	19	76	30.155	485.0356	28.662	461.0264	287.231	4620.1055	0.793	12.7613
7	9	19	76	36.165	64.2410	39.880	70.8417	325.895	578.9053	1.054	1.8719
8	9	25	76	35.737	82.9838	39.083	90.7528	323.148	750.3616	1.035	2.4040
9	9	25	76	41.590	38.8224	50.009	46.6804	360.801	336.7886	1.289	1.2031
10	9	26	76	30.188	485.5713	28.724	462.0259	287.446	4623.5469	0.795	12.7845
11	9	26	76	71.401	16.4803	105.654	24.3866	552.581	127.5435	2.581	0.5957
12	10	7	76	32.094	140.9359	32.283	141.7637	299.711	1316.1172	0.877	3.8530

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	8	2	76	0.0	0.0	87.833	76.6901	0.060	0.0526	0.115	0.1000
2	9	13	76	0.237	1.1653	97.389	479.7600	0.292	1.4399	0.247	1.2190
3	9	14	76	0.275	1.1958	98.107	426.5994	0.310	1.3468	0.257	1.1194
4	9	15	76	0.084	0.4052	94.532	458.6589	0.223	1.0816	0.208	1.0079
5	9	18	76	0.756	2.0041	107.094	283.7266	0.528	1.3988	0.382	1.0131
6	9	19	76	0.0	0.0	89.596	1441.1550	0.103	1.6577	0.139	2.2375
7	9	19	76	0.270	0.4793	98.010	174.1011	0.307	0.5460	0.256	0.4549
8	9	25	76	0.238	0.5522	97.412	226.1955	0.293	0.6801	0.248	0.5754
9	9	25	76	0.677	0.6317	105.607	98.5780	0.492	0.4591	0.362	0.3376
10	9	26	76	0.0	0.0	89.643	1441.9050	0.104	1.6759	0.140	2.2479
11	9	26	76	2.913	0.6723	147.341	34.0084	1.505	0.3475	0.942	0.2174
12	10	7	76	0.0	0.0	92.312	405.3694	0.169	0.7422	0.177	0.7767

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	8	2	76	0.0	0.0	0.037	0.0322	0.070	0.0614	0.022	0.0191
2	9	13	76	0.0	0.0	0.047	0.2297	0.142	0.7003	0.031	0.1541
3	9	14	76	0.183	0.7966	0.047	0.2060	0.148	0.6417	0.032	0.1392
4	9	15	76	0.0	0.0	0.044	0.2121	0.121	0.5855	0.028	0.1381
5	9	18	76	4.377	11.5962	0.057	0.1499	0.215	0.5701	0.041	0.1084
6	9	19	76	0.0	0.0	0.039	0.6218	0.084	1.3437	0.024	0.3792

EVENT NUMBER	MO	OA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CAOMIUM> LBS	<CAOMIUM> MG/L
7	9	19	76	0.138	0.2454	0.047	0.0840	0.147	0.2608	0.032	0.0567
8	9	25	76	0.0	0.0	0.047	0.1083	0.142	0.3305	0.031	0.0727
9	9	25	76	3.683	3.4379	0.055	0.0514	0.204	0.1904	0.039	0.0368
1C	9	26	76	0.0	0.0	0.039	0.6226	0.084	1.3493	0.024	0.3799
11	9	26	76	23.159	5.3454	0.098	0.0226	0.518	0.1196	0.081	0.0186
12	10	7	76	0.0	0.0	0.041	0.1820	0.104	0.4566	0.026	0.1153

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***


 DEVELOPED BY

               REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
               5103 WEST BELOIT ROAD
               MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
          NICHOLAS KOBRIGER
          PHONE 1-414-643-3625



***************                DENVER - 1977                                 ***************


                              SITE CHARACTERISTICS
                              --------------------
                              TOTAL DRAINAGE AREA(AC)          =      35.30
                              LENGTH OF HIGHWAY(MI)            =       0.68
                              AVERAGE DAILY TRAFFIC            =  149000.00
                              INTIAL POLLUTION LEVEL(LBS)      =    2000.00
                              USER SUPPLIED KI FACTOR          =       0.0

                              SITE TYPE SELECTED IS PAVED AND UNPAVED WITH CURBS AND INLETS ON PAVED AREA.
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 281.3416
K2 FACTOR FOR THIS SITE = 6.5000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	(TOTAL SOLIDS) POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	4	11	77	1.	0.29	2.67	0.086	5.551	0.01555	11061.2	2000.00	2191.31	210.65
2	4	12	77	1.	0.10	1.67	0.020	4.281	0.00469	2575.0	1960.66	2171.97	65.26
3	4	15	77	3.	0.46	6.25	0.148	8.510	0.01736	18930.3	2106.71	2680.64	286.01
4	4	19	77	4.	0.65	13.25	0.231	8.510	0.02719	29648.4	2394.63	3159.88	511.83
5	5	7	77	18.	0.20	0.25	0.041	2.055	0.01971	5190.2	2648.06	6091.68	732.45
6	5	14	77	7.	0.12	0.42	0.022	2.693	0.00810	2796.8	5359.22	6698.41	343.67
7	5	28	77	14.	0.13	0.33	0.023	2.140	0.01072	2940.6	6354.73	9033.11	608.18
8	6	5	77	8.	0.35	3.75	0.093	6.923	0.01350	11970.8	8424.92	9955.42	835.99
9	6	6	77	1.	0.08	0.25	0.015	2.477	0.00598	1897.2	9119.43	9310.74	354.70
10	6	9	77	3.	0.09	1.67	0.016	4.281	0.00370	2028.6	8956.04	9529.97	226.33
11	6	18	77	9.	0.20	2.83	0.043	5.754	0.00747	5508.3	9303.64	11025.45	522.54
12	6	23	77	5.	0.05	0.17	0.007	2.376	0.00285	868.4	10502.91	11459.47	210.48
13	7	5	77	12.	1.15	2.58	0.460	4.525	0.10162	58922.3	11248.99	13544.74	6547.57
14	7	20	77	15.	0.60	7.67	0.185	7.090	0.02611	23722.4	6997.17	9866.85	1540.10
15	7	24	77	4.	0.34	1.17	0.095	3.646	0.02614	12210.0	8326.75	9092.00	1420.35
16	7	25	77	1.	0.30	1.33	0.090	3.849	0.02349	11586.6	7671.65	7862.96	1113.37

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 5.11
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 1.58
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 201856.75
POUNDS OF TOTAL SOLIDS DISCHARGED = 15529.46

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	4	11	77	0.0	0.0	45.519	65.9905	298.402	432.6016	2.430	3.5231
2	4	12	77	0.0	0.0	23.420	145.8478	260.165	1620.1582	1.636	10.1902
3	4	15	77	0.0	0.0	56.974	48.2621	318.221	269.5627	2.842	2.4071
4	4	19	77	134.450	72.7189	91.297	49.3794	377.610	204.2354	4.075	2.2038
5	5	7	77	273.444	844.8311	124.832	385.6821	435.634	1345.9351	5.279	16.3105
6	5	14	77	28.511	163.4685	65.738	376.9062	333.385	1911.4612	3.156	18.0974
7	5	28	77	195.154	1064.2317	105.943	577.7410	402.951	2197.4138	4.601	25.0888
8	6	5	77	338.672	453.6746	140.570	188.3034	462.865	620.0393	5.844	7.8291
9	6	6	77	35.460	299.7244	67.414	569.8108	336.286	2842.4148	3.217	27.1884
10	6	9	77	0.0	0.0	47.902	378.6499	302.524	2391.3767	2.516	19.8863
11	6	18	77	141.200	411.0640	92.926	270.5273	380.428	1107.5056	4.133	12.0322
12	6	23	77	0.0	0.0	45.492	840.0955	298.355	5509.6562	2.429	44.8594
13	7	5	77	3936.969	1071.4463	1008.731	274.5259	1965.011	534.7778	37.030	10.0776
14	7	20	77	782.261	528.7869	247.595	167.3673	648.046	438.0608	9.689	6.5495
15	7	24	77	706.820	928.2832	229.393	301.2673	616.552	809.7319	9.035	11.8660
16	7	25	77	513.422	710.5664	182.732	252.8978	535.816	741.5593	7.359	10.1847

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	4	11	77	34.620	50.1890	36.997	53.6349	315.956	458.0503	0.987	1.4307
2	4	12	77	30.258	188.4294	28.855	179.6914	287.896	1792.8538	0.798	4.9685
3	4	15	77	36.880	31.2411	41.217	34.9143	330.500	279.9644	1.085	0.9189
4	4	19	77	43.655	23.6113	53.862	29.1321	374.082	202.3275	1.378	0.7455
5	5	7	77	50.274	155.3249	66.217	204.5846	416.663	1287.3210	1.665	5.1448
6	5	14	77	38.610	221.3707	44.445	254.8276	341.628	1958.7234	1.160	6.6495
7	5	28	77	46.545	253.8260	59.258	323.1519	392.679	2141.3938	1.504	8.1998
8	6	5	77	53.380	71.5057	72.015	96.4695	436.646	584.9170	1.800	2.4109
9	6	6	77	38.941	329.1436	45.063	380.8906	343.757	2905.5642	1.174	9.9240
10	6	9	77	35.090	277.3762	37.874	299.3865	318.981	2521.4675	1.007	7.9619
11	6	18	77	43.976	128.0240	54.462	158.5510	376.150	1095.0520	1.392	4.0533
12	6	23	77	34.614	639.2144	36.987	683.0232	315.922	5834.0586	0.987	18.2197
13	7	5	77	224.727	61.1595	391.864	106.6458	1538.981	418.8337	9.225	2.5105
14	7	20	77	74.503	50.3619	111.445	75.3341	572.539	387.0203	2.715	1.8354
15	7	24	77	70.910	93.1284	104.740	137.5569	549.427	721.5759	2.559	3.3614
16	7	25	77	61.701	85.3931	87.549	121.1657	490.180	678.4004	2.160	2.9899

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	4	11	77	0.154	0.2232	95.847	138.9528	0.255	0.3695	0.226	0.3277
2	4	12	77	0.0	0.0	89.741	558.8567	0.107	0.6637	0.141	0.8788
3	4	15	77	0.324	0.2741	99.012	83.8728	0.332	0.2810	0.270	0.2287
4	4	19	77	0.832	0.4498	108.497	58.6819	0.562	0.3040	0.402	0.2174
5	5	7	77	1.328	4.1030	117.763	363.8401	0.787	2.4318	0.531	1.6398
6	5	14	77	0.453	2.5987	101.434	581.5720	0.391	2.2392	0.304	1.7413
7	5	28	77	1.048	5.7173	112.544	613.7336	0.660	3.6011	0.458	2.4986
8	6	5	77	1.561	2.0910	122.111	163.5768	0.893	1.1958	0.591	0.7920
9	6	6	77	0.478	4.0409	101.897	861.2751	0.402	3.3961	0.310	2.6215
10	6	9	77	0.189	1.4958	96.506	762.8540	0.271	2.1410	0.235	1.8590
11	6	18	77	0.856	2.4912	108.947	317.1665	0.573	1.6681	0.408	1.1882
12	6	23	77	0.154	2.8359	95.840	1769.8562	0.255	4.7032	0.226	4.1720
13	7	5	77	14.412	3.9222	361.998	98.5177	6.719	1.8284	3.927	1.0687

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
14	7	20	77	3.145	2.1261	151.684	102.5343	1.611	1.0889	1.002	0.6776
15	7	24	77	2.876	3.7768	146.655	192.6050	1.489	1.9552	0.932	1.2247
16	7	25	77	2.185	3.0241	133.761	185.1235	1.176	1.6271	0.753	1.0424

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	4	11	77	0.0	0.0	0.045	0.0653	0.131	0.1893	0.030	0.0431
2	4	12	77	0.0	0.0	0.039	0.2417	0.085	0.5270	0.024	0.1477
3	4	15	77	0.606	0.5132	0.048	0.0409	0.154	0.1308	0.033	0.0279
4	4	19	77	5.032	2.7215	0.058	0.0314	0.226	0.1221	0.042	0.0229
5	5	7	77	9.356	28.9064	0.067	0.2085	0.295	0.9128	0.051	0.1590
6	5	14	77	1.736	9.9528	0.051	0.2911	0.173	0.9896	0.035	0.2024
7	5	28	77	6.920	37.7387	0.062	0.3389	0.256	1.3971	0.046	0.2525
8	6	5	77	11.385	15.2515	0.072	0.0964	0.328	0.4396	0.056	0.0747
9	6	6	77	1.952	16.4999	0.051	0.4332	0.176	1.4883	0.036	0.3022
10	6	9	77	0.0	0.0	0.046	0.3615	0.136	1.0712	0.030	0.2404
11	6	18	77	5.242	15.2600	0.058	0.1702	0.229	0.6670	0.043	0.1244
12	6	23	77	0.0	0.0	0.045	0.8319	0.131	2.4101	0.030	0.5495
13	7	5	77	123.332	33.5649	0.318	0.0864	2.133	0.5805	0.293	0.0798
14	7	20	77	25.186	17.0250	0.102	0.0691	0.551	0.3722	0.085	0.0575
15	7	24	77	22.839	29.9948	0.097	0.1275	0.513	0.6735	0.080	0.1052
16	7	25	77	16.822	23.2814	0.084	0.1161	0.416	0.5755	0.067	0.0932

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     DEPARTMENT OF TRANSPORTATION---PREDICTIVE PROCEDURE
FOR DETERMINING POLLUTANT CHARACTERISTICS IN HIGHWAY RUNOFF  *** RELEASE III ***

 DEVELOPED BY

             REXNORD,CORPORATE RESEARCH & DEVELOPMENT GROUP,ENVIRONMENTAL RESEARCH CENTER
             5103 WEST BELOIT ROAD
             MILWAUKEE,WISCONSIN ,53215

     IF ANY PROBLEMS OCCUR IN RUNNING THIS MODEL PLEASE CONTACT.
         NICHOLAS KOBRIGER
         PHONE 1-414-643-3625



***************             DALLAS,TEXAS - 1977 - MODEL CALCULATED              ***************

                            SITE CHARACTERISTICS
                            --------------------
                            TOTAL DRAINAGE AREA(AC)          =       2.26
                            LENGTH OF HIGHWAY(MI)            =       0.17
                            AVERAGE DAILY TRAFFIC            =   33000.00
                            INTIAL POLLUTION LEVEL(LBS)      =       0.0
                            USER SUPPLIED KI FACTOR          =       0.0

                            SITE.TYPE SELECTED IS AN ALL PAVED BRIDGE OR DECK
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QUANTITY RESULTS

K1 FACTOR FOR THIS SITE = 73.5488
K2 FACTOR FOR THIS SITE = 5.0000

EVENT NUMBER	MO	DA	YR	DRY DAYS	RAINFALL INCHES	RAIN DURAT HOURS	RUNOFF INCHES	RUNOFF DURAT HOURS	AVE.RUNOFF INTENSITY INCHES/HOUR	RUNOFF CUBIC FEET	<TOTAL SOLIDS> POUNDS AFTER PREVIOUS STORM	POUNDS AT START OF STORM	POUNDS WASHED OFF
1	6	15	77	3.	0.40	1.15	0.369	1.978	0.18650	3026.4	0.0	37.51	22.75
2	6	23	77	8.	0.19	0.10	0.165	0.802	0.20625	1357.0	14.76	114.79	73.86
3	7	9	77	16.	0.08	0.05	0.059	0.746	0.07885	482.5	40.93	240.99	78.51
4	7	21	77	12.	1.05	0.35	0.999	1.082	0.92306	8193.5	162.48	312.52	309.42
5	7	26	77	5.	1.13	0.45	1.076	1.194	0.90140	8829.5	3.10	65.61	64.89
6	7	27	77	1.	1.35	1.20	1.289	2.034	0.63395	10578.4	0.72	13.23	12.67
7	8	1	77	5.	0.25	0.45	0.224	1.194	0.18723	1834.0	0.56	63.07	39.34
8	8	14	77	13.	0.05	1.00	0.030	1.810	0.01644	244.1	24.74	187.28	14.77
9	8	18	77	4.	0.16	0.55	0.136	1.306	0.10440	1118.5	172.50	222.52	90.48
10	8	20	77	2.	1.33	3.18	1.270	4.252	0.29873	10419.4	132.04	157.04	121.77
11	8	22	77	2.	0.33	0.16	0.301	0.869	0.34638	2469.9	35.27	60.28	49.61
12	8	22	77	0.	0.24	0.13	0.214	0.836	0.25594	1754.5	10.67	10.67	7.70
13	8	28	77	6.	0.18	0.10	0.156	0.802	0.19416	1277.5	2.97	77.99	48.44

TOTAL RAINFALL DURING SIMULATION PERIOD (INCHES) = 6.74
TOTAL RUNOFF DURING SIMULATION PERIOD (INCHES) = 6.29
TOTAL RUNOFF DURING SIMULATION PERIOD (CUBIC FEET) = 51585.11
POUNDS OF TOTAL SOLIDS DISCHARGED = 933.21

QUALITY ANALYSIS

EVENT NUMBER	MO	DA	YR	<SS> LBS	<SS> MG/L	<VSS> LBS	<VSS> MG/L	<TVS> LBS	<TVS> MG/L	<TKN> LBS	<TKN> MG/L
1	6	15	77	8.855	46.9212	4.544	24.0795	18.327	97.1075	0.235	1.2455
2	6	23	77	35.943	424.7478	14.306	169.0606	29.622	350.0476	0.404	4.7708
3	7	9	77	38.409	1276.3972	15.195	504.9539	30.650	1018.5530	0.419	13.9265
4	7	21	77	160.794	314.6934	59.300	116.0568	81.683	159.8624	1.181	2.3115
5	7	26	77	31.190	56.6466	12.594	22.8718	27.640	50.1988	0.374	0.6795
6	7	27	77	3.516	5.3297	2.620	3.9720	16.100	24.4065	0.202	0.3059
7	8	1	77	17.119	149.6804	7.522	65.7736	21.772	190.3732	0.287	2.5052
8	8	14	77	4.630	304.2214	3.022	198.5446	16.565	1088.3767	0.209	13.7158
9	8	18	77	44.754	641.6331	17.482	250.6306	33.296	477.3574	0.459	6.5746
10	8	20	77	61.340	94.4038	23.459	36.1036	40.212	61.8872	0.562	0.8647
11	8	22	77	23.093	149.9278	9.675	62.8162	24.264	157.5292	0.324	2.1017
12	8	22	77	0.881	8.0551	1.671	15.2711	15.002	137.1160	0.185	1.6947
13	8	28	77	22.476	282.1267	9.453	118.6582	24.006	301.3384	0.320	4.0151

EVENT NUMBER	MO	DA	YR	<BOD5> LBS	<BOD5> MG/L	<TOC> LBS	<TOC> MG/L	<COD> LBS	<COD> MG/L	<TN> LBS	<TN> MG/L
1	6	15	77	2.023	10.7200	2.097	11.1087	10.065	53.3291	0.151	0.8010
2	6	23	77	3.199	37.7991	5.010	59.2010	20.389	240.9372	0.221	2.6137
3	7	9	77	3.306	109.8527	5.275	175.2947	21.329	708.7817	0.228	7.5620
4	7	21	77	8.617	16.8640	18.437	36.0836	67.974	133.0322	0.544	1.0645
5	7	26	77	2.992	5.4347	4.499	8.1701	18.577	33.7392	0.209	0.3794
6	7	27	77	1.791	2.7156	1.522	2.3076	8.030	12.1721	0.137	0.2082
7	8	1	77	2.382	20.8254	2.985	26.1019	13.214	115.5406	0.173	1.5085
8	8	14	77	1.840	120.8810	1.642	107.8925	8.454	555.4783	0.140	9.2142
9	8	18	77	3.581	51.3405	5.957	85.4092	23.747	340.4541	0.244	3.4976
10	8	20	77	4.301	6.6190	7.741	11.9137	30.068	46.2758	0.287	0.4414
11	8	22	77	2.641	17.1465	3.628	23.5526	15.491	100.5741	0.188	1.2203
12	8	22	77	1.677	15.3287	1.239	11.3238	7.026	64.2129	0.131	1.1932
13	8	28	77	2.614	32.8150	3.561	44.7038	15.256	191.4989	0.186	2.3394

EVENT NUMBER	MO	DA	YR	<TPO4> LBS	<TPO4> MG/L	<CHLORIDES> LBS	<CHLORIDES> MG/L	<LEAD> LBS	<LEAD> MG/L	<ZINC> LBS	<ZINC> MG/L
1	6	15	77	0.023	0.1207	3.363	17.8213	0.103	0.5478	0.033	0.1754
2	6	23	77	0.074	0.8731	5.101	60.2802	0.390	4.6038	0.076	0.8986
3	7	9	77	0.079	2.6099	5.259	174.7734	0.416	13.8125	0.080	2.6568
4	7	21	77	0.309	0.6056	13.110	25.6586	1.709	3.3443	0.274	0.5361
5	7	26	77	0.065	0.1179	4.796	8.7106	0.339	0.6163	0.069	0.1244
6	7	27	77	0.013	0.0193	3.021	4.5793	0.047	0.0712	0.025	0.0374
7	8	1	77	0.038	0.3355	3.893	34.0434	0.191	1.6673	0.046	0.4040
8	8	14	77	0.015	0.9727	3.092	203.1750	0.059	3.8591	0.026	1.7352
9	8	16	77	0.091	1.2976	5.666	81.2366	0.483	6.9202	0.090	1.2904
10	8	20	77	0.122	0.1875	6.730	10.3581	0.658	1.0126	0.116	0.1790
11	8	22	77	0.050	0.3223	4.277	27.7661	0.254	1.6478	0.056	0.3614
12	8	22	77	0.008	0.0707	2.852	26.0655	0.019	0.1748	0.020	0.1871
13	8	28	77	0.048	0.6085	4.237	53.1864	0.247	3.1041	0.055	0.6865

EVENT NUMBER	MO	DA	YR	<IRON> LBS	<IRON> MG/L	<CHROMIUM> LBS	<CHROMIUM> MG/L	<COPPER> LBS	<COPPER> MG/L	<CADMIUM> LBS	<CADMIUM> MG/L
1	6	15	77	0.931	4.9340	0.005	0.0256	0.007	0.0388	0.002	0.0095
2	6	23	77	1.698	20.0635	0.013	0.1538	0.022	0.2617	0.009	0.1056
3	7	9	77	1.768	58.7406	0.014	0.4573	0.023	0.7809	0.010	0.3187

EVENT NUMBER	MO	DA	YR	<IRON> LBS	MG/L	<CHROMIUM> LBS	MG/L	<COPPER> LBS	MG/L	<CADMIUM> LBS	MG/L
4	7	21	77	5.231	10.2384	0.051	0.0992	0.090	0.1770	0.042	0.0820
5	7	26	77	1.563	2.8392	0.012	0.0210	0.020	0.0355	0.008	0.0140
6	7	27	77	0.780	1.1825	0.003	0.0049	0.004	0.0067	0.000	0.0006
7	8	1	77	1.165	10.1870	0.007	0.0641	0.012	0.1036	0.004	0.0347
8	8	14	77	0.812	53.3254	0.004	0.2342	0.005	0.3295	0.001	0.0439
9	8	18	77	1.947	27.9165	0.016	0.2248	0.027	0.3867	0.011	0.1615
10	8	20	77	2.417	3.7192	0.021	0.0318	0.036	0.0555	0.016	0.0241
11	8	22	77	1.334	8.6618	0.009	0.0593	0.015	0.0981	0.006	0.0360
12	8	22	77	0.706	6.4483	0.002	0.0222	0.003	0.0271	0.0	0.0
13	6	28	77	1.317	16.5275	0.009	0.1124	0.015	0.1855	0.005	0.0676

APPENDIX H
FLOW, TOTAL RAIN AND DRY DAYS SCALLERGRAM FOR TYPE II SITES

Scatter plots are presented in this appendix to:

1. Show the tendency of the Nashville dry day and rainfall data to cluster.

2. Show why the Nashville data tended to skew the Type II equation for predicting runoff volume with total rain and dry days since the last storm event.

The scatter plots in this appendix (Figures H-1 to H-4) present all log transformed data using log scales on both the X-axis and Y-axis. Data points on each graph are represented by the letter "A" for single data points and by the letter "B" if two values fall on the same data point. These scatter plots were produced using the scatter plot option of the Statistical Analysis System Program (SAS) during regression analyses of monitored data.

Figure H-1 shows the scatter plot of Nashville dry day and flow data. The data form two distinct clusters. One cluster forms around the X-axis and represents the numerous data points for rainfall events which occur after no dry days. The second cluster which appears in the center of the plot represents rainfall events occurring after a dry day period. This scatter plot shows the atypical rainfall pattern of Nashville as compared to the Milwaukee and Denver sites. At Nashville a dry period consisting of 5 to 17 dry days was normally followed by a rain period lasting 3 to 6 days. Data collected at the Milwaukee and Denver sites did not consistently exhibit these extended rainfall periods.

Figure H-2 which plots the Nashville rain and flow data shows a strong relationship between these two parameters. Figure H-3 also displays a strong relationship when these same two parameters are plotted for the combined Milwaukee Hwy. 45 and Denver data. However, when the data from all three sites is plotted (Figure H-4), the strong relationship observed on the previous two plots is lost due to a skewing of the data to the lower portion of the scatter.

The scatter plot analyses explain, at least partially, why the significance of a Type II equation predicting runoff volume from total rainfall and dry days decreased when the Nashville data was combined with the Milwaukee Hwy. 45 and Denver data.

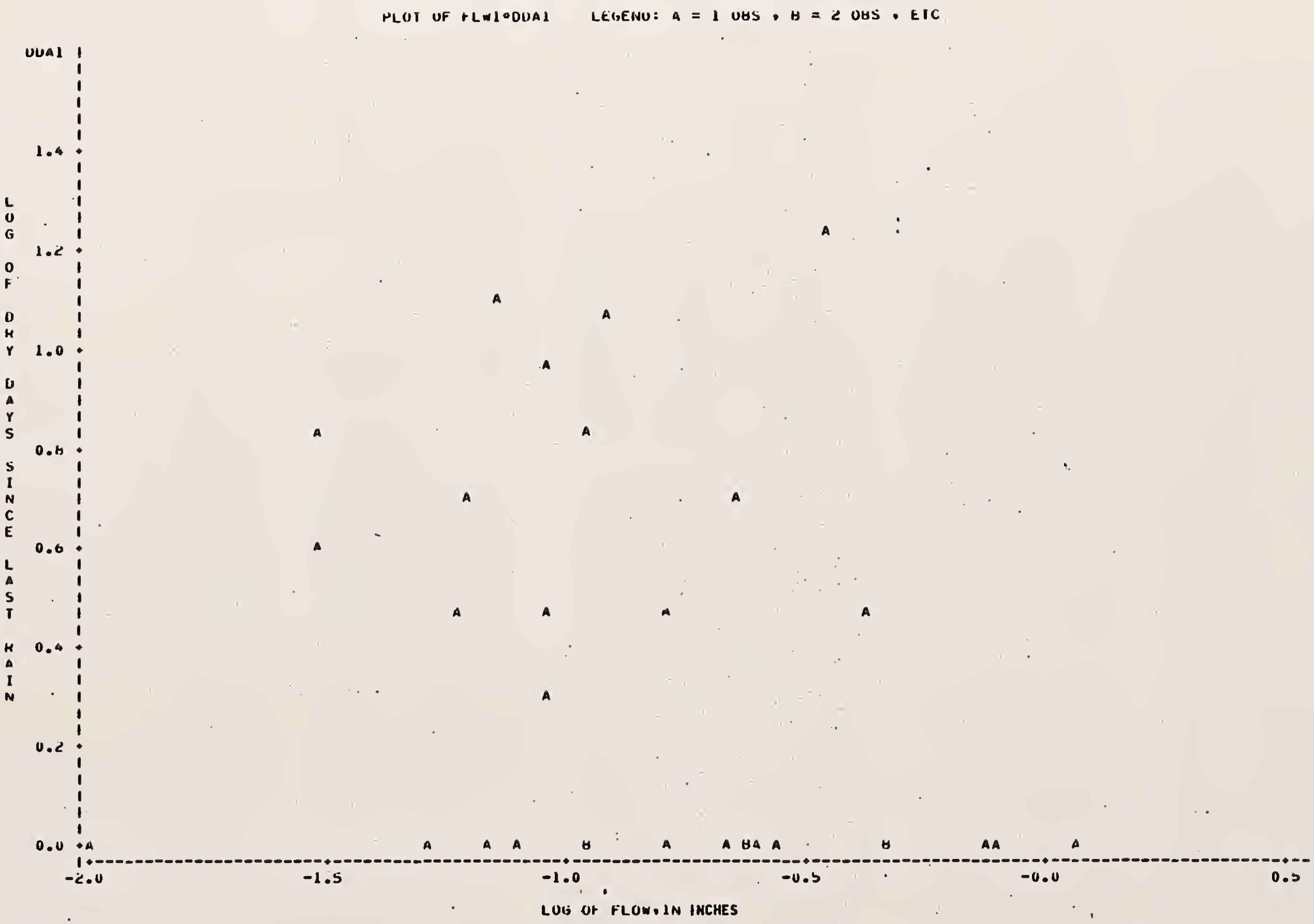

Figure H-1. Scatter plot of Nashville I-40 dry day and flow data.

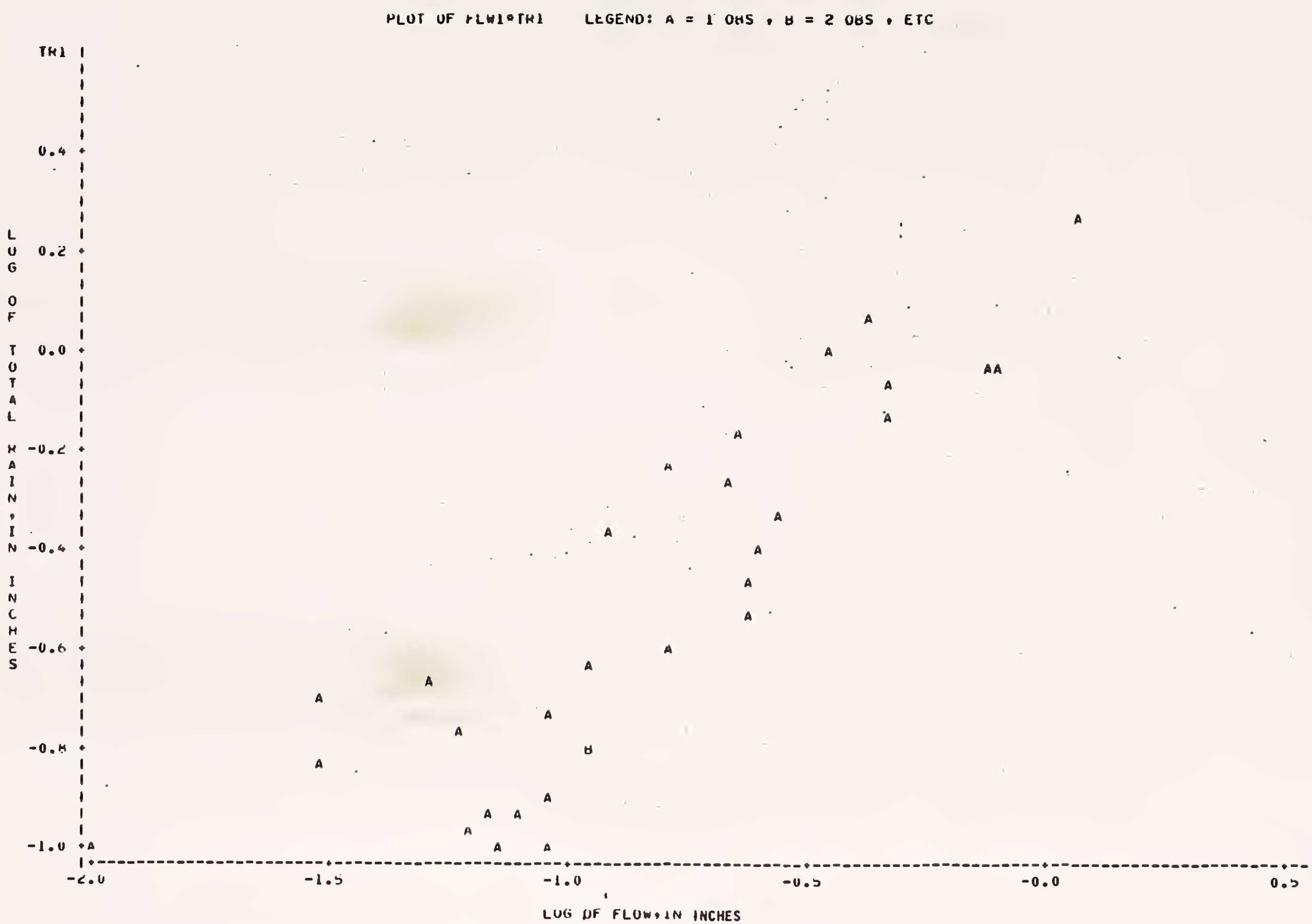

Figure H-2. Scatter plot of Nashville I-40 total rain and flow data.

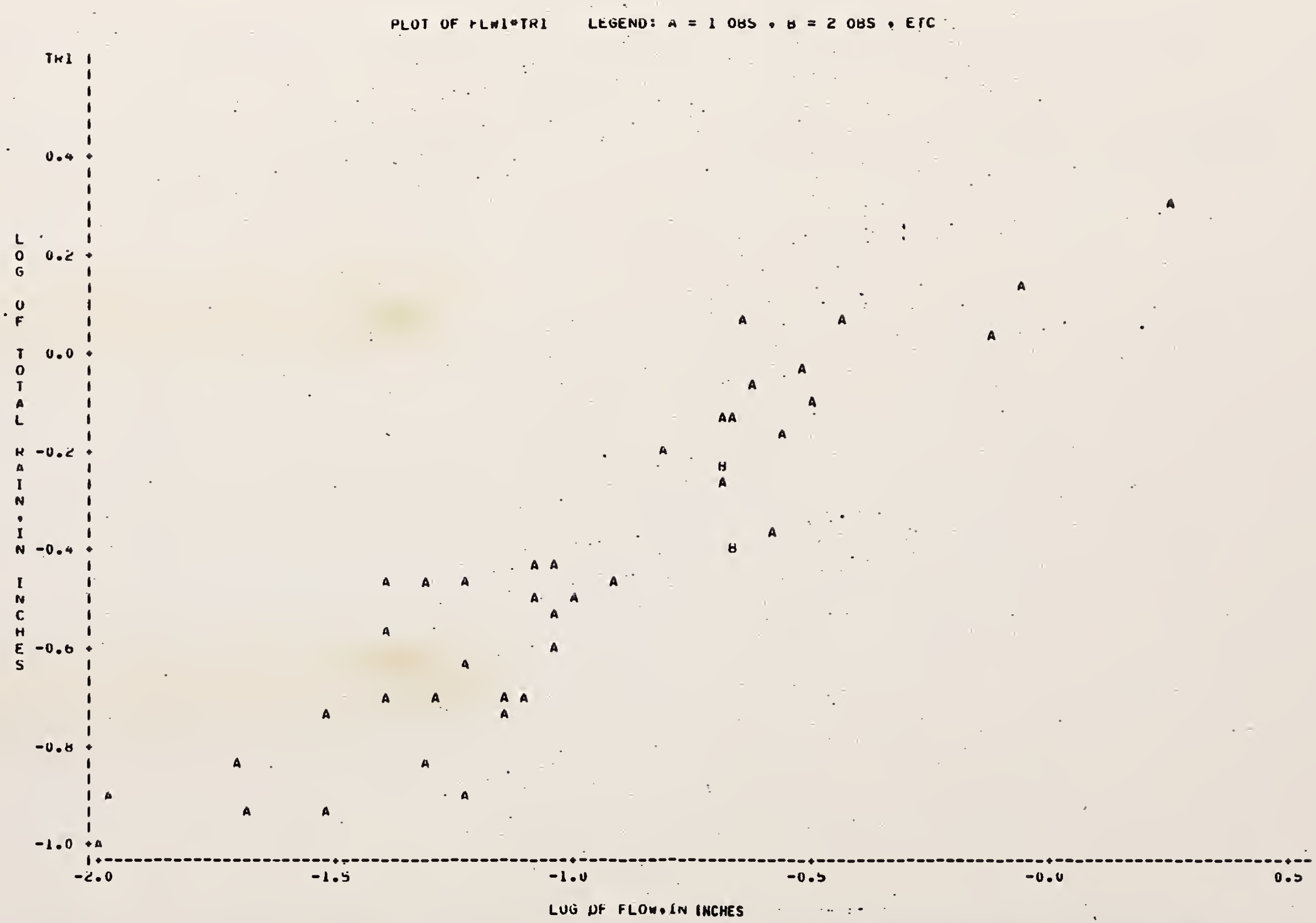

Figure H-3. Scatter plot of flow and total rain for the Milwaukee Hwy. 45 and Denver I-25 sites.

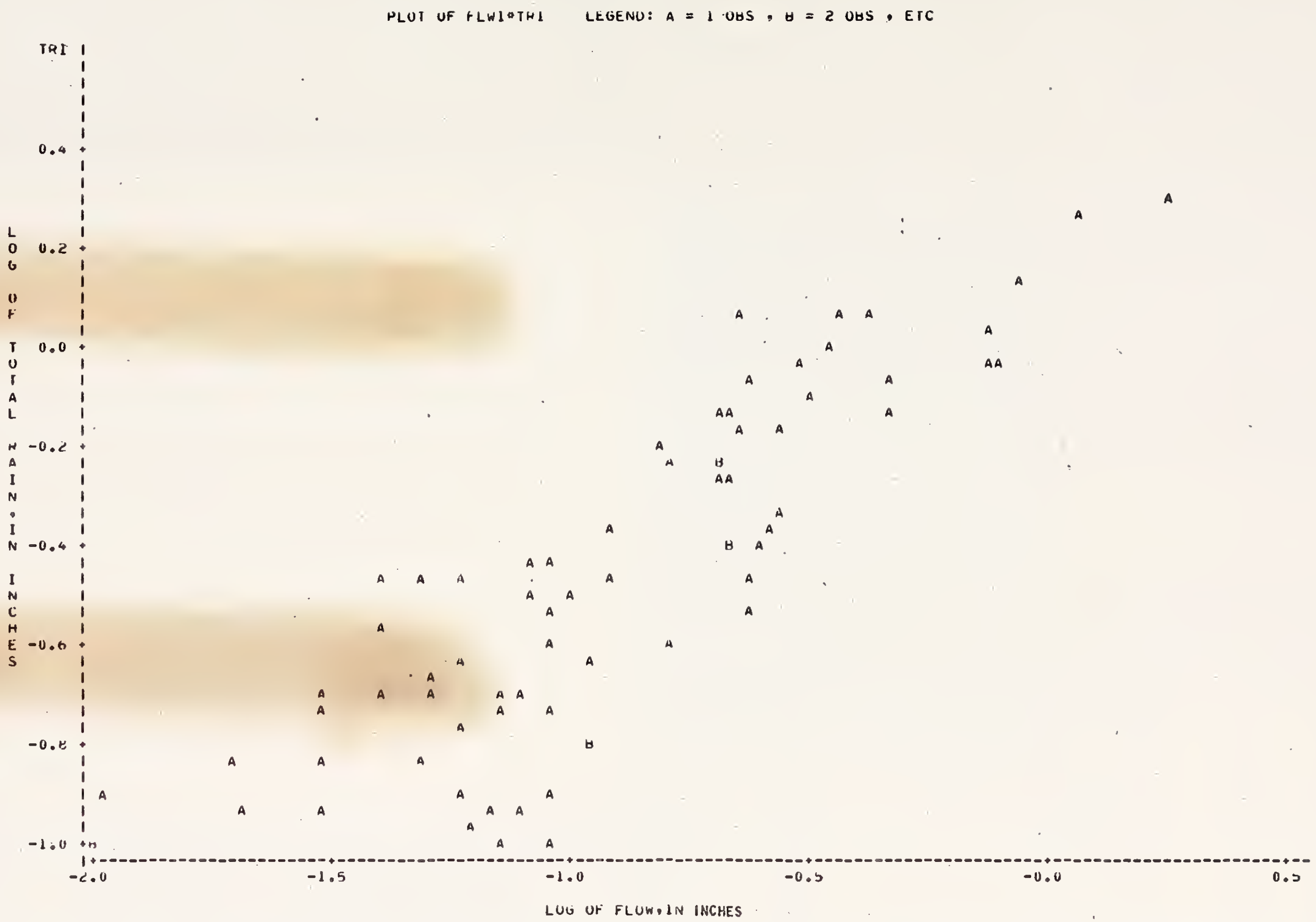

Figure H-4. Scatter plot of flow and total rain for the Nashville I-40, Milwaukee Hwy. 45 and Denver I-25 sites.

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FEDERALLY COORDINATED PROGRAM (FCP) OF HIGHWAY RESEARCH AND DEVELOPMENT

The Offices of Research and Development (R&D) of the Federal Highway Administration (FHWA) are responsible for a broad program of staff and contract research and development and a Federal-aid program, conducted by or through the State highway transportation agencies, that includes the Highway Planning and Research (HP&R) program and the National Cooperative Highway Research Program (NCHRP) managed by the Transportation Research Board. The FCP is a carefully selected group of projects that uses research and development resources to obtain timely solutions to urgent national highway engineering problems.*

The diagonal double stripe on the cover of this report represents a highway and is color-coded to identify the FCP category that the report falls under. A red stripe is used for category 1, dark blue for category 2, light blue for category 3, brown for category 4, gray for category 5, green for categories 6 and 7, and an orange stripe identifies category 0.

FCP Category Descriptions

1. Improved Highway Design and Operation for Safety

Safety R&D addresses problems associated with the responsibilities of the FHWA under the Highway Safety Act and includes investigation of appropriate design standards, roadside hardware, signing, and physical and scientific data for the formulation of improved safety regulations.

2. Reduction of Traffic Congestion, and Improved Operational Efficiency

Traffic R&D is concerned with increasing the operational efficiency of existing highways by advancing technology, by improving designs for existing as well as new facilities, and by balancing the demand-capacity relationship through traffic management techniques such as bus and carpool preferential treatment, motorist information, and rerouting of traffic.

3. Environmental Considerations in Highway Design, Location, Construction, and Operation

Environmental R&D is directed toward identifying and evaluating highway elements that affect the quality of the human environment. The goals are reduction of adverse highway and traffic impacts, and protection and enhancement of the environment.

4. Improved Materials Utilization and Durability

Materials R&D is concerned with expanding the knowledge and technology of materials properties, using available natural materials, improving structural foundation materials, recycling highway materials, converting industrial wastes into useful highway products, developing extender or substitute materials for those in short supply, and developing more rapid and reliable testing procedures. The goals are lower highway construction costs and extended maintenance-free operation.

5. Improved Design to Reduce Costs, Extend Life Expectancy, and Insure Structural Safety

Structural R&D is concerned with furthering the latest technological advances in structural and hydraulic designs, fabrication processes, and construction techniques to provide safe, efficient highways at reasonable costs.

6. Improved Technology for Highway Construction

This category is concerned with the research, development, and implementation of highway construction technology to increase productivity, reduce energy consumption, conserve dwindling resources, and reduce costs while improving the quality and methods of construction.

7. Improved Technology for Highway Maintenance

This category addresses problems in preserving the Nation's highways and includes activities in physical maintenance, traffic services, management, and equipment. The goal is to maximize operational efficiency and safety to the traveling public while conserving resources.

0. Other New Studies

This category, not included in the seven-volume official statement of the FCP, is concerned with HP&R and NCHRP studies not specifically related to FCP projects. These studies involve R&D support of other FHWA program office research.

* The complete seven-volume official statement of the FCP is available from the National Technical Information Service, Springfield, Va. 22161. Single copies of the introductory volume are available without charge from Program Analysis (HRD-3), Offices of Research and Development, Federal Highway Administration, Washington, D.C. 20590.